Impact of Energy Consumption on Economic Growth in Nigeria: An ARDL Estimation Approach

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Abstract
The study investigated the impact of energy consumption on economic growth in Nigeria using the Autoregressive Distributed Lag (ARDL) model technique. Annual data on gross domestic product growth rate, electricity consumption, natural gas consumption, gross fixed capital formation and employment rate were sourced from the Central Bank of Nigeria (CBN), Nigeria Bureau of Statistics (NBS) and the World Development Indicators (WDI) from 1990 to 2023. The findings revealed that the current year electricity consumption had a negative and insignificant impact on economic growth. The first lag of electricity consumption positively and significantly impacted economic growth. This suggests that the previous year's electricity consumption level influences Nigeria's economic growth rate. Further findings revealed that natural gas consumption had a positive and insignificant impact on economic growth in Nigeria during the study period. In addition, energy consumption has implications for growth in Nigeria. Therefore, the study recommended that governments at all levels should formulate and implement energy policies capable of boosting energy consumption and economic growth in Nigeria.

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

Introduction

Energy consumption promotes economic growth and development by increasing productivity and income as well as creating employment for the teeming population (Ishioro, 2023; Babatunde, 2016). Hence, the efficient energy market aimed at providing energy commodities to power the industrial, transport, household and service sectors of the economy (Orji *et al*, 2020). Africa is naturally endowed with energy resources which include the sun, wind, hydro, coal, natural gas, electricity, and petroleum amongst others. In Northern and Western Africa, there has been a great dependence on fossil fuels in the generation of electricity as a result of the concentration of oil and gas in these regions. In contrast, countries in Central and the Eastern parts of Africa largely depend on hydropower to generate electricity (Akinlo, 2018). In the Southern part of Africa, energy consumption from the power sector is generated using coal and to some extent the use of hydropower (Odhiambo, 2023).
In Nigeria, energy consumption has been considered over the years as an engine of growth for all sectors of the economy. This is because energy serves as the mainstay of wealth creation at the centre of operations, which facilitates the activities of other sectors of the Nigerian economy to enhance economic growth (Odularu & Okonkwo, 2019). Energy consumption in the Nigerian economy usually consolidates the activities of other sectors which often provides essential services to direct production activities in agriculture, manufacturing, mining and commerce to boost economic growth (Ekeocha, Penzin & Ogbuabor 2020). Despite the Nigerian economy being endowed with abundant energy resources, it suffers from a persistent energy crisis (Ishioro, 2023).

The performance of the Nigerian economy in terms of growth and development has been unsatisfactory (Ashakah, 2023). Statistics revealed that the growth of Nigeria's economy as at 1990 was 8.2% and decreased to 5.4%, 4.6%, and 3.5% in 2000, 2001, and 2002 correspondingly (World Bank, 2015). More so, in the Nigerian economy, economic growth measured by Gross Domestic Product (GDP) growth rate was recorded as 2.7% in 2015, -1.6%

in 2016, 0.8% in 2017, 1.9% in 2018, 1.94% in 2019 and -1.79% in 2020 (World Bank, 2020). Today, Nigeria is seen as one of the greatest developing nations in Africa with highly endowed natural resources including potential energy resources (Umeji et al. 2023). The question that comes to mind is whether the abundance of energy resources in Nigeria has an impact on its growth.

The impact of energy consumption on the Nigerian economy needs to be comprehensively analyzed and understood for appropriate policy formulation. The review of the existing literature showed that some empirical studies (Ishioro, 2023; Acheampong *et al*., 2021; Pasternak, 2020; Nguyen *et al*, 2020; Sarkodie & Adams, 2020; Anochiwa *et al*, 2020; Orji *et al.*, 2020; Shobande, 2019; Sankaran et al., 2019; Odhiambo, 2023; Pourali, 2014; Rafal, 2014; Adegbemi & Babatunde, 2013; Pasten & Santamarina, 2012) investigated the impact of energy consumption on economic growth. However, the results of the existing studies failed to have a consensus, hence the current study becomes relevant to add to the discourse on the impact of energy consumption on economic growth.
The purpose of this study is to provide further evidence for policy formulation and implementation capable of promoting investment and economic growth in Nigeria. This study wholly focused on the impact of energy consumption on economic growth in Nigeria using the Autoregressive Distributed Lag (ARDL) which allows the modelling of the relationships between variables integrated in different orders.
This paper is structured as follows: Section 2 reviews relevant literature, Section 3 outlines the methodology adopted for analysis, Section 4 discusses the results, and Section 5 provides a summary, conclusion, and policy recommendations.

