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ASSESSING THE EFFECT OF ENERGY CONSUMPTION ON ECONOMIC GROWTH IN NIGERIA (1980-2023)

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Abstract

The aim of this study is to assess the effect of energy consumption on economic growth in Nigeria, adopting the time series data panning from 1980 to 2023 and the Autoregressive Distributed Lag (ARDL) modeling approach, the study employed real GDP growth as the dependent variable with electricity consumption rate, Liquefied Petroleum Gas consumption, and inflation rate as dependent variables. The findings reveal that electricity consumption rate (ELCONSR) and liquefied petroleum gas consumptions (LPGCONS) are positively related to economic growth in the long run. While, inflation rate (INFLR) is negatively related to economic growth and statistically insignificant in the long run. The results of the estimates also indicated that the coefficient of liquefied petroleum gas consumptions is positive at both first and second lags and statistically significant only at first lag in relation to economic growth with the inflation rate having positive coefficients in the short run but statistically insignificant. The findings of the study further showed a negative coefficient for error correction technique with the speed of adjustment of - 0.089 percent for the convergence of long run equilibrium. The study also recommends for adequate energy infrastructure to ensure stable and improved electricity availability for consumption, to minimize and reduce the price of liquefied petroleum gas for improved household consumption rate, and to embark on sustainable monetary measures that will enhance adequate control of inflation to at least a single digit so as to enhance purchasing power in the economy.

Keywords: Energy, Consumption, Real GDP, ARDL

1. Introduction

Sustainability in energy is very crucial for meaningful economic growth and development of a nation. In most of the emerging economies including Nigeria, the energy demand is higher and this consequently determines the level of energy consumption. Several energy sources have been utilized in developing economies to meet the demand for energy use yet, the consumption remains unsatisfied. In any economy, energy is required to accomplish various tasks and activities involving industrial usage, individual usage, households, offices, machines, and equipment, to mention but a few. Energy demand is synonymous with energy consumption and it is a derived demand. Energy consumption is not done for its own sake but for other purposes including production, movement, and other activities (Stevens, 2000; Bhattacharyya, 2006;

Anochiwa, et al., 2020).

The level at which energy is available for consumption serves as a measure of the economic growth of a given nation. Thus, the more energy is consumed, the more it is used to determine the economic activities in an economy (Eggoh et al., 2011; Behmiri and Manso 2014; Babatunde and Adenikinju, 2016).

However, the economies with higher per capita energy consumption are more advanced than those economies with low levels of consumption (Wolde-Rufael, 2009). The energy crisis emphasized the value of energy consumption to achieve the growth aspiration of many global economies especially developing countries (Erbaykal, 2018).

Reports indicated that Africa is endowed naturally with energy resources in terms of petroleum, coal, Liquefied natural gas, electricity, sun, wind, and hydro among others. Owing to the concentration of oil and gas in this region, some countries depend greatly on fossil fuels for the generation of electricity power (Akinlo, 2018). In Sub-Saharan Africa, the demand for energy consumption has increased for utilization of energy from natural gas, petroleum, coal, and electricity. Over the years, the energy sector in this region had been crippled with various challenges involving inconsistency in the supply of energy (Adegbelemi & Babatunde, 2013) and energy became a scarce resource in the African economies than in the developed world (World Bank, 2020).

In Nigeria, energy consumption consolidates the performance of other sectors that usually provide essential services in terms of direct production activities in such sectors as agriculture, commerce, manufacturing, and mining, to improve economic growth (Ukoima & Agwu, 2019). Energy consumption is regarded as an engine of growth for almost all sectors of the economy as energy serves as the mainstay of wealth creation that boosts the operational activities of other sectors to enhance economic growth in Nigeria (Odularu & Okonkwo, 2019).

