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The Impact of Electricity Consumption on Economic Growth in Nigeria: 1981-2017

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Abstract

A major factor that drives the process of economic growth across the world is energy supply and its consumption. Being a secondary source of energy, electricity supply is obtained by converting primary energy resource such as fossil fuels involving oil resources, natural gas and wind energy as well as coal. This study is conducted with the objective of investigating the impact of electricity consumption on economic growth in Nigeria for the period 1981 – 2017. Annual time series data were exploited for the study while a Distributed Lag (DL) mechanism was used to capture both the immediate and remote impact of electricity consumption on economic growth in Nigeria. The study found that both the current and past level of electricity consumption has significant impact on economic growth in Nigeria. It recommended among other things, massive investment in electricity infrastructure through diversifying into other sources of energy such as solar and thermal energy so as to meet the consumption needs of electricity and to increase the productive capacity of the economy for sustained economic growth.

Keywords: Electricity Consumption, Economic growth, Autoregressive Distributed Lag and Megawatt.

INTRODUCTION

A major factor that drives the process of economic growth across the world is energy. Energy consumption is the form of electricity consumption that uses electric energy. Electric energy consumption is the actual energy demand made on existing electricity supply. Electricity is related to power. Power is the ability performs a task (work). It is a rate of change in energy used. Common units are watts or horsepower. Watts (W) and kilowatt-hours (kWh) are the most common units used. To know how much energy is consumed, power is multiplied by the time. As a matter of fact, the relationship between power and consumption is *time*. A 100W bulb consumes 100W assuming the voltage across it is what's specified on the package, which is usually 120V. If the voltage in a socket is lower, the bulb will consume less power. It is approximately a fixed resistance. Most economic activities across the globe are driven by energy supply. As a result, there is a direct linkage between energy consumption and economic growth as observed in most literatures. As an indispensable tool that drives the process of development, the need for energy is constantly on the increase while scarcity in the supply of energy poses a great danger to the wheel of economic progress. Being a secondary source of energy, electricity supply is obtained by converting primary energy resources such as fossil fuels involving oil resources, natural gas and wind energy as well as coal.

Following this introduction, the rest of the paper is divided as: section 2 presents the literature review; section 3 presents the theoretical framework and methodology; section 4 presents the empirical estimates while section 5 presents the concluding remarks and recommendations.

LITERATURE REVIEW

The nexus between energy consumption and economic growth have been widely investigated over time. The argument in the literature is whether growth leads to consumption of energy or it is the other way round. Findings from extant studies are mixed depending either on the country-specific effects or the methodologies adopted. On the whole, evidence revealed that there exist, a strong correlation between energy consumption and economic growth. In some instances where bidirectional causality is found to exist between economic growth and energy consumption, the implication is that both economic growth and energy consumption complements each other as opposed to where a unidirectional causality is found.

For instance, in some of the developed countries, studies relating the effect of energy consumption and economic growth for the United States by Kraft and Kraft (1978), using Sims causality tests shows that over the period 1947 – 1974), there was a unidirectional causality from Gross National Product (GDP) to energy consumption. However, this was not the case for YU and Hwang (1984) who tested the relationship between energy and GNP in the United States between 1947 and 1979 with the aid of Sims causality analysis and found no causality between GNP and electricity consumption.

In China, Shiu and Lam (2004) investigated the relationship between electricity consumption and economic growth for the period 1970 – 2000 using Johansen Co-integration and Granger Causality test. They found unidirectional causality from electricity consumption to economic growth.

In the case of Spain, Ciarreth and Zarraga (2007) used both linear and non-linear causality mechanism to investigate the relationship between electricity consumption and economic growth for the period 1971-2005. The linear estimated found a unidirectional linear causality from economic growth to electricity consumption while the non-linear estimates found no causality between economic growth and electricity consumption.

In related study, Gorgul and Lach (2011) investigated the causality between electricity consumption and economic growth for Poland within the period 200 – 2009. The study used both linear and non-linear causality test and found a bidirectional causality between GDP and electricity consumption.

In studies relating to group of countries, Yu and Choi (1985) studied the causality relationship between energy and GNP by comparing five countries for the period 1950 – 1976. They used Sims and Granger causality tests and found that there was unidirectional causality from energy consumption to GNP in the Philippines and a reverse causality from GNP to energy consumption in South Korea. The study found no causality in the case of United States, United Kingdom and Poland.

In another group of countries studies, Bildirici and Kayokci (2012) adopted an Autoregressive Distributed Lag (ARDL) method and Granger causality test to investigate the causality between economic growth and electricity consumption in emerging countries of Europe. The study found a bidirectional causality between electricity consumption and economic growth in Belarus, Czech Republic, Hungary, Poland and Romania. They found a unidirectional causality from economic growth to electricity consumption in Albania while they found a unidirectional causality from electricity consumption to economic growth for Bulgaria and Slovakia in the long term.

In the same vein, Bildirici, Bakirtas and Kayilkci (2012) applied the same ARDL model to investigate the directional causality between electricity consumption and economic growth for a group of eleven (11) countries for the period 1978 – 2010. The study found a unidirectional causality from electricity consumption to real GDP in the United States, China, Canada and Brazil. Unidirectional causality was found from economic growth to energy consumption in India, Turkey, South Africa, Japan, United Kingdom, France and Italy.

