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Energy Consumption and Economic Growth Nexus in Nigeria: A Time-Series Analysis

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ABSTRACT

This study examines the relationship between energy consumption and economic growth in Nigeria over the period spanning 1990 to 2022. It specifically investigates the roles of electricity consumption and natural gas consumption within an Autoregressive Distributed Lag (ARDL) framework. The study employs annual time-series data sourced from the World Development Indicators. Unit root tests reveal a mixture order of integration, of I(0) and I(1) among the variables, justifying the application of the ARDL bounds testing approach. The findings reveal the existence of a long-term relationship among the variables. Empirical results show that electricity consumption exerts a positive and statistically significant effect on economic growth, particularly through its lagged values, while natural gas consumption remains statistically insignificant. The study concludes that electricity supply is crucial to enhance Nigeria's economic performance, whereas inefficiencies in gas utilization limit its growth impact. Policy recommendations emphasize the need for improved electricity infrastructure, enhanced energy efficiency, and better integration of gas resources into the Nigerian economy.

Keywords: ARDL, Energy Consumption, Economic Growth, Electricity, Natural Gas, Nigeria

INTRODUCTION

Energy lies at the heart of modern economic existence, serving as a fundamental driver of production, consumption, and overall economic performance. It powers industrial machinery, transportation systems, households, and digital infrastructure, making it indispensable to both developed and developing economies. As such, the availability, accessibility, and efficient utilization of energy have become critical determinants of economic growth and sustainability (Ishioro, 2023; Babatunde, 2016; Ashakah *et al.* 2025). No economy can achieve sustained development without a reliable energy supply, a reality that became particularly evident following the 1973 oil crisis, which exposed the vulnerability of economies to energy shocks and underscored the strategic importance of energy in economic planning (Aliyu, Lawal & Beki, 2018; Erbaykal, 2007).

Over time, global demand for energy has continued to rise, driven by population growth, urbanization, industrial expansion, and improvements in living standards. While developed economies have made significant progress in diversifying and stabilizing their energy systems, many developing regions, especially Africa, still face persistent energy challenges. Despite being richly endowed with energy resources such as solar, wind, hydro, coal, natural gas, and petroleum, Africa remains one of the most energy-deficient regions in the world (Esso & Loesse, 2017; Akinlo, 2018). Access to electricity is limited, particularly in rural areas, and energy supply is often unreliable. This paradox of resource abundance alongside energy poverty continues to constrain economic development across the continent (World Bank, 2020b).

Energy utilization across Africa varies by region, with fossil fuels dominating in Northern and Western Africa, hydropower in Central and Eastern Africa, and coal in Southern Africa (Akinlo, 2008; Esso & Loesse, 2017). However, a common challenge persists in the form of inadequate infrastructure, inefficient energy systems, and low levels of investment. As a result, over 500 million people lack access to reliable electricity (Chinedu, Daniel & Ezekwe, 2019). This limited access not only hinders industrialization and productivity but also worsens inequality, as energy distribution tends to favour urban and wealthier populations.

These energy challenges have contributed to the slow and unstable economic growth observed in many African countries. Sub-Saharan Africa accounts for only about 2% of global GDP, with growth patterns often characterized by volatility and susceptibility to both internal and external shocks (World Bank, 2015; IMF, 2018). This raises important questions about the extent to which energy consumption drives economic growth in the region and whether improving energy access can significantly enhance economic performance.

Nigeria provides a particularly important case within this context. As the largest economy in Africa and a country richly endowed with oil, natural gas, coal, and renewable resources, Nigeria should, in theory, enjoy energy security and strong economic growth. In reality, however, the country faces a persistent energy crisis marked by unreliable electricity supply, inefficiencies in generation and distribution, and heavy dependence on fossil fuels (Odularu & Okonkwo, 2019; Ukoima & Agwu, 2018). Frequent power outages and reliance on self-generated electricity have increased production costs and constrained economic activities.

Despite rising energy consumption, especially in petroleum products, Nigeria's economic growth has remained inconsistent. The country has experienced fluctuations in GDP growth, including contractions such as -1.6% in 2016 and -1.79% in 2020 (Central Bank of Nigeria, 2020; World Bank, 2020a). This apparent disconnect between increasing energy use and unstable economic performance raises a critical question: does energy consumption truly drive economic growth in Nigeria, or are structural inefficiencies limiting its impact?

From a theoretical perspective, several hypotheses explain the nexus between energy use and economic growth. Theoretically, energy consumption is expected to positively influence economic growth by enhancing productivity, reducing operational constraints, and supporting technological advancement (Ismail & Hassan, 2016).