Thus, as an emerging economy, Nigeria requires a stable and efficient energy supply system to support and improve its economic growth, a country that is supposed to be the largest and major oil producer in the oil market has been reduced to the major importer of oil, making the nation vulnerable to oil shocks. Thus, several studies have examined the link between energy consumption and economic growth in both developed and emerging economies thereby revealing conflicting findings where some conclusions showed a positive relationship, while others indicated negative, or mixed results (Onakoya et al., 2013; Mustapha and Fagge, 2015; Zhang and Broadstock, 2016). Other studies that revealed energy consumption has an impact on economic growth in many countries include Belke et al., 2011; and Michael et al., 2019. The findings of

these studies showed positive for some, while others negative. Hence, the debate on the impact of energy consumption and economic growth is yet to be concluded empirically (Solarin et al., 2017; Dogan and Deger, 2016; Ozturk, 2015) particularly in Nigeria as a case study of a developing economy and an oil producing country. Therefore, the findings in this study will contribute to the knowledge and narrow the literature gap thereby assessing the effect of energy consumption on economic growth in Nigeria.

Besides this introductory section, the second section of this study reviews related literature, section three consists of the methodology, and the fourth section analyzes the results and discusses them and section five serves as the conclusion.

2. Literature Review

2.1 Empirical Review

Many studies have been conducted on the impact of energy consumption and economic growth. Prominent among the studies consists of the study of Tijani and Sani (2024) who examined energy consumption and economic growth in Nigeria using time series data from 1986 to 2020 with the specific objectives of ascertaining the effect of electricity consumption on economic growth, finding out the effect of premium motor spirit (PMS) consumption on economic growth, and to assess the causal relationship between energy consumption and economic growth in Nigeria. Adopting the Autoregressive Distributed Lag (ARDL), and the Granger Causality test, the findings indicated in objective one that an increase in electricity consumption led to a decrease in Gross Domestic Product (GDP) in Nigeria. Hence, electricity consumption had a significant negative effect on Gross Domestic Product (GDP) in Nigeria. Based on second the objective, the results showed that an increase in premium motor spirit consumption led to an increase in Gross Domestic Product (GDP) in Nigeria as premium motor spirit consumption had a significant negative effect on Gross Domestic Product (GDP) in Nigeria whereas the results of objective three indicates that a bi-

directional relationship runs between energy consumption and economic growth in Nigeria.

Okeoma, et al. (2023) evaluated the impact of energy consumption on economic growth in Nigeria from 1981 to 2018. The study adopted an ex-post facto method of research design, the Ordinary Least Square (OLS) regression technique, and the Johansen co-integration test for analysis. The results showed that gross fixed capital formation, electricity consumption, and crude oil consumption have a positive and significant impact on economic growth in Nigeria while coal consumption has a positive but insignificant impact on economic growth in Nigeria also there exists a long-term relationship between energy consumption and economic growth in Nigeria.

While, Bekun, et al. (2023) studied the asymmetric relationship between coal energy consumption, economic growth, rising urban population and emission level in South Africa from 1965-2018. The study adopted the novel Non-linear Autoregressive distributed lag methodology (NARDL) and the findings validate the asymmetric relationship between the variables under review. The result further indicated that positive shock by GDP increases CO₂ emission level while negative impact affects CO₂ emission in the long run. Whereas, on the other hand, coal consumption positive shock exhibits a detrimental impact on environmental quality in South Africa but urban population indicates non-significant effect on emission levels over the sampled period.

Similarly, Nkansah, Horace & Koranteng (2022) investigated electricity consumption determinants in West African countries, specifically involving Cote D'Ivoire, Ghana, Nigeria, and Senegal employing panel data from 1980 to 2018. The findings showed significant positive relationships between population growth, GDP, trade openness, and electricity consumption. The results also revealed that foreign direct investment has a positive influence on energy consumption but the consumer price index has a negative impact.

Whereas, Anochiwa, et al., (2020) examine the relationship between economic growth and energy consumption in Nigeria using ARDL bound test regression analysis. The study disaggregated energy consumption into electricity, coal, and petroleum with a growth rate of GDP data used from 1980 to 2017. The results indicated that petroleum and electricity variables are positive and significant to growth while coal is positive but not significant. The overall findings revealed that energy consumption has a positive relationship with economic growth. The study concluded that coal deposits must be put to use to increase energy production and consumption thereby stimulating other economic activities for growth.