Relatedly, Ansgar, Dreger and Franke (2010) investigate the causal link between energy consumption for 25-member OECD countries from 1981 to 2007. Applying a principal component analysis, they show that there exist long run relationship between energy consumption and economic growth. They further show that energy consumption was price-inelastic and conclude that there is a bidirectional causal relationship between energy consumption and economic growth.

In some studies relating to energy and developing countries, there exist mixed findings. For instance, in Turkey, Ozun and Cifter (2007) applied the wavelet analysis to investigate a multi-scale causality between energy consumption and GNP for emerging markets for the periods 1968 – 2002. Their results found a unidirectional causality running from GNP to energy consumption in the long-term. The result was different from earlier study by Altinay and Karagol (2005) who applied the Dolado-Lutkepohl and Granger-Causality test to investigate the direction of causality between electricity consumption and economic growth for Turkey within the period 1950 – 2000. Their finding was a unidirectional causality from electricity consumption to economic growth. In some other studies relating to Turkey, Aktas and Yilmaz (2008) used Granger-causality mechanism to investigate the causal relationship between electricity consumption and economic growth for the period 1970 – 2004 and found a unidirectional causality from economic growth to electricity consumption.

In the studies by Yaprakh and Yurtrancikmaz (2012) as well as Nazhoglu, Kayhan and Adiguezel (2014) applying Johansen cointegration and Granger causality, and Bound testing cointegration respectively, a bidirection causality between economic growth and electricity consumption was found for the period 1970 – 2010 and 1967 – 2007 respectively for the Turkish economy. On the direction of relationship between economic growth and electricity consumption for Turkey, Karagol, Erbaykal and Ertughul (2007) used an ARDL bond test and found a positive relationship between economic growth and electricity consumption for the period 1974 – 2004, in the long-run and a negative relationship in the short-run. Aslan (2014) found positive impact on economic growth and that there was a bidirectional causality between economic growth and electricity consumption in Turkey for the period 1968 – 2008 with the use of ARDL bond test and Granger-causality test.

In the case of Pakistan, Hye and Riaz (2008) applied an ARDL bond test and Granger Causality test for the period 1971 – 2007 and found a unidirectional causality from economic growth to electricity consumption in the long-run. On the other hand, Atif and Siddiqi (2010) using Granger causality test and a modified WALD test for the period 1971 – 2007 found a unidirectional causality from electricity consumption to economic growth for Pakistan.

In the case of Ghana, Adom (2011) applied the Toda and Yamamoto Granger causality test for the period 1971 – 2008 and found a unidirectional causality from economic growth to electricity consumption. Also Enu and Havi (2014) employed the ADF, Cointergration, VEC and Granger-causality test to investigate the influence of electricity consumption on economic growth in Ghana for the period 1980 – 2012. The result showed that in the long-run, electricity consumption has a causal effect on GDP per capita while in the short-run, electricity consumption negatively affects real GDP per capita with a unidirectional causality running from electricity consumption to economic growth.

In the case of Nigeria, Ogundipe and Apata (2013) applied a Johansen and Joselius Cointegration test and the Granger-Causality test for the period 1980 – 2008 and found a bi-directional causality between economic growth and electricity consumption. On the other hand, Akinwale, Jesuleye and Siyanbola (2013) applied VAR and ECM for the period 1970 – 2005 and found a unidirectional causality from economic growth and electricity consumption in Nigeria.

THEORETICAL FRAMEWORK AND METHODOLOGY

Although, received theoretical orthodoxy (classical and neoclassical thinking etc) did not give any recognition to energy as a factor of production, modern economists have developed theoretical models that incorporate the role resources (including energy) in the growth process. Among those numerous economists, Stem (1999) opined that energy is a key factor in the production process. The role of thermodynamics and its variants in economic growth process were captured in the endogenous growth models, built around the Harrod-Domar "AK" model. Consequently, the simplified version of the production function with diminishing returns is given as:

$$Y = AK \quad - 1$$

Where Y is the level of output; A is a positive constant and K is the Capital stock.

The above production function can be described following Romar (   ) as

$$Y = f(AK, L) \quad - 2$$

Here, L is the stock of Labour while other variables were as previously defined.

Since Romar recognized investment in research and technology and endogenous, the aggregate production function is described as:

$$Y = f(A, K, L) \quad - 3$$

In order to investigate the role of energy in economic growth, the above production function is augmented with electricity consumption as:

$$Y = f(K, L, EC) \quad - 4$$

Where: EC is electricity consumption. Since the focus of this paper is on the impact of electricity consumption on economic growth, the econometric model is framed as:

$$RGDP = f(EC) ----------------------------- 5$$

Here; RGDP is real gross domestic product, while EC is electricity Consumption Linearizing equation (5) yields:

$$RGDP = \beta_0 + \beta_1 EC + \mu -------------------------- 6$$

Where, μ is a random error term; β_0 is the intercept of the function and β_1 is the coefficient. With the presence of no cointegration among the variables, equation (6) is distributed as:

$$RGDP_{t-2} = \beta_0 + \beta_1 EC_t + \beta_2 EC_{t-2} + \mu_t ------------------ 7$$

