

Impact of Energy Consumption on Economic Growth in Nigeria: An Approach of Time Series Econometric Model

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Abstract

The study examined the impact of energy consumption on economic growth over a period of 1980 to 2017. The specific objectives are to: investigate to what extent does components of energy consumption effect Economic Growth in Nigeria and ascertain if there is long-term relationship between components of energy consumption and Economic Growth in Nigeria. The Expost-facto research method was the research design. The methods of data analysis were Augmented Dickey-Fuller Unit Root test statistic, Engle-Granger Co-integration test, error-correction mechanism, Heteroscedasticity White Test, Ramsey Reset and Durbin-watson test. The study concluded that there is impact of energy consumption on Economics growth in Nigeria. The empirical result shows that the coefficient of petroleum oil has 78% positive significant effect on Real Gross Domestic Product (RGDP), Liquidified natural gas (GAS) has 44% positive significant effect on Real Gross Domestic Product (RGDP) and the electricity (ELECT) has 20% positive insignificant effect on Real Gross Domestic Product (RGDP). The RGDP has no long-run relationship with PETRO, GAS, and ELECT. Hence, the energy consumption has no long-run relationship with economic growth. This study therefore recommends that companies in charge of oil refining and transportation should increase petroleum supply around the country by connecting the major towns with petroleum pipelines. Nigeria Government should formulate policy that encourages crude oil drilling companies to use sophisticated technology that will not cause crude oil spillage in the oil drilling environment.

Keywords: Energy Consumption, Petroleum oil, Electricity, Liquidified Natural Gas Economic Growth

Introduction

Energy is a fundamental resource in the economy. Every facet to economic activities in this planet earth required energy in one form or the other to function effectively. Consequently, economic growth is directly related to energy consumption. As Alam, (2006) puts it, “energy is the indispensable force driving all economic activities”.

Nigerians use a lot of energy in homes, in businesses, and in industry. They also use energy for personal travel and for transporting goods. United State of America (USA) Energy and information Administration identified five major energy consuming sectors: industrial sector includes facilities and equipment used for manufacturing, agriculture, mining, and construction; transportation sector includes vehicles that transport people or goods, such as cars, trucks, buses, motorcycles, trains, aircraft, boats, barges, and ships; residential sector includes homes and apartments; commercial sector includes offices, malls, stores, schools, hospitals, hotels, warehouses, restaurants, and places of worship and public assembly and electric power sector consumes primary energy to generate most of the electricity the other four sectors consume. To point out how energy consumption is important, Ojinnaka (2008) opined that energy consumption runs hand in hand with the national product hence energy is a fundamental resource in the economy.

Energy as generally defined as ability to do work. Energy comes in different forms: Heat (thermal), Light (radiant), Motion (kinetic), Electrical, Chemical, Nuclear energy and Gravitational. Researches of scholars have identified major categories of Energy namely: Stored (potential) energy and Working (kinetic) energy. Energy sources are divided into two groups: Renewable (an energy source that can be easily replenished) and Nonrenewable (an energy source that cannot be easily replenished). Renewable and nonrenewable energy sources can be used as primary energy sources to produce useful energy such as heat or used to produce secondary energy sources such as electricity. There are five main renewable energy sources: Solar energy (from the sun), Geothermal energy (from heat inside the earth), Wind energy, Biomass (from plants), Hydropower (from flowing water). Most of the energy consumed in the Nigeria is from nonrenewable energy sources: Petroleum products, Hydrocarbon gas liquids, Natural gas, Coal, Nuclear energy. Crude oil, and coal are called fossil fuels because they were formed over millions of years by the action of heat from the earth's core and pressure from rock and soil on the remains (or fossils) of dead plants and creatures such as microscopic diatoms. Nuclear energy is produced from uranium, a nonrenewable energy source whose atoms are split (through a process called nuclear fission) to create heat and, eventually, electricity.