Also, Kassim, F. A. and Isik, A. (2020) investigated the impact of energy consumption on industrial growth using such variables as manufacturing value added, electricity consumption, per capita income, exchange rate, import, and export employing yearly time series data from 1985 through 2017 in Nigeria. The study adopted the OLS method of regression, unit root, cointegration, and Granger causality tests for estimation. The findings showed a negative and insignificant relationship between electricity consumption and industrial growth. The Granger causality indicates a unidirectional causality running from electricity consumption to the growth of industries in Nigeria.

3. Methodology

The study assesses the effect of energy consumption on economic growth in Nigeria. Annual time series data on Real Gross Domestic Product (RGDP), electricity consumption rate (ELCONSR), Liquefied Petroleum Gas Consumption (LPGCONS), and Inflation rate (INFLR) spanning from the period of 1986 to 2023 are used. The data is obtained from World Bank Development indicators (WDI, 2023), National Bureau of Statistic (NBS, 2023), and Central Bank of Nigeria Statistical Buletin (CBN, 2023).

3.1 Model Specification

Adopting the model of Bekun, et al. (2023) with modifications, the study assesses the effect of energy consumption on economic growth in Nigeria and specifies the model as follows:

$$CO_2 = f(GDP, COAL, URB) \quad (1)$$

Where; CO_2 is carbon dioxide emissions, GDP is the gross domestic product as a proxy of economic growth, $COAL$ is the coal consumption, and URB is urbanization which is the control variable.

However, this study modified the model in equation (1) thereby including and dropping some variables towards assessing the effect of energy consumption on economic growth in Nigeria.

The model of this study is specified in a functional form as follows:

$$RGDP = f(ELCONSR, LPGCONS, INFLR) \quad (2)$$

The model is thus modified in an econometric form as follows:

$$RGDP_t = \beta_0 + \beta_1 ELCONSR_t + \beta_2 LPGCONS_t + \beta_3 INFLR_t + \varepsilon_t \quad (3)$$

After introducing a log to improve the linearity of the equation, the model is specified as:

$$LRGDP_t = \beta_0 + \beta_1 ELCONSR_t + \beta_2 LLPGCONS_t + \beta_3 INFLR_t + \varepsilon_t \quad (4)$$

Where: $RGDP$ = Real Gross Domestic Product, $ELCONSR$ = Electricity Consumption Rate, $LPGCONS$ = Liquefied Petroleum Gas Consumption, and $INFLR$ = Inflation Rate as the control variable, β_0 = Intercept term, β_1 , β_2 , and β_3 = Coefficients of the independent variables, and ε = Error term.

3.2 Descriptive Statistics and Trend Analysis

This study adopted the procedure of descriptive statistics to summarize and describe features of a data set such that a pattern of relationship will emerge from the data and to identify how the data is normally distributed to the fitness of regression.

3.3 Unit Root Test

The level of stationarity of the variables under consideration is tested using the unit root test. This explains the variables' stationary or non-stationary characteristics to ensure that the model has a constant mean and constant variance if all the variables are stationary. The order of integration of the variables is determined using the Augmented Dickey-Fuller (ADF) unit root test developed by Dickey and Fuller in 1979. Three specifications—none, intercept, and intercept and trend are used in running the ADF tests as shown in equations (5), (6), and (7) respectively.

$$y = \delta y_{t-1} + \varepsilon_t \quad (5)$$

$$y = \beta_0 + \delta y_{t-1} + \varepsilon_t \quad (6)$$

$$y = \beta_0 + \delta y_{t-1} + \beta_{1t} + \varepsilon_t \quad (7)$$

Where y represents the variable of interest, ε_t is the residual, β_0 is the constant, δy_{t-1} is the lag values of β_{1t} . If $\delta < 1$, then the series is stationary. If $\delta = 1$, then the series is non-stationary. However, if $\delta > 1$, the

series is regarded as nonstable or explosive. The null hypothesis (H_0) of the ADF unit root test is that the variable has a unit root (nonstationary). Therefore, the decision rule is that we reject the null hypothesis if the p-value is less than 5% level of significance, implying that the series is stationary and does not have a unit root.