Review of Literature

This section extensively reviews the both methodological and empirical literature on energy consumption and economic growth.

Mombekova *et al*, (2024) investigated the impact of energy consumption on economic seven developing countries (China, India, South Africa, Indonesia, Turkey, Mexico, Thailand). The impact was examined with Swamy's Random Coefficients Model and Seemingly Unrelated Regression (SUR) models, and a positive effect of economic growth on energy consumption was observed at the 5% significant level. It was recommended that energy policies should be used to boost economic growth.

Umeji *et al* (2023) examined the impact of renewable energy consumption on economic growth in Nigeria from 1990 to 2020 using the ARDL estimation technique. The results showed a significant positive impact of renewable energy consumption on economic growth. In Nigeria during the period of the study. The study recommended that the government should encourage investments in the renewable energy sector by providing a conducive business environment and also created awareness on the importance of the use of renewable energy to boost growth. Ishioro (2023) examined the impact of electricity energy consumption (ELE) on quality of life in Nigeria by using Autoregressive Distributed Lag (ARDL) model as the econometric estimation technique. The outcomes of the ARDL test indicated that there was no short and long-run connectivity between ELE and HDI (quality of life). The study concluded that ELE had not been beneficial for the enhancement of the quality of life in the short- and long-run in Nigeria.

Odhiambo (2023) re-examined the impact of energy consumption on economic growth in South Africa over the period from 1981 to 2020 using a non-linear ARDL model and four proxies of energy consumption, which are largely from non-renewable sources. The study found that in the short run, positive shocks in electricity and oil consumption affected economic growth positively, while negative shocks affect growth negatively. In the long run, the study found that positive shocks in oil consumption affect economic growth positively, positive shocks in electricity consumption affected economic growth positively, and negative shocks in coal and gas consumption affected economic growth negatively. The study recommended that the government should apply good economic policies to boost energy consumption in the short-run and long-run.

Mohammed (2023) investigated the impact of electricity consumption on economic growth in Nigeria from 1986 to 2021 by using the Autoregressive Distributed Lag (ARDL) model. The results showed that energy consumption, inflation, and industrial product were statistically significant and positively affect Nigeria's short and long-run economic growth. Based on the findings, the study recommended that government should undertake serious measures to curtail the shortage of electricity consumption in the country to promote economic growth in general. Adeyemi and Falade (2022) examined the impact of energy consumption on economic growth in Nigeria using the Autoregressive distributed lag (ARDL) and fully modified ordinary least squares (FMOLS) techniques from 1981 to 2019. The results of the short-run analysis showed that energy consumption was positively significant with agricultural sector output, while the reverse outcome was obtained for the construction sector. The long run results showed that energy consumption was positively and significantly related to all sectors save for trade and services. Therefore, it was recommended that the government should pursue an energy development agenda through the diversification of energy sources and ensured adequate energy allocated to productive sectors.

Acheampong *et al* (2021) investigated the impact of access to energy on human development in 79 energy-poor countries from sub-Saharan Africa, South Asia and Caribbean-Latin America. Using data from 1990 to 2018 and Lewbel's two-stage least squares approach, the study found that clean energy and electricity have a positive impact on human development in the aggregated sample. Furthermore, the study found that clean energy and electricity improved human development in the Caribbean, Latin America and sub-Saharan Africa, but worsened human development in South Asia.