Crude oil is the dominant source of commercial energy use, accounting for over 70% of national commercial energy consumption, of this, the transport sector accounts for about 70% of commercial energy consumption. In Nigeria, crude oil has been a major economic growth determinant. For the past three decades it has claimed the topmost position in the export list of the country (National Bureau of statistics, 2006). Presently, there are eleven huge Oil producing and exporting companies in the country. The share of oil in total exports is over 90%. Nigeria was one time the 6th largest oil producing country in the world but today it is presently 8th due to the unrest in the Niger Delta region of Nigeria which is under intense militant crises. Oil is Nigeria's major sources of revenue used for development. As at January, 2005, Nigerian's proven crude oil reserve stood at 35.2 billion barrels. The Energy Information

Association (EIA) (2007) is of the view that Coal is not part of the country's energy consumption mix.

Nigeria is heavily endowed with 22 mines of coal resources which have a total proven capacity of 2 billion tonnes. Coal was the first energy resource to be exploited in Nigeria. It then immediately became the power of the country but its relevance began to drop immediately after oil was discovered. The level of significance attributed to coal by the nation began to drop very quickly and today it is insignificantly used as an energy resource. In many countries which use coal as an energy resource, increased coal consumption reflects the increasing output of industry, transportation, and even agriculture. Coal resources are mainly located in Udi Hill Enugu State and it is sub bituminous with low sulphur and ash content (Gbadebo & Okonkwo, 2009).

Nigeria has abundant reserve of natural gas. In energy terms, the quantity of natural gas is at least twice as much as the oil, and the horizon for the availability of natural gas is definitely longer than that of oil. The known reserves of natural gas have been estimated at about 2.4×10^{12} cm³ and are expected to last for more than a century as a domestic fuel and a major export. Nigeria has the largest natural gas reserves in Africa and is among the top ten in the world. However, due to a lack of utilization infrastructure, Nigeria still flares about 40% of the natural gas it produces, accounts for about 20% of all gas flared worldwide. In Nigeria, 75% of the associated gas was burnt off that is flared. This wastage was due to the inadequate infrastructure

and the remedy is therefore to build suitable infrastructure to reduce this wastage which could have been used to boost supply and increase receipt from sellers of this energy product. Natural gas can be also converted into liquid state known as the Liquefied Natural Gas (LNG) (Gbadebo & Okonkwo, 2009).

Despite this abundance of natural resources, the citizens still suffer from epileptic power supply. The frequent power outages have been seen to be dependent on the low generating capacity relative to the installed capacity. Several governments of Nigeria have in the past and present pursued the goal of providing constant electricity supply in all the parts of the country. Despite the huge investments made in the power sectors by several administrations over the years, there has been little or no significant improvement on the supply of electricity (Okorie & Adasi-Manu, 2016). There is also the fact that the Nigerian economy has reflected a steady increase in growth over the years even with a power sector that functions below par. The size of the economy marked by the Gross National Income per capita is put at \$2,710 (World Bank, 2014). Only 40% of Nigerians have access to electricity (Energy Information Administration, 2007). However, majority of the electricity is supplied to the urban areas. According to the encyclopaedia on energy (2006), energy is a vital ingredient to economic growth and that this has been discovered for as long as economic data has been compiled.

The relationships between energy consumption and economic growth have been investigated over time but there is still need for continuous research and development. Many studies are based on whether the economic growth leads to energy consumption or vice-versa. There is no consensus regarding this so-called energy consumption-growth. The findings of many empirical studies show that there is a strong correlation between electricity use and economic development (Adeyemi & Ayomide, 2013; Enu & Havi, 2014; Ongono, 2009). Similar studies reveal that there exists positive and insignificant effect of electricity consumption on

economic growth (Ayodele, 2004). According to Adeyemi & Ayomide (2013), the debate on the effect of energy consumption on economic growth and development remains inconclusive, given the conflicting results of current studies. In support of the argument, it is evidence from the empirical review carried out that there are diverse result by various studies, where some studies found that energy consumption (Petroleum and electricity) has positive and significant effect on economic growth (Gbadebo, & Okonkwo, 2009; Orhewere & Machame, 2011; Ansgar *et al.*, 2010; Adegbemi, Adegbemi, Olalekan, Babatunde, 2013; Aqeel & Butt, 2001). Some studies like that of Adegbemi, Adegbemi, Olalekan, & Babatunde, 2013; Aqeel & Butt, 2001; Aminu, & Aminu, 2015 opined that liquefied natural Gas consumption in Nigeria has positive but insignificant effect on economic growth. This study will improve on those studies by including additional variables. This major problem which this study is designed to solve is whether the components of energy consumption in Nigeria have significant effect on economic growth. The specific objectives are to:

1. investigate to what extent does components of energy consumption effect Economic Growth in Nigeria.
2. ascertain if there is long-term relationship between components of energy consumption and Economic Growth in Nigeria.