EMPIRICAL ESTIMATES

The Regression estimates as presented in table (4.5) below are carried out in line with the empirical specification of equation (7). The results are plausible in that the estimated parameters are significantly high at 5 percent level. Prior to actual estimation, the characteristics of the time series properties were tested via the unit root test as presented in table 4.1 below:

Table 4.1 Unit Root (Stationarity) Test

Variable	Critical value at 5 percent	ADF value at 5 percent	status
RGDP	-2.4999	- 4.033048	I(1)
EC	-2.9499	- 3.473366	I(1)

Source: *Author's Computation, (2018)*

The result of unit root as presented above shows that all the variables are integration of the order 1. Hence, the linear combination of the variables were estimated at a level from without the intercept and their residual obtained and subjected to co-integration test. The co-integration test indicates that the null hypothesis of no co-integration among these variables can be rejected.

Table 4.2 Test of Co-integration with Trace Test

Hypothesized No of CE(s)	Eigen Value	Trace Statistic	5 percent critical value	1 percent critical value
None*	0.357151	15.89421	15.41	20.04
At most 1	0.012200	0.429610	3.76	6.65

Source: *Author's Computation, (2018)*

*(*)   denotes rejection of the hypothesis at the 5 percent (1 percent) level
\>   Trace test indicates 1 co-integrating equation(s) at the 5 percent level.
\>   Trace test indicates no co-integration at the 1 percent level.

Table 4.3 Test of Co-integration with maximum Eigen value

Hypothesized No of CE(s)	Eigen Value	Max-Eigen Statistic	5 percent critical value	1 percent critical value
None*	0.357151	15.46460	14.07	18.63
At most 1	0.012200	0.429610	3.76	6.65

Source: *Author's Computation, (2018)*

*(*)   denotes rejection of the hypothesis at the 5 percent (1 percent) level
\>   Max-Eigen value test indicates 1 co-integrating equation(s) at the 5 percent level.
\>   Max-Eigen value indicates no co-integration at the 1 percent level.

Since both the trace statistic and Maximum-Eigen value statistic indicates no co-integration among the variables, the study ran a distributed lag model and granger-causality test in place of the Johansen method. This is due to the presence of a fractionally – integrated series with fractional differencing operator as exhibited by the data. The utilization of the Granger-causality and distributed lag model was intended to avoid spurious regression. Hence, the vector Error Correction Mechanism (VECM) was used to test the short-run relationship among the variables.

Results of the Granger-causality test are presented in table 4.4 below:

Table 4.4 Granger-Causality Test

Null hypothesis	Obs.	F-statistic	Probability	Decision
EC does not Granger-cause RGDP	35	1.63948	0.21100	Reject
RGDP does not Granger-cause EC		1.49079	0.24141	Reject

Source: *Author's Computation, (2018)*

The results of causality test shows that the null hypothesis of electricity consumption does not Granger-cause economic growth can be rejected – meaning that electricity consumption can result to economic growth in Nigeria. Hence, improvement in energy consumption may have great impact on the growth and development of a country.

Table 4.5 Regression Results

Variable	Coefficient	Std Error	t-Statistic	Prob.
EC	3.043126	1.609914	1.890242	0.0673
EC_{t-2}	1.597320	0.330192	4.837551	0.0000
CONSTANT	- 11.22502	5.827238	- 1.926303	0.0625

R-Squared	0.601443	Mean Dep. Variable	7.056486
Adjusted R-Squared	0.577999	SD dep. Variable	1.721364
S.E of Regression	1.118226	Akaike Inf. Criterion	3.138969
Sum. of Sq. resid.	42.51461	Schwarz Criterion	3.269584
Log Likelihood	- 55.07093	F-Statistic	25.65392
Durbin-Watson Stat.,	2.052708	Prob. F-Stat	0.00000

Source: *Author's Computation, (2018)*

The regression results show that in the absence of electricity consumption, economic growth would decline (in absolute term) by over 1122 percent. The result indicate that on the average, the immediate impact of electricity consumption on economic growth is over 300 percent (in absolute term) while the remote impact is over 159 percent.

The implication of this finding is that a more frequent utilization of electricity consumption can be beneficial to the growth of the economy.

CONCLUSION AND RECOMMENDATION

An attempt has been made in this study to examine the impact of electricity consumption on economic growth in Nigeria for the period of 1981 – 2017. A distributed lag model was employed to analyze the time series data. A unit root test is performed on the data in order to examine the stationary status of the data. Since the series has a unit root, there resulted in the use of first-differencing mechanism. The study found the existence of a unique co-integration relationship among the variables while the application of the VECM estimates show some possibilities of a high speed of adjustment to the steady state. Since electricity consumption is found to have a very high impact on economic growth via a Granger-Causality test, there is the need to strengthen both the effectiveness and efficiency of electricity generating capacity. This could be achieved by constant maintenance of machineries and expanding thermal plants to generate sustainable power supply and consumption.

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