Okoye *et al* (2021) examined the impact of energy consumption on economic growth using the Auto-regressive Distributed Lag from 1981 and 2017. The results indicated that energy consumption and gross fixed capital formation significantly determined growth of economic activities in Nigeria. The study recommended that the government should formulate viable economic policies to boost energy consumption and growth in Nigeria

Anochiwa *et al* (2020) examined the relationship between economic growth and energy consumption in Nigeria by using ARDL bound test regression analysis. The study disaggregated energy consumption into electricity, coal and petroleum with growth rate of GDP data is used from 1980 to 2017. The findings showed that petroleum and electricity variables were positive and significant to growth while coal was positive but not significant. Overall outcome was that energy consumption had a positive relationship with economic growth. The study recommended that the government should enhance energy consumption to boost economic growth in Nigeria.

Pasternak (2020) investigated the relationship between human well-being and consumption of energy and electricity in sixty (60) populous countries encompassing 90% of the world's population over the period 1997 - 2020 using correlation analysis. The findings showed that there was a significant positive relationship between electricity consumption and the Human Development Index. It also revealed that HDI attained a maximum value when electricity consumption annually was about 4,000 kWh per capita, which was lesser as well as greater than the consumption levels of most developed and developing countries, respectively.

Sarkodie and Adams (2020) investigated the nexus between electricity, human development income level, income inequality and political system environment in Sub-Saharan Africa, using data from 1990 to 2017. Using a non-parametric regression analysis, human development was found to have a positive impact on access to electricity consumption.
Nguyen et al. (2020) examined the relationship between energy consumption and economic growth in Indonesia. The used Autoregressive Distributed Lag (ARDL) model in assessing the energy consumption and its link with economic growth in Indonesia for the period of 2000-

2019. The findings revealed that energy consumption impacted economic growth within the given historic data. The study recommended policies related to energy consumption to enhance the economic growth in Indonesia.

Ezeocha *et al* (2019) examined the impact of energy consumption on growth from 1999Q1 to 2016Q4 using a nonlinear ARDL model and an ARDL-ECM specification. The study found that the role of energy consumption as a driver of growth remained negligible throughout. The study concluded that Nigeria could attain high levels of sustainable growth with improved and stable energy production and supply.

Shobande (2019) investigated the effects of energy on socioeconomic predators for 23 African countries using data from 1999 to 2014. The study used the human development index (HDI) and inequality-adjusted Human Development Index to investigate the relationship. Using the Gary Becker hypothesis and the Michael Grossman demand for healthcare model, the study found a positive relationship between energy consumption and human development.
Sankaran et al. (2019) investigated the effects of electricity consumption, per capita income, real exchange rate, and import and export on manufacturing output by using time series data between 1980 and 2016 about 10 late industrialized nations. The ARDL bound testing approach and the way to deal with cointegration were applied to estimate the long-run connection between the variables. Error correction methods (ECM) were used to find the short-run dynamics. To test the causality among the variables, the Toda- Yamamoto test was performed. The results demonstrated the existence of short-run and long-run relationships among the variables and Toda-Yamamoto causality results support the existence of growth, conservation, feedback and neutrality hypotheses for different nations.

Nkoro *et al* (2019) investigated the impact of energy consumption on economic growth from 1980 to 2016 using a modified Ordinary Least Square technique which allows for time gaps in the model. It was observed that only renewable energy impacted on economic growth in the long-run whereas non-renewable energy component impacted on economic growth in the short-run. The study recommended improvement in electricity production and distribution in Nigeria.
Pourali (2014) examined the relationship between environmental life quality indices and energy consumption in high energy-consuming countries including America, China, Japan, India, Iran, Russia, etc. using fixed effects model estimation over the period 2007 - 2011. The energy consumption was proxied by energy consumption based on oil consumption; the environmental life quality indices were under-5 children mortality, agricultural subsidies, access to drinking water, access to sanitation and CO2 per capita. The results indicated that there is a significant positive relationship between environmental life quality indices and energy consumption.

Ouedraogo (2013) investigated the relationship between human development and energy consumption in 15 developing countries, using data from 1988 to 2008. The study used total energy consumption and electricity as measures of energy. Using panel cointegration and panel-based error correction models, the study found a neutral effect on energy consumption and electricity on HDI. However, in the long term, a 1% increase in energy consumption led to a reduction in HDI by 0.8% and a 1% increase in per capita electricity consumption led to an increase in HDI by 0.11%.
In summary, several empirical studies focused on the impact of energy consumption on economic growth, but the results are mixed. Therefore, it becomes imperative to further investigate the impact of energy consumption no economic growth in Nigeria.