This theory which is known as the growth hypothesis postulates that energy consumption drives economic growth, implying that reductions in energy consumption could adversely affect economic performance. The conservation hypothesis on the other hand posits that economic advancement leads to increased energy consumption, implying that energy conservation policies may not harm economic growth. Empirical evidence remains mixed.

While some studies report a positive and even bidirectional relationship between energy consumption and growth, others find weak, unidirectional, or insignificant relationships (Akinlo, 2008; Esso & Loesse, 2017). These inconsistencies suggest that the energy–growth relationship is complex and may vary depending on country-specific factors.

In Nigeria, this complexity is further intensified by structural challenges such as inadequate infrastructure, unstable power supply, and volatility in energy prices, particularly premium motor spirit (PMS). These issues create an uncertain business environment, limiting firms' ability to operate efficiently and reducing overall economic productivity. Although various government policies and reforms have been introduced to address these challenges, their impact has remained limited (National Bureau of Statistics, 2021).

Against this backdrop, this study examines the relationship between energy consumption and economic growth in Nigeria, with particular emphasis on electricity and natural gas consumption. By utilizing time series data over an extended period, the study aims to provide empirical evidence on how different forms of energy consumption influence economic performance.

The significance of this study lies in its potential to inform policy and contribute to the broader understanding of energy's role in economic development. As Nigeria continues to pursue economic diversification and sustainable growth, improving energy efficiency and reliability remains essential. This study therefore provides insights that can guide policymakers in designing effective energy strategies, enhancing infrastructure, and promoting investment in the sector.

In summary, this paper contributes to the literature by offering a comprehensive empirical analysis of the energy–growth relationship in Nigeria, highlighting key structural challenges, and providing policy-relevant

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recommendations. It ultimately seeks to deepen understanding of how energy consumption shapes economic performance and what this implies for sustainable development.

LITERATURE REVIEW AND THEORETICAL FRAMEWORK

Review of Empirical Literature

Empirical investigations into the relationship between energy consumption, economic growth, and quality of life have produced a rich but often conflicting body of evidence. Across countries and methodological approaches, scholars have attempted to determine whether energy acts as a catalyst for development, a passive input, or, in some cases, an inefficiently utilized resource with limited developmental returns. What emerges from this extensive literature is not a single unified conclusion, but rather a spectrum of outcomes shaped by country-specific realities, energy composition, and institutional frameworks.

A useful starting point in this discourse is the strand of literature that examines the link between energy consumption and quality of life, often proxied by indicators such as life expectancy and the Human Development Index (HDI). Early cross-country evidence by Mazur (2011), using Pearson correlation analysis for industrialized economies, suggests that beyond a certain threshold, increased energy and electricity consumption does not necessarily translate into improved life expectancy. This finding introduces the notion of diminishing returns to energy use, particularly in already energy-sufficient economies. In a similar vein, Qiaosheng, Maslyuk and Clulow (2012), employing the Lorenz curve and Gini coefficient across 129 countries, demonstrate that the energy–human development relationship is non-linear: while low-income countries experience substantial HDI gains from increased energy consumption, such gains taper off in middle- and high-income economies.

However, evidence from developing regions, especially Africa, tends to paint a different picture. Studies such as Seng and Meisen (2005) and Martinez and Ebenhack (2008) consistently find that increases in electricity consumption significantly enhance both social and economic development in low- and medium-HDI countries. These findings are reinforced by Acheampong *et al*. (2021), who, using Lewbel's two-stage least squares technique across energy-poor countries, show that access to electricity and clean energy positively influences human development, particularly in sub-Saharan Africa. Similarly, Niu *et al*. (2013) establish a bidirectional causality between electricity consumption and multiple human development indicators, suggesting a mutually reinforcing relationship between energy access and development outcomes.

Despite this generally positive narrative, country-specific studies, particularly for Nigeria, introduce important nuances. For instance, Ishioro (2023), using the Autoregressive Distributed Lag (ARDL) framework, finds no significant short- or long-run relationship between electricity consumption and quality of life indicators (HDI1), implying that energy usage in Nigeria may not be efficiently translated into welfare improvements. This contrasts with findings by Akintunde *et al*. (2020) and Felix and Adeola (2023), which show that while electricity consumption positively affects life expectancy, fossil fuel consumption exerts adverse effects, highlighting the importance of energy composition rather than mere quantity.

Another critical dimension of the literature focuses on the role of energy in driving economic growth. A substantial number of studies support the "growth hypothesis," which posits that energy consumption is a key driver of economic expansion. For Nigeria, Odularu and Okonkwo (2009), Anochiwa et al. (2020), and Eneche *et al*. (2023) all report a positive and significant relationship between energy consumption, particularly electricity and petroleum, and economic growth. These findings are further supported by Mamudu and Ochei (2020), who demonstrate that electricity consumption, generation, and pricing significantly influence real GDP.

