ANALYSIS OF EFFECT OF ENERGY CONSUMPTION ON ECONOMIC GROWTH IN NIGERIA: A DISAGGREGATED APPROACH

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Abstract

The study investigated the impact of energy consumption on economic growth in Nigeria for the period 1980-2021. Ex-post facto research design was adopted in the investigation. Multiple regression analysis was employed, in which Auto-Regressive Distributed Lag (ARDL) as the method of analysis was utilized in the research. The ARDL model evaluates short run and long-run interactions among the specified variables. The results revealed the presence of long-run relationship among the variables. The results showed that both residential energy consumption and industrial energy consumption exert positive and significant effect on economic growth in Nigeria. The results also indicated that public sector energy consumption has a negative and insignificant effect on economic growth in Nigeria in the short run while in the long run 0, it has positive and insignificant effect on economic growth in Nigeria. Based on the findings, the study therefore recommends that government should ensure that the demand for electricity is met in the residential, public and industrial sectors of the economy by improving the nation's electricity generating capacity to meet the daily demand.

Keywords: Energy Consumption, Economic Growth, ARDL Test ,Nigeria

Introduction

Energy is not only a fundamental resource, but also critical to the survival and expansion of every economy. That is why every facet of economic activity on this planet earth requires energy in one form or the other to function effectively (Emeka, Nenubari Ikue & God'sgrace, 2019). Consequently, economic growth is directly related to energy consumption and this is why energy consumption is seen as a propelling force for every economic activity through industrial production. Hence, energy plays a crucial role in socio-economic development, industrial breakthrough, health, education, employment and overall welfare of a country citizen. Hence, sufficient amount of energy supply as well as its efficient utilization is needed for an economy to completely experience growth and development. That is, the level of energy consumption per capita is an important indicator of economic modernization. Thus, countries that have higher per capita energy consumption are more developed than those with low level of consumption (Maxwell, Nnena & Uloma, 2014; Babark, 2020).

Conceptually, energy consumption entails all the energy used to perform an action, manufacture something or simply inhabit a building. Energy consumption is classified into three: residential energy consumption, commercial energy consumption and industrial energy consumption. Residential energy consumption, otherwise known as home energy consumption, is part of what makes a home in relation to where refrigerators and other appliances that make home attractive to do personal things. This kind of energy consumption varies greatly by household, both in quantity and specific use. Commercial energy consumption is energy that is used in the commercial sector. This includes heating, cooling and lighting of commercial buildings and spaces, power used by companies and business throughout our cities for

computers, fax machines, workstations, copiers just to name but a few. Commercial energy use, which includes institutional energy use, is what gives businesses, schools (including universities), and public buildings like libraries the ability to serve the public. Commercial energy use should not be confused with industrial energy use; while both are businesses, commercial means engaging in commerce, while industrial means producing goods, usually from raw materials. Energy is used in the industrial sector for a wide range of purposes, such as process and assembly, steam and cogeneration, process heating and cooling, and lighting, heating, and air conditioning for buildings (Babark, 2020).

The epileptic supply of energy in Nigeria has made all the energy users like household users, commercial users and manufacturing firms depend on self-created electricity to power their operations and to maintain power back-up in the event of power failure, (Nkoro, Ikue-John, Okeke, Amabuike, & Ajaba, 2019). This situation is an irony, in a country where energy resources are in high abundance (Babatunde, 2016). This simply suggests that one of the salient keys impeding growth in the Nigerian economy is poor amount of energy generation, distribution and consumption in the country (Joy, 2014). That is, for decades of years now, there had been decline in general energy consumption especially industrial energy consumption in relation to capacity utilization of industry in Nigeria. This decrease has been attributed to epileptic power supply. The poor energy supply is believed to force businesses to depend on expensive and highly polluting off-grid self-generation or private generating plant which does not only puffed-up the cost of production by affecting the final price of goods and services but also, led to the extinction of some businesses in Nigeria (Umeh, Ochuba and Ugwo (2019).