Methods and Model Specification

Model Specification

The model for the study was specified based on the assumptions of the neoclassical growth theory which assumed that economic growth depends on capital and labour:

GDPGR = f(K, L) --(1)

Where GDPGR represents gross domestic product growth rate (a proxy for economic growth), K represents capital and L denotes labour force. The model assumes that the labour force grows at a constant exogenous rate. The empirical model for the study was built by incorporating other growth factors into the specification of the neoclassical growth model as follows:

GDPGR= f(K, L, ELC, NGC) ---(2)

The econometric form of the functional model is specified as follows:

$$GDPPGR_i = \alpha_0 + \alpha_1 GFC_t + \alpha_2 EMP_t + \alpha_3 ELC_t + \alpha_4 NGC_t + \mu_t \text{----------------------(3)}$$

Where:

- GDPPGR is the gross domestic product growth rate as a proxy for economic growth,
- GFC is gross capital formation; a proxy for capital
- EMP is total employment rate; a proxy for labour
- ELC is electricity energy consumption
- NGC is natural gas energy consumption
- μ represents the error term
- α represents the parameters of the variables

Method of Data Analysis

The Autoregressive Distributed Lag Model (ARDL) was employed in data analysis as used by Ishioro (2023). Before estimating the model, the variables were tested for unit root using the Augmented Dickey-Fuller (ADF) test to determine the level of variable integration. It was also considered appropriate to test for cointegration of the variables using the bounds test procedures. Post estimation test- stability test focusing on the Brown-Durbin-Evans cumulative sum of recursive residual test, was carried out to confirm the stability of the model.

The Data and Sources

Time series data were sourced from the Central Bank of Nigeria (CBN), the Nigeria Bureau of Statistics (NBS) and the World Development Indicators (WDI). The annual data for the study covered the period from 1990 to 2023. The study sourced data on gross domestic product per capita (GDPPC) to proxy economic growth as the dependent variable, and electricity consumption, and natural gas consumption as the major independent variables.

Results and Discussion

This sub-section presents the results of the preliminary data analysis, model estimation and post-model estimation test.

Summary of Descriptive Statistics

Table 1. Summary of Descriptive Statistics

	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

Source: Author's Computation 2025

Table 1 shows the descriptive statistics of the variables for the study. GDPGR (Gross Domestic Product Growth Rate) has a mean of approximately 4.29%, while NGC has a higher mean of 67.93. 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. Standard Deviation (Std. Dev.) indicates the variability or spread of each variable around the mean. For instance, 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.

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 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) Tests whether each variable's distribution is normal. Probabilities above 0.05 indicate that we do not reject the null hypothesis of normality. Here, all variables have JB probabilities greater than 0.05, meaning they appear normally distributed.

Correlation Matrix Analysis

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 2. Matrix of Correlation Coefficients

VARIABLES	GDPGR	GFC	EMP	ELC	NGC
GDPGR	1	-0.107	-0.218	0.053	0.075
GFC	-0.107	1	0.025	0.765	-0.824
EMP	-0.218	0.025	1	0.047	0.0120
ELC	0.053	0.765	0.047	1	-0.895
NGC	0.075	-0.824	0.012	-0.895	1

Source: Author's Computation 2025

The correlation matrix in Table 2 reveals the strength and direction of relationships among the variables used in the analysis. 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 -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. This inverse relationship may 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 Test Results

Before estimating the specified models, the variables were tested for unit roots to ascertain whether they were stationary. The Augmented Dickey-Fuller unit root testing processes were used. The results are presented in Figure 4.3.