Beyond Nigeria, international evidence largely corroborates this pro-growth stance. Belke, Dreger and de Haan (2012) and Kasperowicz and Štreimikienė (2016) find strong positive relationships between energy use and economic growth across OECD and European economies, often accompanied by bidirectional causality. Similarly, Mukhtarov et al. (2017) and Zhixin and Xin (2012) report feedback relationships, indicating that energy consumption and economic growth reinforce each other over time. Opara (2026) examined the long-run impact of energy consumption on economic growth and the causal relationship between the duos in selected member states of the Economic Community of West African States (ECOWAS). Using annual panel data from

1990 to 2024, and employing the Panel Dynamic Ordinary Least Squares (PDOLS) estimator the study evaluated the long-run effect of electricity consumption on economic growth, proxied by GDP per capita growth, while controlling for exchange rate, lending interest rate, and inflation and found that electricity consumption exerts a positive and statistically significant long-run effect on economic growth within the ECOWAS sub-region. Pairwise Granger causality tests were further used to explore short-run dynamics. Causality analysis found, no significant short-run causality between energy consumption and growth. The findings suggest that the economic benefits of improved electricity supply materialize gradually rather than immediately.

Nevertheless, not all studies align with this optimistic perspective. Some empirical works lend support to the "neutrality" or "conservation" hypotheses. For example, Oyaromade *et al*. (2014) find no causal relationship between energy consumption and economic growth in Nigeria, while Abalaba and Dada (2023) report only weak evidence of a long-run relationship, with energy influencing growth primarily in the short run. Kassim and Abdurrahman (2020) also observe a negative and insignificant relationship between electricity consumption and industrial growth, attributing this to inefficiencies and inadequate power supply within the Nigerian economy.

The divergence in findings becomes even more pronounced when the type and quality of energy are considered. Increasingly, recent literature distinguishes between renewable and non-renewable energy sources. Sasmaz *et al*. (2020) and Yunashev *et al*. (2020) show that renewable energy consumption positively affects human development, while studies such as Wang, Danish and Wang (2018) reveal that renewable energy does not always translate into improved development outcomes, depending on the country context. In Nigeria, Joseph and Tosin-Amos (2023) find that renewable energy has a net positive long-run effect on life expectancy despite short-run fluctuations, reinforcing the long-term benefits of clean energy transitions.

Environmental and health considerations further complicate the energy–development nexus. Zhang *et al*. (2022) and Shobande (2019) highlight that certain forms of energy consumption, particularly those associated with pollution, can worsen health outcomes by increasing mortality rates and reducing life expectancy. Conversely, studies like Majeed *et al*. (2021) emphasize that renewable energy improves health outcomes by reducing disease prevalence and enhancing overall well-being.

From a methodological standpoint, the literature employs a wide array of econometric techniques, including ARDL, panel cointegration, Generalized Method of Moments (GMM), vector error correction models (VECM), and causality tests such as Granger and Toda-Yamamoto. While these approaches provide robust insights, they also contribute to inconsistencies in findings due to differences in model specifications, variable proxies, and data coverage.

Taken together, the empirical literature reveals three key stylized facts. First, energy consumption generally promotes economic growth and human development, particularly in low-income and energy-deficient economies. Second, the relationship is highly sensitive to the type, efficiency, and distribution of energy use, with renewable energy showing more consistent developmental benefits. Third, and most importantly, the evidence for Nigeria remains inconclusive and fragmented, with studies reporting positive, negative, and neutral relationships depending on the variables and methodologies employed.

It is within this context of empirical ambiguity that the present study is situated. Despite the extensive body of research, there remains a clear gap regarding the consistency and robustness of the energy–growth relationship in Nigeria. Specifically, existing studies often fail to reconcile the paradox of increasing energy consumption alongside persistent developmental challenges. This study, therefore, seeks to bridge this gap by providing a more integrated and context-specific analysis of how energy consumption influences economic growth, while also accounting for broader welfare implications.

Theoretical Framework

This study is anchored primarily on the Endogenous Growth Theory, which emphasizes the role of internal factors such as human capital, innovation, infrastructure, and productive inputs in driving long-run economic growth. The theory was developed by scholars such as Lucas (1988) and Romer (1990) as an extension of the neoclassical growth model.

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Endogenous growth theory argues that economic growth is generated within the economic system rather than being driven by exogenous technological progress as assumed in the neoclassical growth model. According to the theory, sustained economic growth results from investments in human capital, technological innovation, and knowledge accumulation, which enhance productivity and generate positive spillover effects across the economy (Romer, 1990).