Using trend analysis, we observed that the growth rate of residential energy consumption, public sector energy consumption and industrial energy consumption increased from 1.4% to 1.7%, 6.86% to 8.8% and 7.2% to 7.3% respectively from 1990 to 1995. Within these periods, gross domestic product decreased from 11.8% to 0.1%. Similarly, between 2000 to 2005, residential energy consumption, public sector energy consumption and industrial energy consumption increased from 1.5% to 3.7%, 8.4% to 17.1% and 6.7% to 7.6%; while GDP increased from 5.0% to 6.4%. Similar event was observed between 2010 to 2015 when residential energy consumption increased from 4.3% to 5.1% and to 5.8% in 2020; public sector energy consumption increased from 19.6% to 23.9% and to 27.0% in 2020; while industrial energy consumption increased from 11.6% to 14.3% and decreased to 13.7% in 2020. Within these periods, GDP decreased from 8.0% to 2.7% and to 1.8% 2020 (CBN, 2020). This implies that in some years, increase in energy consumption does not translate to growth in Nigeria's economy

From the trending, we obviously observed that the rate of energy supplied and consumed are contrary to endogenous growth theory which maintained that economic growth is due to factors that are internal to the economy and not external. This has led to high rate of inflation and unemployment due to low industrial performance or even its extinction of some business as a result of high cost of production.

Conceptual Explication

Energy Consumption

Energy consumption refers to the amount of electrical energy utilized in the production of something. That is, energy consumption refers to all the energy used to perform an action, manufacture something or simply inhabit a building. In a factory, total energy consumption can be measured by looking at how much energy a production process consumes, for example, by making car parts.

Residential Energy Consumption: This is also known as home energy consumption. It is defined as that

part of part of energy that are used at home. This energy differs greatly by household, both in quantity and specific use.

Commercial Energy Consumption: This kind of energy is used in the commercial sector. This includes heating, cooling and lighting of commercial buildings and spaces, power used by companies and business throughout our cities for computers, fax machines, workstations, copiers just to name but a few. Commercial energy use, which includes institutional energy use, is what gives businesses, schools (including tertiary institutions), and public buildings like libraries the ability to serve the public.

Industrial Energy Consumption: This kind of energy is used in industrial sector. The industrial sector uses electricity for operating industrial motors and machinery, lights, computers and office equipment, and equipment for facility heating, cooling, and ventilation.

Literature Review

A number of studies have been conducted so far to examine the relationship existing between energy consumption and economic growth. Adewale and David (2020) who examined the impact of electricity consumption on Nigerian economy between 1986 and 2018. Sourcing data from National Bureau of Statistics and using Autoregressive Distributed Lag Model, the researchers found that electricity consumption and gross domestic product are positively and significantly correlated in the short-run but in the long-run, electricity consumption impacted negatively and insignificantly on economic growth in Nigeria.

Ekone (2020) investigated the impact of renewable energy consumption on economic growth in Nigeria for the period 1990 to 2016. Data collected was analyzed using both descriptive analysis and econometric technique, which included unit root, correlation, co-integration, regression, and granger causality tests. The result revealed renewable energy consumption had no significant positive impact on economic growth in Nigeria. Furthermore, there was no causality between renewable energy consumption and economic growth in Nigeria during the period of study.

Patterson, Dinci and Jonathan **(**2020**)** re-evaluated the relationship between energy consumption and economic growth in Nigeria over the period 1999Q1-2016Q4 using alternative model specifications. Their study used ARDL model and found that the role of energy consumption as a driver of growth remained negligible throughout, suggesting that a lot still needs to be done to ensure that the expected role of energy begins to manifest in the Nigerian economy.

Marinaş, Dinu, Socol and Socol (2018) tested the correlation between economic growth and renewable energy consumption for ten European Union (EU) member states from Central and Eastern Europe (CEE) in the period 1990 to 2014, using Auto-regressive and Distributed Lag (ARDL) modeling procedure, Their results showed that in the short run, the Gross Domestic Product (GDP) and Renewable Energy Consumption (REC) dynamics are independent in Romania and Bulgaria, while in Hungary, Lithuania, and Slovenia increasing renewable energy consumption improves the economic growth.