Table 3: Unit Root Test Results

Augmented Dickey-Fuller Unit Root Test							
Variables	Level			1st Difference			Integration
	Statistics	Prob.	Inference	Statistics	Prob.	Inference	Order
GDPGR	-3.6833	0.0093	Stationary	N/A	N/A	N/A	I(0)
GFC	-1.5187	0.5115	Non-stationary	-3.8944	0.0056	Stationary	I(1)
EMP	-1.7431	0.4005	Non-stationary	-5.7240	0.0000	Stationary	I(1)
ELC	-0.4972	0.8791	Non-stationary	-6.6432	0.0000	Stationary	I(1)
NGC	-1.0236	0.7327	Non-stationary	-6.6607	0.0000	Stationary	I(1)

Source: Author's Computation 2025

Table 3 shows the results of the Augmented Dickey-Fuller unit root test. The ADF test statistic for GDPGR was -3.683, which is lower than the 1%, 5%, and 10% critical values (-3.654, -2.957, and -2.617, respectively). With a p-value of 0.0093, this result indicates that GDPGR is stationary at the level, rejecting the null hypothesis of a unit root.

Initially, the ADF test for GFC at level yielded a statistic of -1.519, with a p-value of 0.5115, which is not statistically significant. This implies that GFC is non-stationary at level. However, after first differencing, the ADF test statistic for D(GFC) was -3.894, which is significant at the 1% level, with a p-value of 0.0056. This result suggests that GFC is stationary at first difference. The ADF test for EMP at level produced a statistic of -1.743 with a p-value of 0.4005, indicating non-stationarity at level. However, after first differencing, the ADF test statistic for D(EMP) was -5.724, which is significant at the 1% level, with a p-value of 0.0000. This confirms that EMP is stationary at first difference.

The ADF test for ELC at level produced a statistic of -0.497 with a p-value of 0.8791, indicating non-stationarity. When differenced once, the ADF test statistic for D(ELC) was -6.643, which is significant at the 1% level, with a p-value of 0.0000. This finding suggests that ELC is stationary at first difference. The ADF test for NGC at level yielded a statistic of -1.024 with a p-value of 0.7327, indicating non-stationarity at level. After differencing, the ADF test statistic for D(NGC) was -6.661, significant at the 1% level with a p-value of 0.0000. This implies that NGC is stationary at first difference.

Based on the ADF test results, GDPGR is stationary at level, while GFC, EMP, ELC, and NGC become stationary after first differencing. Thus, for further analysis, GDPGR can be included in its original form, while GFC, EMP, ELC, and NGC should be used in their first-differenced forms to ensure stationarity in the model. This approach addresses potential issues of spurious regression in subsequent analyses.

Cointegration Test Results

The study conducted ARDL bounds cointegration test to determine the existence of a long run relationship among the variables. The results of the cointegration tests are presented below in Table 4.

Table 4: ARDL Bound Test: Cointegration Test

- Null Hypothesis: No levels relationship
- Number of Cointegrating Variables: 4
- Trend Type: Restricted constant (Case 2)
- Sample Size: 32

Test Statistic	**Value**
F-statistic	3.618486

Sample Size	**10%** **I(0)**	**5%** **I(1)**	**1%** **I(0)**
30	2.525	3.560	3.058
35	2.460	3.460	2.947
Asymptotic	2.200	3.090	2.560

Table 4 shows that the calculated F-statistic is 3.618486. This value is critical in determining whether there exists a long-run relationship (cointegration) among the variables. To interpret this result, we compare the F-statistic to the critical values provided for different significance levels of 5%. For a sample size of 32, the critical values for the bounds test at the 5% significance level are: I(0): 3.560, I(1): 3.460. Since the calculated F-statistic (3.560) falls between the I(0) and I(1) critical values at the 5% significance level, we can reject the null hypothesis of no levels relationship. This suggests that there is evidence of a long-run cointegration relationship among the variables at the 5% significance level.

Model Estimation Results
Table 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

Post-Estimation Test

Table 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

Table 6 shows the result of serial correlation test. 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 in the model validated the reliability of the regression results and ensures that the model's residuals behave as expected (Ashakah & Wanogho, 2021).

Discussion Results

The estimated coefficient of 0.290907 for GDPGR(-1) indicates a positive relationship of the lagged GDPGR with the current GDPGR, suggesting that previous GDP growth has a positive effect on current GDP growth. The p-value of 0.0836 indicates that this relationship is statistically insignificant because it failed the statistical test at the 5% level. The negative coefficient of GFC (-0.175710) with a probability value of 0.0729 suggests that an increase in GFC is associated with a decrease in GDP growth rate, only the impact is insignificant at the 5% level. The results differed from the findings of Ashakah (2023) and Ogbebo and Ashakah, (2021). The differences in findings could be attributed to differences in economic policies.