In the context of this study, energy consumption can be viewed as a critical productive input that facilitates industrial production, transportation, and technological advancement. Adequate energy supply improves the efficiency of capital and labour, thereby increasing productivity and output. Consequently, higher levels of energy consumption can stimulate investment, expand productive capacity, and promote sustained economic growth.

The relevance of endogenous growth theory to this study lies in its recognition that infrastructure and productive inputs—such as energy—play a crucial role in enhancing economic performance. As the Nigerian economy industrializes and adopt modern technologies, the demand for energy increases significantly. Therefore, energy consumption becomes a key determinant of economic growth, particularly in developing economies like Nigeria where energy shortages can constrain productive activities.

Although the neoclassical growth model developed by Solow (1956) emphasizes capital accumulation and labour growth as drivers of economic growth, it treats technological progress as an exogenous factor. In contrast, endogenous growth theory explains technological advancement and productivity improvements as outcomes of deliberate investment decisions within the economy. This perspective provides a more suitable framework for analysing the relationship between energy consumption and economic growth.

Based on this theoretical perspective, the study posits that increased energy consumption enhances production capacity and economic activities, thereby contributing positively to economic growth.

METHODOLOGY

Research Design

This study uses a quantitative approach with the ARDL time-series analysis. The ARDL-bounds test econometric method examines both short-run and long-run dynamics as well as addresses potential endogeneity and omitted variable bias via robustness checks.

Sources and Nature of Data

This study employs annual time series data for regression analysis. The data are sourced from the World Development Indicators (2024), ensuring reliability and consistency. The study covers the period 1990 to 2022, which is sufficient to capture long-term trends and structural changes.

Economic growth is proxied by gross domestic product per capita (GDPPC) as the dependent variable. The key independent variables include electricity consumption, natural gas consumption, and coal consumption, while other control variables such as gross capital formation and employment are included to improve model robustness.

Model Specification

The functional model for examining the impact of energy consumption on economic growth is expressed as:

$$GDPPGR_t = \alpha_0 + \alpha_1 GFC_t + \alpha_2 EMP_t + \alpha_3 ELC_t + \alpha_4 NGC_t + \mu_t \text{ ----------- } (1)$$

Where:

GDPPGR is the gross domestic product growth rate as a proxy for economic growth,

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GFC is gross capital formation

EMP is total employment

ELC is electricity energy consumption

NGC is natural gas energy consumption

μ represents the error term

α represents the parameters of the variables

Estimation Techniques

The study employs the Autoregressive Distributed Lag (ARDL) model for estimation. This technique is appropriate because the variables are integrated at different orders. It allows for the estimation of both short-run and long-run relationships within a unified framework.

Prior to estimation, the Augmented Dickey-Fuller (ADF) test is conducted to determine the stationarity of the variables. The ARDL- bounds testing approach is then applied to examine the existence of long-run relationships among the variables and to estimate the model.

Post-estimation diagnostics include Breusch-Godfrey Serial Correlation LM Test and the Brown–Durbin–Evans CUSUM test, which assesses the stability of the model. All analyses are carried out using EViews 12 software.

RESULTS OF ANALYSES AND DISCUSSION

Pre-Estimation Tests

Descriptive statistics

The descriptive statistics of the variables of the study are presented in Table 5.1. These include the mean (average) values of the variables, the median, maximum and minimum values of the variables, the Jarque-Bera statistic, and others.

Table 4.1. Descriptive Statistics of Variables

	GDPGR	GFC	EMP	ELC	NGC
Mean	4.287737	27.94223	0.857471	28.92304	67.92864
Median	4.230061	27.49712	0.912860	27.10090	72.89910
Maximum	15.32916	53.18669	1.484338	41.86490	82.40869
Minimum	-2.035119	0.000000	0.000000	17.59131	44.68114
Std. Dev.	3.958301	11.99483	0.390878	8.265232	12.56859
Skewness	0.465009	0.075741	-0.712941	-0.019358	-0.536340
Kurtosis	3.389531	2.534995	3.341980	1.452931	1.993083
Jarque-Bera	1.397917	0.328868	2.956373	3.293019	2.976217
Probability	0.497103	0.848374	0.228051	0.192721	0.225799
Sum	141.4953	922.0935	28.29656	954.4603	2241.645
Sum Sq. Dev.	501.3807	4604.030	4.889140	2186.050	5055.022
Observations	33	33	33	33	33

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Source: Author's Computation

Table 4.1 shows that GDPGR (Gross Domestic Product Growth Rate) has an average growth rate of approximately 4.29%, ELC has mean value of 28.92%, while NGC (possibly a government spending indicator) has a higher average of 67.93%. The mean shows where most values of each variable tend to cluster. The median value further informs us of the central location in each data set, minimizing the impact of outliers. Notably, the GDPGR and GFC (Gross Fixed Capital Formation) medians are very close to their means, suggesting a relatively symmetric distribution for these variables.