3.4 Autoregressive Distributed Lag Bound Cointegration Test (ARDL)

This study also adopts the Autoregressive Distributed Lag Bound Cointegration Test (ARDL) to analyse the data. The ARDL model is an ordinary least squares (OLS)-based model that may be used to analyze both non-stationary time series and time series with mixed

order of integration as developed by Pesaran et al. (2001) and Shin and Smith (1995, 1999). Based on the t-test or F-test criteria, it is used to confirm the long-term association between the variables. The main benefit of this method is that pre-unit root testing was disregarded. The variable may be mutually co-integrated, stationary $I(0)$, or integrated of order $I(1)$. This is a significant advantage of the bound testing technique since the key variables should be steady while the other variables should not be (Bahmani-

Oskooee & Mitra, 2008). Furthermore, the bound test method can be used to determine both the short-run and long-run outcomes for a given model.

4. Results and Discussion

4.1 Descriptive Statistics

The study presents the results of descriptive statistics of the variables in Table 1 as follows:

Table 1: Results of Descriptive Statistics

	RGDP	ELCONSR	LPGCONS	INFLR
Mean	1375.846	14.96659	5.543182	19.09023
Median	1108.175	13.50500	3.285000	12.95000
Maximum	3200.950	27.96000	58.95000	72.80000
Minimum	270.0300	4.690000	0.240000	5.400000
Std. Dev.	870.3223	7.999254	10.21911	16.30050
Skewness	0.348603	0.322436	3.984059	1.828284
Kurtosis	1.705453	1.501720	19.57044	5.327760
Jarque-Bera	3.963570	4.877956	619.7955	34.44643
Probability	0.137823	0.087250	0.000000	0.000000
Sum	60537.24	658.5300	243.9000	839.9700
Sum Sq. Dev.	32570821	2751.487	4490.496	11425.37

Source: Author's computation, 2024

Table 1 present the result of the descriptive statistics which indicates that the mean of RGDP is the highest as 1376 and LPGCONS has the lowest figure of 5.54. The findings also show that all the variables have positive median, which indicates an evenly distributed series. RGDP also recorded the highest maximum value of 3201 and ELCONSR has the lowest maximum of 27.96 amongst the variables. The result in Table 4.1 also revealed that RGDP is also having the highest standard deviation of 870.3 with the ELCONSR having the lowest figure of 7.99. The skewness of all the variables are positive indicating a steeper tail on the left side of the distribution. The kurtosis of RGDP and ELCONSR are less than 3

showing a thin tailed distribution (platykurtic) and more than 3 for LPGCONS and INFR indicating a fat tailed distribution as leptokurtic. The Jarque-Bera statistic values of all the variables of interest are quite far from zero suggesting the variables are not normally distributed.

4.2 Unit Root Test

This study employed a unit root testing approach to ascertain stationarity of the variables the Augmented Dickey-Fuller (ADF) and Phillip Perron (PP) approaches. The results are presented in Table 2 as follows:

Table 2: Results of the Unit Root Test

Variables	Test Techniques				Order of Integration
	ADF t-statistics		PP t-statistics		
	Levels	1 st Diff	Levels	1 st Diff	
LGDP	-0.844661	-6.950825*	-1.183771	-6.713158*	I(1)
ELCONSR	-0.503372	-8.198918*	-0.440996	-8.023668*	I(1)
LLPGCONS	7.563099	5.866006**	11.10650	-5.492452***	I(1)
INFLR	-3.119637	-6.036160*	-2.972101	-10.14480*	I(0)

Note: *, **, and *** represent 1%, 5% and 10% significant levels respectively

Source: Author's computation using E-views 9, (2024).

Table 2 presents the unit root results of variables at levels and the first difference using Augmented Dickey-Fuller (ADF) and Phillip Perron (PP) approaches. The result shows that all the variables excluding the INFLR are nonstationary at levels and at 5% level of significant but becomes stationary at first difference. This implies that we cannot reject the null hypothesis that all the nonstationary variables- LGDP, ELCONSR, and LLPGCONS have unit roots while we can reject the null hypothesis that the stationary variable INFLR has a unit root. The results of both ADF and PP unit root tests indicated that the variables used in the model have

mixed order of integration which gives room to use the ARDL model for further estimation.