Empirical Review

The link between energy consumption and economic growth has attracted the attention of the researchers and scholars. The issue under review is a vital subject that should be subjected to painstaking empirical review in order to keep abreast with the positions of the concerned researchers and scholars on this subject and to determine the gap inherent in the earlier related studies.

Gbadebo, & Okonkwo, (2009) investigated the relationship between energy consumption and the Nigerian economy from the period of 1970 to 2005. The energy sources used to test for this relationship were crude oil, electricity and coal. By applying the co-integration technique, the results derived infer that there exists a positive relationship between current period energy consumption and economic growth. With the exception of coal which was positive, a negative relationship was noted for lagged values of energy consumption and economic growth.

Adegbemi, Adegbemi, Olalekan, Babatunde, (2013) investigated the causal relationship between energy consumption and Nigeria's economic growth for the period of 1975 to 2010. Secondary time-series data were analyzed using co-integration and ordinary least square techniques. The result shows that in the long run, total energy consumption had a similar movement with economic growth except for coal consumption. The empirical results reveal that petroleum, electricity and the aggregate energy consumption have significant and positive relationship with economic growth in Nigeria. However, gas consumption although positive, does not significantly affect on economic growth. The impact of coal was negative but significant; therefore this is just the time to increase the use this resource to the nation's benefit.

Aminu, & Aminu, (2015) in the study to re-examine the causal relationship between energy consumption and economic growth using Nigeria's data from 1980 to 2011 in a multivariate framework by including labour and capital in the causality analysis. Applying Granger causality

test, impulse response and variance decomposition analysis; the results of the causality test reported absence of causality and that of variance decomposition found that capital and labor are more important in affecting output growth compared to energy consumption.

Orhewere & Machame (2011) carried out a study aiming at determining the relationship between energy consumption and economic growth over a period of 1970 to 2005. The method of analysis was unit root test, co-integration statistics, and vector error correction based Granger causality test. The study found a unidirectional causality from electricity consumption to GDP both in the short-run and long-run. Unidirectional causality from Gas consumption to GDP in the short-run and bidirectional causality between the variable in the long-run. Although no causality was found in either direction between oil consumption and GDP in the short-run, a unidirectional causality from oil consumption to GDP is found in the long-run. Our findings imply that a policy to reduce energy consumption aimed at reducing emission will have negative impact on the GDP in Nigeria.

Enu & Havi (2014) carried a study aiming at examining the extent to which electricity consumption influences economic growth in Ghana. The study employed Augmented Dickey-Fuller test, Co-integration test, Vector Error Correction Model and Granger Causality test. The study revealed that, in the long term, a hundred percent increase in electricity power consumption will cause real gross domestic product per capita to increase by approximately fifty-two percent. However, in the short run, electricity consumption negatively affects real gross domestic product per capita. The study again revealed that unidirectional causality runs from electricity consumption to economic growth meaning that any policy actions taken to affect the smooth consumption of electricity in Ghana will definitely affect her gross domestic product per capita.

Adeyemi & Ayomide (2013) examined the relationship between electricity consumption and economic growth in Nigeria using the Johansen and Juselius Co-integration technique based on the Cobb-Douglas growth model covering the period 1980-2008. The study adopted also conducted the Vector Error Correction Modelling and the Pairwise Granger Causality test. The study found the existence of a unique co-integrating relationship among the variables in the model with the indicator of electricity consumption impacting significantly on growth. Also, the study shows an evidence of bi-directional causal relationship between electricity consumption and economic growth.

Ansgar *et al.* (2010) set out to determine the long-run relationship between energy consumption and real GDP, including energy prices, for 25 OECD countries from 1981 to 2007. They used principal component analysis to show how development both at an international level and national level account for the long-run relationship energy consumption and economic growth. Based on their results, international developments account most for the long-run relationship between energy consumption and real GDP. Their results also show that energy consumption is price-inelastic. Furthermore, they concluded that there is a bi-directional causal relationship between energy consumption and economic growth.