The maximum and minimum values provide the range of each variable. GDPGR, for instance, ranges from a low of -2.04% to a high of 15.33%, indicating significant variability in economic growth. Similarly, GFC spans from 0 to 53.19, suggesting wide variability in capital formation across the observed period.

The standard deviation indicates the variability or spread of each variable around the mean. Result in Table 4.1 indicates that GDPGR has a standard deviation of 3.96, suggesting moderate variation around its average growth rate. On the other hand, NGC has a higher standard deviation, showing that its values fluctuate more widely over time.

Skewness describes the symmetry of the distribution. A skewness close to zero implies a symmetric distribution. GDPGR and GFC show slight positive skewness, meaning a few values fall above the mean. EMP (Employment) and NGC exhibit negative skewness, meaning values are more often below the mean. The Kurtosis on the other hand, indicates the "tailedness" of the data. A kurtosis of around 3 suggests a normal distribution. GDPGR has a kurtosis slightly above 3, suggesting somewhat more outliers, while ELC and NGC have lower kurtosis, indicating lighter tails or fewer extreme values.

The Jarque-Bera (JB) Test ascertains whether each variable's distribution is normal. Probabilities above 0.05 indicate that we do not reject the null hypothesis of normality. Thus, as evidenced in Table 4.1, all variables have JB probabilities greater than 0.05, meaning they appear normally distributed.

Correlation Coefficients

The Pearson's pairwise correlation coefficients between pairs variables of the study are presented in Table 4.2. The coefficients indicate the extent or degree of correlation between pairs of the variables.

Table 4.2. Matrix of Correlation Coefficients

VARIABLES	GDPGR	GFC	EMP	ELC	NGC
GDPGR	1	-0.107337	-0.217571	0.053454	0.074989
GFC	-0.107337	1	0.025426	0.764607	-0.823938
EMP	-0.217571	0.025426	1	0.046698	0.011981
ELC	0.053454	0.764607	0.046699	1	-0.894881
NGC	0.074989	-0.823938	0.011981	-0.894881	1

Source: Author's Computation

The correlation matrix reveals the strength and direction of relationships among the variables used in the analysis. Theoretically, Correlation values range from -1 to 1, where values close to 1 or -1 indicate strong relationships, while values near 0 suggest weaker associations.

Starting with GDPGR (Gross Domestic Product Growth Rate), the correlations with other variables are relatively low. The correlation between GDPGR and GFC (Gross Fixed Capital Formation) is slightly negative (-0.107), suggesting a weak, inverse relationship. Similarly, the correlation between GDPGR and EMP (Employment) is

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-0.218, indicating a slight negative association. In contrast, GDPGR has a weak positive correlation with ELC (Electricity Consumption) at 0.053 and with NGC at 0.075, implying minimal relationships.

GFC shows a strong positive correlation of 0.765 with ELC, indicating that higher capital formation is associated with increased electricity consumption.

Conversely, GFC and NGC exhibit a strong negative correlation of -0.824, suggesting that as capital formation rises, NGC (potentially government consumption) tends to decrease.

EMP has weak correlations with other variables, showing no strong association with GDPGR, GFC, ELC, or NGC. The relationship between ELC and NGC is notably strong and negative (-0.895), suggesting that as electricity consumption increases, NGC decreases.

The strong negative correlation between electricity consumption and natural gas consumption (-0.895) suggests the possible presence of multicollinearity in the model. This inverse relationship may also point to substitution effects or resource allocation changes.

Overall, the matrix highlights some significant relationships among variables, notably between GFC and ELC and between ELC and NGC, which could have implications for resource distribution and economic policy.

Unit Root and Cointegration

Table 4.3: Unit Root Test (ADF Results)

Variable	Level (Prob.)	First Difference (Prob.)	Order of Integration
GDPGR	0.0093	—	I(0)
GFC	0.5115	0.0056	I(1)
EMP	0.4005	0.0000	I(1)
ELC	0.8791	0.0000	I(1)
NGC	0.7327	0.0000	I(1)

The ADF results confirm a mix of I(0) and I(1) variables. This justifies the use of the ARDL estimation technique.