The estimated coefficient of -0.152930 for EMP with a p-value of 0.9269 showed that employment rate was not statistically significant in determining growth during the period of the study. The implication of this finding is that economic policies needed to be targeted at human capital development for labour to positively impact on growth. Similar, the estimated coefficient of -0.070993 for ELC with a probability value of 0.7880 showed that the current level of electricity was not statistically significant in impacting growth during the period of the study. This finding is disagreement with the finding of Ishioro (2023). The finding suggests that electricity consumption need to be enhanced to significantly impact on GDP growth rate.

The positive and significant estimated coefficient of 0.466691 for ELC(-1) with a probability value of 0.0401 indicated that lagged electricity consumption had a positive effect on GDP growth during the period of the study. The impact is significant at the 5% level. This suggests that the previous year electricity consumption impacts positively on the current year economic growth. The result is in agreement with the findings of Abalaba and Dada (2023) and Ogbebor and Ashakah (2021). The estimated coefficient of 0.126188 for NGC with a probability value of 0.3000 revealed that natural gas consumption had a positive but insignificant impact on growth during the period of the study. This result differed from the findings of Orji *et al* (2020). The reasoning could be attributed to differences in energy policies in Nigeria and Poland. The implication of the finding for the Nigerian economy is that improved energy policy has potential of enhancing economic growth.

The R-squared of 0.458862 indicates that approximately 46% of the variability in GDP growth was explained by all the explanatory variables included in the model. Adjusted R-squared of 0.328989 suggests that after adjusting for the number of predictors, about 33% of the variability in GDP growth rate was explained. F-statistic of 3.533163 with a p-value of 0.011364 indicated that the model as a whole is statistically significant, suggesting that all the independent variables significantly affect GDP growth. Durbin-Watson statistic of 2.275385 suggested the absence of autocorrelation in the estimated model, and the cusum plot (appendix 1) at 5% significance level revealed that the estimated model was stable.

Conclusion

The study investigated the impact of energy consumption on economic growth in Nigeria using the ARDL estimation technique. Annual data on gross domestic product growth rate, electricity consumption, natural gas consumption, gross fixed capital formation and employment rate were sourced from the Central Bank of Nigeria (CBN), Nigeria Bureau of Statistics (NBS) and the World Development Indicators (WDI) from 1990 to 2022. The findings revealed that the current year electricity consumption had a negative and insignificant impact on economic growth. The first lag of electricity consumption positively and significantly impacted economic growth. This finding implies that the government's energy policies have a lag period of a year before they impact the Nigerian economy. The findings revealed that natural gas consumption had a positive and insignificant impact on economic growth in Nigeria during the study period. The findings further showed that energy consumption has implications for growth in Nigeria. Overall, the current research contributes to the discourse of the impact of energy consumption on economic growth, emphasizing the need for targeted and informed interventions in the energy sector to promote sustainable economic growth. The implications of this research are profound, as they not only contribute to the academic discourse on the energy-economics nexus but also provide actionable insights for policymakers. The emphasis on electricity consumption as a key driver of economic growth highlights the urgency of addressing Nigeria's energy challenges.

Recommendations

Based on the findings, the study recommends the following:

i. The observed positive and significant impact of the first lag of energy consumption on economic growth in Nigeria implies that energy consumption would help to boost economic growth. To this end, governments at all levels should promote energy consumption to boost economic growth in Nigeria.

ii. The observed negative effect of the current year's energy consumption on economic growth in Nigeria implies that energy policies have not been effectively formulated and implemented. Based on this finding, there is a need for the government to formulate appropriate energy policies to boost energy consumption and economic growth in Nigeria.

iii. The observed positive effect of natural gas consumption on economic growth in Nigeria implies that natural gas consumption has the potential to boost growth. Built on the result, the study recommends that the Nigerian government should strengthen economic policies to promote natural gas consumption and economic growth.

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Appendix 1: Cusum Plot