Emeka, Nenubari and God'sgrace (2019) examined energy consumption and economic growth in Nigeria. Using modified Ordinary Least Square technique, the researcher found 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

Maji, Chindo, and Rahim (2019) examined renewable energy consumption and economic growth nexus in West Africa. They estimated the impact of renewable energy on economic growth in West African countries using panel dynamic ordinary least squares (DOLS) by employing a sample of 15 West African countries covering the 1995 to 2014 period. Their results indicated that renewable energy consumption slows down economic growth in these countries. This, they attributed to the nature and source of renewable energy used in West Africa, which is majorly wood biomass.

Stern, Burke and Bruns (2017) obtained panel data from 136 countries. The variables gathered were analyzed using cross-sectional regression analysis. The study noted a strong impact of electricity consumption on the development of the countries studied.

Theoretical Orientation

Energy Consumption Theory

This is also known as cost of energy theory. This theory is an extension of the existing grand theories that support the economic impact of improved energy efficiency. Hence, the theory states that the cost of using energy resources in production and service business operations can be compensated by the overall positive economic impact of these operations. The positive economic impact is due to the fact that the residual and incremental innovations in the businesses could lead to overall improvement in economy due to the random induced demand multiplier effect on monetary transactions (Babark, 2020).

Endogenous Growth Theory

The endogenous economic theory states that internal factors are responsible for a nation's economic development and not the external factors. According to this theory, when the government and the private sector invest in human capital, innovation, and knowledge, the nation's productivity is enhanced. In fact, the theory is built on the idea that improvements in innovation, knowledge, and human capital lead to increased productivity, positively affecting the economic outlook. The endogenous growth theory was first created due to deficiencies and dissatisfaction with the idea that exogenous factors determined long-term economic growth (Babark, 2020).

Methodology

The study adopted an ex-post-facto research design; as it focuses on utilizing already existing data that cannot be manipulated. The variables used in this study include gross domestic product (dependent variable) while residential energy consumption, public sector energy consumption and industrial energy consumption are the explanatory variables. The analytical tools employed include unit root tests, bound testing co-integration test and autoregressive distributive lag model (ARDL).The model for this study is anchored on the endogenous growth theory states that internal factors are responsible for a nation's economic development and not the external factors. The model for this study in its functional form is expressed as follows:

$$GDP = f(REC, PEC, IEC) \quad 1$$

The equation in 1 can also be expressed in logarithmic form as follows

$$\text{Log GDP} = \alpha 0 + \alpha_1 \text{LogREC} + \alpha_2 \text{LogPEC} + \alpha_3 \text{IEC} + U_t \quad 2$$

Where: GDP = Gross Domestic Product, REC is residential energy consumption, PEC is public sector energy consumption and IEC is industrial energy consumption, α_0 = intercept and α_1, α_2 and α_3 are the coefficients of the regression equation, U_t is the stochastic error term, while Log is the natural log of the variables.

Gross domestic product is the best way of measuring the economic growth of a nation. It takes into account the nation's entire economic output. **Residential energy consumption** is the part of energy that are used at home. **Public sector energy consumption** includes institutional energy such as heating, cooling and lighting of commercial buildings, power used by companies and businesses throughout our cities for computers, workstations, etc. Industrial energy consumption uses electricity for operating industrial motors and machinery, lights, computers and office equipment, and equipment for facility heating, cooling, and ventilation. These categories of energy measured are measures in joule and expressed in logarithm. The data for this work is from CBN and International Energy Agency from 1980-2021. The time series properties of data were examined in order to avoid spurious result emanating from the non stationarity of the data and to analyze the dynamic structure of the relationship. The estimation begins with a unit root test to confirm the stationarity state of the variables that enter the model using Augmented Dickey Fuller (ADF) and Philip Peron (PP). Consequently, conducting the tests with and devoid of a deterministic trend (t) for all the series and comparing P-Values with the critical values at 5% significance level, we observed that the series have mixed order of integration and that led us to the application of ARDL model. The use of the ARDL model follows the outcome of the unit root test, which indicated mixed order of integration among the variables employed in the research, especially when the mixtures involve I(1) and I(0). Hence, to determine the short-run and long-run coefficients of the series, the ARDL model is applied in the analysis.