4.3 Autoregressive distributed Lag (ARDL) Model

The study employed the ARDL model of estimation involving the ARDL bounds test, short run and long run model of estimation.

ARDL Bounds Test

The ARDL bounds testing results are presented in Table 3 as follows:

Table 3: ARDL Bounds Test Results

Test Statistic	Value	K
F- Statistic	5.639116	4
Critical Value Bounds		
Significance	IO Bound	I1 Bound
10%	2.54	3.65
5%	2.96	4.11
2.5%	3.35	4.39
1%	3.64	5.14

Source: Authors' computation, 2024.

Table 3 indicates the result of the ARDL bound test and it shows that a long-run relationship exists among the variables of the estimate. This is ascertained by the value of the F-bound test statistic (5.639) which is greater than the critical value bound at a 5 percent

significant level both within the I(0) -2.96 and I(1) – 4.11 bounds. Hence, the study revealed the presence of long run relationships among the variables in the model involving electricity consumption rate, liquefied petroleum gas consumption, inflation rate, and economic growth over the period of study. The result

found evidence to suggests that economic growth and other variables in the model move together in the long run.

ARDL Short-Run and Long-Run Estimates

The study presented the results of the ARDL short run and Long run estimates in Table 4 and Table 5 respectively as follows:

Table 4: ARDL Short run Cointegration Form

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	10.58904	42.42395	0.249600	0.8047
D(GDP(-1))	1.023170	0.425895	2.402399	0.0232
D(GDP(-2))	-0.265432	0.244493	-1.085644	0.2869
D(ELCONSR(-1))	9.750013	26.27372	0.371094	0.0052
D(ELCONSR(-2))	8.562013	25.55400	0.335056	0.7401
D(LPGCONS(-1))	13.12167	10.11887	-1.296753	0.0003
D(LPGCONS(-2))	19.06719	17.29011	1.102780	0.2795
D(INFLR(-1))	0.281017	2.505054	0.112180	0.9115
D(INFLR(-2))	1.620830	2.489449	0.651080	0.5203
ECT(-1)	-0.894174	0.453222	-1.752282	0.0002

Source: Author's Computation, 2024.

Table 4 shows that the short run coefficients of GDP is positive and statistically significant at first lag in relation to other variable of interest. The result of the estimates also indicated that the coefficient of electricity consumption rate is positive and statistically significant at first lag in relation to the economic growth. This implied that a one percent change in electricity consumption rate will positively influence the economic growth in the short run. The results of Table 4 also revealed that the coefficient of liquefied petroleum gas consumptions is positive both first and second lags and statistically significant only at first lag. This implied that a 1% change in liquefied petroleum

gas consumption will influence the economic growth in the short run. While, inflation rate indicates positive coefficients in the short run but statistically insignificant. This suggest that inflation rate have no significant influence on economic growth in the short run. The result of error correction technique (ECT) depicts a negative coefficient and statistically significant fulfilling the requirement for adjustment. It showed the speed of adjustment coefficient as -0.0894174, indicating that the present disequilibrium in the short run will be adjusted at a speed of 0.089 percent to the long-run equilibrium convergence.

Table 5: ARDL Long run Coefficient Test Results

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-3.56E-11	6.01E-12	-5.931425	0.0000
GDP	1.000000	1.28E-15	7.79E+14	0.0000
ELCONSR	3.17E-13	1.38E-13	-2.288992	0.0027
LLPGCONS	2.68E-12	7.48E-13	-3.576478	0.0010
INFLR	1.37E-14	4.31E-14	0.318511	0.7518

Source: Author's Computation, 2024.

Table 5 indicated the result of the long run coefficient and it reveals that electricity consumption rate (ELCONSR) and liquefied petroleum gas consumptions

(LPGCONS) are positively related to economic growth in the long run. The result implied that a 1% change in electricity consumption rate and liquefied petroleum

gas consumptions will positively influence the economic growth by -3.17% and 2.68% respectively. While inflation rate is negatively related to economic growth but statistically insignificant in the long run.