Table 4.4: ARDL Bounds Test for Cointegration

Test Statistic	Value	
F-statistic	3.618	
Significance Level	**I(0)**	**I(1)**
10%	2.525	3.560
5%	3.058	4.088
1%	4.280	5.840

The results in table 4.4 indicates that the F-statistic with value 3.618 is greater than the upper bound value of 3.560 at 10% level of significance. The result reveals the presence of cointegration. The ARDL bounds test indicates a long-run relationship among the variables.

The presence of a long-run relationship implies that the variables may be stationary in their levels or differenced forms but do move together over the long term. This result has several implications.

The first implication is that short-term adjustments may occur between the variables, but there is stable long-term equilibrium relationship. Second. policy interventions targeting these variables may yield consistent long-term effects since they exhibit a cointegrated relationship.

Model Estimation Results

Table 4.5. ARDL Model Estimation Results

Dependent Variable: GDP Growth Rate (GDPGR)
Selected Model: ARDL (1,0,0,1,0)

Variable	Coefficient	Std. Error	t-Statistic	Prob.*
GDPGR(-1)	0.290907	0.161437	1.801984	0.0836
GFC	-0.175710	0.093847	-1.872312	0.0729
EMP	-0.152930	1.651261	-0.092614	0.9269
ELC	-0.070993	0.261204	-0.271792	0.7880
ELC(-1)	0.466691	0.215480	2.165822	0.0401
NGC	0.126188	0.119216	1.058477	0.3000
C	-12.53414	12.53129	-1.000228	0.3268
R^2= 0.458862 D.W= 2.275385 F-Statistic = 3.533163 Prob(F-Stat) = 0.011364				

The result reveals that lagged GDPGR with coefficient of 0.290907 and p-value of 0.0836 has a moderately statistically positive significant relationship with the current GDP growth at the 10% level of significance, suggesting persistence in economic performance.

Despite the fact that electricity consumption is insignificant contemporaneously, the result shows that electricity consumption with lagged coefficient and p-value of 0.466691 and 0.0401 respectively has a positive and statistically significant lagged effect on economic growth in Nigeria, implying that past electricity supply contributes to current GDP growth.

On the contrary, as indicated by the coefficient of 0.126188 and probability value of 0.3000, there is positive but insignificant relationship between natural gas consumption and GDP growth in Nigeria. The result further reveals that capital formation shows a weak negative relationship with GDP growth, with coefficient (-0.175710) and p-value (0.0729).

The p-value of 0.0729 indicates statistical significance at the 10% level, implying a potential impact on GDP growth that warrants further investigation. The result equally shows that employment was statistically insignificant, implying no discernible effect of employment on GDP growth in this model.

The R-squared value of 0.458862 indicates the model explains about 46% of variations in GDP growth, and the Durbin–Watson statistic coefficient of 2.275385 indicates the absence of autocorrelation, indicating that the model's assumptions regarding error terms are satisfied.

Diagnostic Tests of Reliability

To evaluate the reliability of the model, we conducted several diagnostic tests, including the VIF multicollinearity test, Breusch-Godfrey Serial Correlation LM Test, and the Jarque-Bera Test for normality.

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These tests are essential in ensuring that the model meets the necessary assumptions of linear regression, which are crucial for drawing reliable conclusions from the results.

Variance Inflation Factor (VIF) Test

Consequent upon the very high correlation coefficient between electricity consumption (ELC) and natural gas consumption (NGC) of – 0.895 as revealed in Table 4.2 (correlation matrix), it becomes necessary to formally conduct a multicollinearity test to ascertain the possibility of multicollinearity using the Variance Inflation Factor (VIF).

The VIF can be approximated from the pairwise correlation using the formula:

$$VIF = \frac{1}{1 - r^2}$$

Where r represents the correlation coefficient between ELC and NGC (= - 0.895).

Substituting the coefficient value in the VIF formula, VIF is obtained as approximately 5.03. The value reveals the presence of moderate multicollinearity between electricity consumption and natural gas consumption, using Nigerian data.

The implication is that the standard errors of the estimated coefficients, particularly that of natural gas consumption, may have been inflated, thereby weakening its statistical significance in the ARDL model and reducing the model's ability to isolate the independent effect of natural gas on economic performance of the economy. Consequently, the insignificant effect of natural gas consumption on economic growth should be interpreted cautiously.

This result may also reflect the inherent structural relationship between electricity generation and natural gas consumption in Nigeria. Given that a significant proportion of Nigeria's electricity generation depends on gas-fired power plants, electricity consumption may already capture much of the growth effect of natural gas. This overlapping relationship reduces the independent explanatory power of NGC in the regression model.