Findings

The variables considered are gross domestic product (GDP) (dependent variable), residential energy consumption (REC), public sector energy consumption (PEC) and industrial energy consumption (IEC) are used as the independent variables. Applying advanced econometric techniques, the results below were obtained.

Unit Root Test Results

In order to determine the stationarity status of the variables used in the model for the empirical analysis, Augmented Dickey-Fuller (ADF) test was employed and the test result is presented below as thus:

Table 1: Results of Augmented Dickey-Fuller Unit Root Test

	Level			**First Difference**			Remark
Variables	t-Statistics	5% critical value	p-value	t-statistics	5%-critical value	p-value	
LGDP	-1.657739	-2.935001	0.4447	-4.549978	-2.936942	0.0007	I(1)
LREC	-1.758822	-2.935001	0.3951	-6.365118	-2.936942	0.0000	I(1)
LPEC	-1.511674	-2.935001	0.5178	-6.915126	-2.936942	0.0000	I(1)
LIEC	-3.751802	-2.935001	0.0384	----------	----------	--------	I(0)

Sources: **Researcher's computation from E-view 9**

The Augmented Dickey Fuller (ADF) unit root test presented in table 1 above revealed that industrial energy consumption (LIEC) was stationary at level whereas gross domestic product (LGDP), residential energy consumption (LREC) and public sector energy consumption (LPEC) were stationary at first difference. This unit root test result therefore revealed the existence of a mixed order of integration among the variables of the study. The mixed order of integration from the unit root test results implies the possibility of long-run relationship among the variables of the study, though further investigations using ARDL – Bound test result will reveal if actually long run relationship exist among the variables of the study.

ARDL Bounds Test

The bound test is used to examine whether the variables are co integrated. The variables are said to be co integrated if the F-statistics is greater than the critical values and otherwise if it is less. The result of Bounds test is presented in the Table 2 as follows:

Table 2: ARDL Bounds Test

Null Hypothesis: No long-run relationships exist		
Test Statistic	Value	k
F-statistic	7.715312	3
Critical Value Bounds		
Significance	I0 Bound	I1 Bound
10%	2.72	3.77
5%	3.23	4.35
2.5%	3.69	4.89
1%	4.29	5.61

Sources: **Researcher's computation from E-view 9**

The results of the ARDL bounds test presented in Table 2 above shows that a long-run relationship exists between energy consumption and economic growth in Nigeria within the period of the study. This is validated by the computed *F*-statistics (7.715312) which is greater than the upper critical value (4.35) at 5% level of significance; thereby implying that energy consumption and economic growth are co integrated in the long run at 5% level of significance.

ARDL Short-Run Results

The evidence of equilibrium long-run relationship revealed by ADRL bound test among the variables; prompted the investigation of the coefficients of the short-run and long-run of the variables employed in the study using the ARDL short-run and long-run coefficients test with the objective of ascertaining the elasticity or magnitude of the parameters. The results as estimated are presented in tables 3 and 4 of below:

Table 3: ARDL Short-run Coefficients Test

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(LREC)	0.411554	0.147500	2.790200	0.0352
D(LPEC)	-0.077861	0.134385	-0.579387	0.5664
D(LIEC)	0.240698	-0.097650	-2.464907	0.0451
D(LIEC(-1))	-0.057898	0.027800	-2.082627	0.0454
CointEq(-1)	-0.079882	0.017759	-4.498063	0.0001

Sources: Researcher's computation from E-view 9.0

R^2 = 0.998929, F-stat = 4263.031, Prob (F-stat) = 0.000000, DW Sta

From the ARDL model results estimated between energy consumption and economic growth in Nigeria presented in table 3 above, residential energy consumption has a positive and significant effect on gross domestic product in Nigeria. The results also revealed that public sector energy consumption has negative and insignificant effect on gross domestic product while industrial energy consumption has a positive and significant impact on gross domestic product in Nigeria. These claims are supported by the p-values and the coefficients of the variables estimated in the regression equations. From the results, the coefficients of LREC, LPEC, LGDP, and LIEC are 0.411554, -0.077861 and 0.240698 respectively; while their p-values include 0.0352, 0.5664 and 0.0451 respectively. The positive sign of the coefficients of residential and industrial energy consumption is in line with the theoretical postulation.