Stability Test

This study employed CUSUM test to ascertain the level of stability of the series. The result is presented in figure 1 as follows:

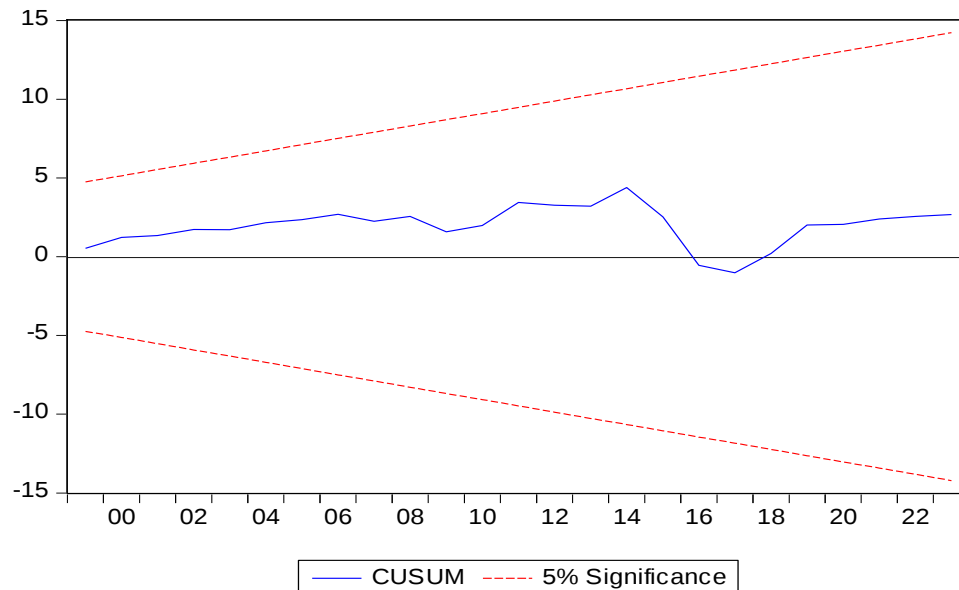


Figure 4.1: CUSUM Sum of Square Plot

Source: Author's computation 2024, using E-views 9.

Figure 1 showed the plot of CUSUM sum of squares. The plot indicates that the series in the model is relatively stable and consistent as it lies within the 5 percent level of significance.

5. Conclusion and Recommendations

This study aimed at assessing the effect of energy consumption on economic growth in Nigeria using the autoregressive distributed lag bound co-integration test approach. The study adopted annual time series for the variables such as real gross domestic product, electricity consumption rate, and liquefied petroleum gas consumption covering the period from 1980 to 2023. The result of the bound test cointegration suggests a long run relationship exist between the dependent and independent variables. The findings of the estimates reveal that electricity consumption rate (ELCONSR) and liquefied petroleum gas consumptions (LPGCONS) are positively related to

economic growth in the long run. While, inflation rate (INFLR) is negatively related to economic growth and statistically insignificant in the long run.

The findings of the study also indicated that the coefficient of liquefied petroleum gas consumptions is positive at both first and second lags and statistically significant only at first lag whereas, inflation rate indicates positive coefficients in the short run but statistically insignificant.

The error correction technique (ECT) depicts a negative coefficient and statistically significant fulfilling the requirement for adjustment from previous disequilibrium. The speed of adjustment coefficient showed a negative sign (-0.0894174), indicating that the present disequilibrium in the short run will be adjusted at a speed of 0.089 percent to the long-run equilibrium convergence.

Based on the foregoing findings, the study recommends that adequate energy infrastructure

should be put in place to ensure stable electricity energy supply and to improve the consumption rate, the price of liquefied petroleum gas should be stable to attract more household consumption rate, and also, the

level of inflation in the country is required to be minimized to a single digit to enhance purchasing power and improvement on economic growth in Nigeria.

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