The Breusch-Godfrey Serial Correlation LM Test

Table 4.6 Breusch-Godfrey Serial Correlation LM Test

Null Hypothesis: No serial correlation at up to 2 lags

Test Statistic	Value	Probability
F-statistic	0.584918	Prob. F(2,23) = 0.5652
Obs*R-squared	1.548822	Prob. Chi-Square(2) = 0.4610

The result in Table 4.6 indicates that the F-statistic for the Breusch-Godfrey test is 0.584918, with a corresponding probability value of 0.5652. Given the high probability value (greater than 0.05), we fail to reject the null hypothesis of no serial correlation.

This indicates that there is no evidence of serial correlation in the residuals of the regression model up to 2 lags. The absence of serial correlation is essential for validating the reliability of the regression results and ensures that the model's residuals behave as expected.

Stability Test

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In this section, we conduct a stability test to evaluate the robustness of the estimated model over the specified period. Stability in an econometric model is crucial as it indicates that the relationships estimated between the variables remain consistent and reliable throughout the study period.

To evaluate the stability of the model, we employ the Cumulative Sum of Recursive Residuals (CUSUM) test and the CUSUM of Squares test (CUSUMSQ). The plots as indicated in Figures 4.1 and 4.2 below remained within the critical bounds at the 5% significance level, indicating that the estimated parameters are stable throughout the sample period (1991–2022). This confirms the structural stability of the model.

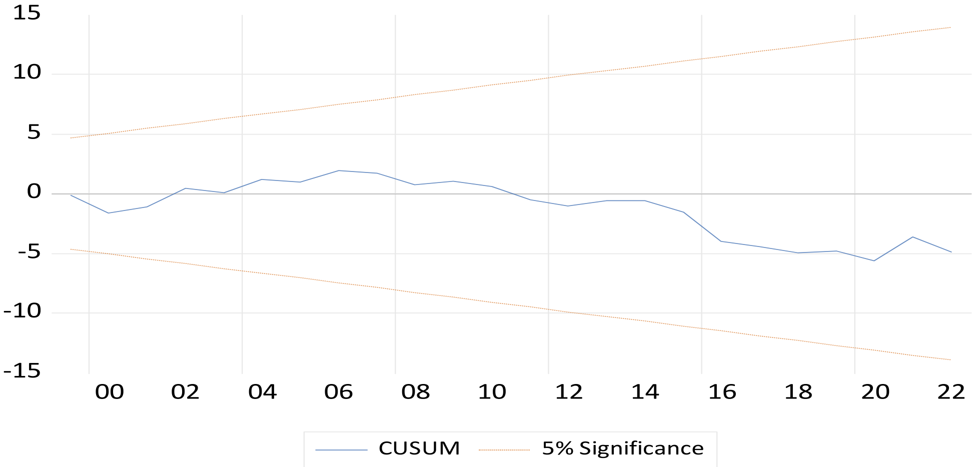

Figure 4.1: Cumulative Sum of Recursive Residuals (CUSUM) Test Result

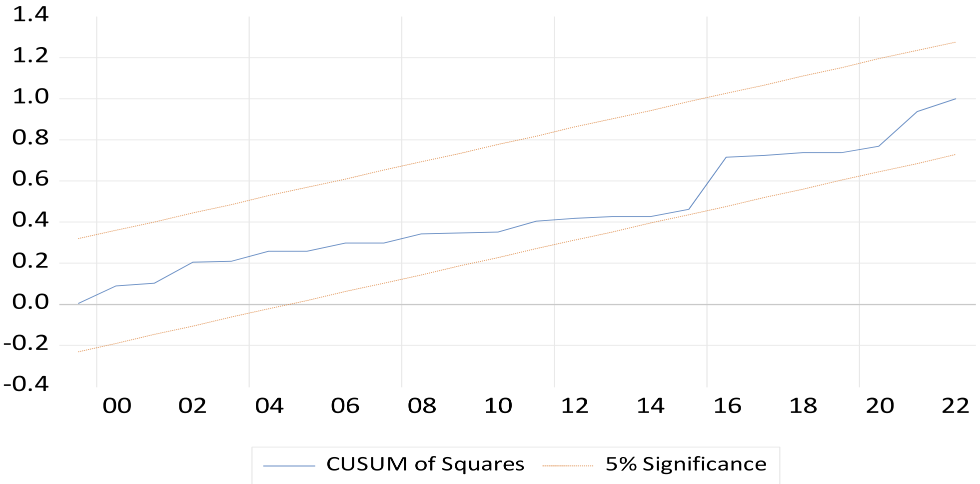

Figure 4.2: CUSUM of Squares Test Result

DISCUSSION OF RESULTS

The ARDL estimation results reveal a mixed relationship between the selected variables and economic growth in Nigeria. The lagged GDP growth rate is positive and significant, indicating persistence in economic growth over time. Gross fixed capital formation shows a significant negative relationship with growth, suggesting possible inefficiencies or misallocation of investment.