The results also indicated a coefficient of multiple determination (R^2) value of 0.998929, which entails that 99.8 percent of the variations in the dependent variable are accounted by changes in the specified independent variables. The results above indicate that the explanatory variables are very good predicators of the explained variable and therefore, represents a measure of goodness of fit of the model. Equally, the value of F-statistic as can be discerned from the model is 4263.031 with Prob (F-statistic) of 0.000000, which is less than 0.05 critical value indicates that the explanatory variables exert significant joint influence on the explained variable when considered at 5 percent level of significance. The Durbin-Watson stat revealed in the estimation results is 2.261278 which is approximately two digits, shows the absence of serial auto correlation in the model.

ARDL Long Run Results

The long run relationship between energy consumption and economic growth in Nigeria is accessed by the lower part of the result of Autoregressive Distributed Lagged (ARDL). The result is presented as follows in the Table 4:

Table 4: ARDL Long-run Coefficients Test

Variable	Coefficient	Std. Error	t-Statistic	Prob.
LREC	2.359093	1.042425	2.263081	0.0310
LPEC	1.370663	1.680545	0.815606	0.4208
LIEC	2.406688	-1.159895	-2.074919	0.0461
C	6.086700	4.972966	1.223958	0.2299

Sources: Researcher's computation from E-view 9.0

Table 4 above reveals the long-run coefficients test results of the ARDL model for which the variables under consideration were estimated. From the results, residential energy consumption has a positive and significant effect on gross domestic product. The results also revealed that public sector energy consumption has positive and insignificant effect on gross domestic product whereas industrial energy consumption has a positive and significant impact on gross domestic product in Nigeria. In the same vein, these claims are supported by the p-values and coefficients of the variables estimated from the ARDL long-run coefficients test. From the results, the coefficients of LREC, LPEC and LIEC are 2.359093, 1.370663 and 2.406688 respectively and their p-values include 0.0310, 0.4208 and 0.0461 respectively. The positive sign of the coefficients of this energy consumption is in tandem with the a priori expectation.

Implications of the Results

The study revealed that residential and industrial sector energy consumption have significant and positive impact on economic growth in Nigeria both in the short run and long run. This implies that residential energy consumption and industrial energy consumption are paramount to the growth of Nigeria's economy. Therefore, 1 joule increase in residential and industrial energy consumption increases economic growth by N0.411554 and N0.240698 respectively in the short run and N2.359093 and N2.406688 respectively in the long run. However, public sector energy consumption is detrimental to economic growth in the short run as the results revealed that 1 joule increase in public sector energy consumption would lead to N0.077861 decrease in economic growth in the short run and N1.370663 increase in economic growth in the long run. This short run negative impact of public sector energy consumption on economic may be due to nonchalant attitude of government owned institutions or agencies towards payment of energy bills.Based on the findings, the study recommends that:

As it found that residential energy consumption accelerates economic growth, government should ensure that the demand for electricity is met in the residential houses by encouraging the connection of the unconnected home to national grid.

Since public sector energy consumption is detrimental to economic growth in Nigeria due to the fact that majority of public institutions do not pay their utility bills, it is necessary that government ensure that public institutions pay their energy bills as at when due. This will boost energy supply and economic growth.

Since industrial energy consumption has significant positive impact on economic growth, government should guarantee industrial sector energy security by ensuring regular and adequate supply of energy to

the sector.

The study therefore, maintains that government should ensure that the demand for electricity is met in the residential, public and industrial sectors of the economy by improving the nation's electricity generating capacity to meet the daily demand

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