Employment and current electricity consumption both have negative and insignificant effects on GDP growth, implying limited direct impact in the short run. However, lagged electricity consumption is positive and significant, showing that past electricity use supports economic growth, likely through improved production capacity over time.

Natural gas consumption has a positive but insignificant effect on growth, indicating no strong short-term influence. The model explains about 45.8% of variations in GDP growth, and the significant F-statistic confirms overall model validity.

The Durbin-Watson statistic suggests no autocorrelation problem. Overall, the findings highlight that energy impacts economic growth in Nigeria are complex and more effective in lagged or indirect forms rather than immediate effects.

SUMMARY, POLICY IMPLICATIONS AND CONCLUSION

Summary

This study examined the relationship between energy consumption and economic growth in Nigeria over the period 1991–2022 using the Autoregressive Distributed Lag (ARDL) estimation framework. The findings reveal a statistically significant positive effect of electricity consumption on economic growth, underscoring its central role in driving economic performance. In contrast, natural gas consumption was found to be statistically insignificant within the study period. Diagnostic and stability tests confirm the robustness of the estimated model.

Overall, the results emphasize the importance of energy—particularly electricity—as a critical input in Nigeria's growth process and highlight persistent structural inefficiencies in the utilization of natural gas resources.

Policy Implications

The findings suggest several policy directions. First, there is a need to scale up investment in electricity generation, transmission, and distribution infrastructure to ensure reliable and adequate supply. Strengthening public–private partnerships and attracting foreign direct investment into the power sector are essential in this regard, alongside expanding rural electrification to stimulate inclusive growth.

Second, promoting energy efficiency across key sectors—especially in manufacturing and services—is crucial. Adoption of energy-saving technologies and improved regulatory standards can enhance productivity while reducing wastage.

Third, despite its insignificant impact in this study, natural gas remains vital for energy diversification. Policies should therefore focus on improving gas infrastructure, including pipeline networks and storage systems, to enhance domestic utilization and industrial application.

Finally, an integrated energy policy framework that aligns electricity and gas development with macroeconomic objectives is required. Such a framework should be supported by continuous monitoring and evaluation to ensure responsiveness to evolving economic and technological conditions.

Conclusion

This study establishes that electricity consumption is a significant driver of economic growth in Nigeria, while natural gas has yet to exert a measurable impact within the period analyzed. The results reinforce the urgency of addressing electricity supply constraints as a pathway to sustainable economic development.

Beyond its empirical contribution, the study provides policy-relevant insights into the energy–growth nexus, emphasizing the need for targeted interventions to optimize energy use in Nigeria's evolving economic landscape.

Limitations of the Study

Regardless of the contributions of this study to the literature on energy-economic growth nexus in Nigeria, the study has several limitations that should be acknowledged. The limitations include:

i. The study relied on annual time-series that cover only from 1990 to 2022. Notwithstanding that the period is sufficient for long-run analysis, the use of annual data may conceal structural breaks and short-run fluctuation that could be better captured by employing monthly or quarterly data;
ii. The study proxied energy consumption with only electricity consumption and natural gas consumption, undermining other important energy sources in Nigeria like coal energy, renewable energy and petroleum energy, due to data limitation. This may limit the extensiveness of the analysis;
iii. Another limitation is the use of GDP growth rate as the only indicator of economic growth, despite the fact that economic growth is multidimensional. Hence, the study may not capture broader welfare and development outcomes;
iv. Even though the ARDL framework captures both short and long-run dynamics, the model may not fully account for structural breaks, external shocks, policy and regime changes that affect Nigeria within the scope of this study.

Despite the limitations, the study still provides useful analytical insights in the Nigerian energy-economic growth nexus and offers a basis for further research and policy formulation.

Contribution to Knowledge

This study contributes to the literature by disaggregating the effects of electricity and natural gas consumption on economic growth in Nigeria. It provides context-specific evidence and applies the ARDL methodology to capture both short- and long-run dynamics. The findings offer nuanced insights for policy formulation in developing economies with similar structural energy challenges.

Directions for Future Research

Future studies should extend the time horizon and incorporate renewable energy variables to reflect emerging global energy transitions. Further research on energy efficiency and its interaction with economic growth is also recommended. Comparative analyses across developing economies could provide broader insights, while incorporating socio-economic factors such as urbanization and industrialization would deepen understanding of the energy–growth relationship.

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