Ayodele (2004) carried out a research on improving and sustaining power (electricity) supply for socio economic development in Nigeria. His results obtained shows that electricity consumption is positively related to economic growth. He concluded that electricity

consumption have diverse impact in a range of socio economic activities and also on the living standards of Nigerians.

Aqeel and Butt (2001) researched on energy and its relationship with economic growth in Pakistan. He made use of cointegration and Hsiao's version of Granger causality. The empirical results revealed that economic growth causes total energy consumption which is quite different from the findings of other researchers. The results show no bidirectional relationship between economic growth and gas consumption. On the other hand, the study also found a bidirectional relationship between economic growth and electricity consumption. The study concluded that energy conservation policy on petroleum consumption would not lead to any side-effects on economic growth in Pakistan.

Ongono (2009) carried a study on Energy consumption and economic performance in Cameroon. The results of this study show that there is no Granger causality between electricity consumption and economic performance (GDP) at the national level and primary sector. The result also revealed that in the secondary sector, production Granger causes electricity consumption. Furthermore, in the tertiary sector, the causality runs from electricity consumption to production. He recommended that any policy aimed at strengthening growth and reduce poverty must pay special attention on energy production.

Molem, & Ndifor, (2016) carried a study aimed at determining effect of Energy Consumption on Economic Growth in Cameroon from the period of 1980 to 2014. The energy sources used to test for this relationship were Petroleum and electricity. The study made use of secondary time-series data. Using the Generalised Method of Moments technique, the results obtained shows that Gross Domestic Product (GDP), population growth rate and petroleum prices, have a positive relationship with petroleum consumption. Also, there was an established positive relationship between Gross Domestic Product (GDP), population growth rate, electricity prices and electricity consumption. Again, the study found a positive and significant relationship between petroleum consumption, electricity consumption, Gross domestic investment (GDI) and population growth rate and economic growth. Furthermore, the empirical result revealed that the rate of inflation and economic growth are positively related.

Methodology

This study made use of ex-post-facto research design which enables us to measure the effect or relationship between dependence variable and explanatory variables using time-series secondary data. To empirically examine the impact of energy consumption on the economic growth in Nigeria, the researcher subjected the data collected to Augmented Dickey-Fuller Unit Root test statistic, Engle-Granger Co-integration test, error-correction mechanism, Heteroscedasticity White Test, Ramsey Reset and Durbin-watson test.

Data Sources To investigate how energy consumption could affect economic growth in Nigeria, a number of variables have been taken into consideration in this study. These variables consist of petroleum oil (metrics Tonnes), liquidified natural gas (million cubic metres) and electricity (Megawatts per Hour) and Real Gross Domestic Product (RGDP) for the period of 1980-2017 and are defined in our model specification. All the variables were sourced from Central Bank of Nigeria's (CBN) statistical bulletin for various years.

VI. Model Specification

This study is anchored on the Aminu, & Aminu, (2015) in the study who re-examine the causal relationship between energy consumption and economic growth using Nigeria's data. Thus, the model is represented in a functional form of the model was shown below:

$$RGDP = F(PETRO, GAS, ELECT)$$

Where,

PETRO = petroleum Oil (Independent variable)

GAS = Liquidified Natural Gas (Independent variable)

ELECT = Electricity (Independent variable)

RGDP = Real Gross Domestic Product (Dependent variable)

In a linear function, it is represented as follows:

$$RGDP = \beta_0 + \beta_1 PETRO + \beta_2 GAS + \beta_3 ELECT + U_t \dots\dots\dots (2)$$

Where: β_0 = Constant term, β_1 to β_3 = Regression coefficient and U_t = Error Term.

Results and Discussion

The ADF test is used to test whether the variables are non stationary (unit root). If the results indicate that all series are stationary in the first difference or all series are generated by 1(1) and 1(1) process, condition of stationarity is established or confirmed (Gujarati, 2004). The unit root was carried out to avoid non-sense regression and violation of ordinary least square assumption.

Table 1

Results of Stationarity (unit root) test

Variables	ADF- Statistics	Critical Value	Order of integration
RGDP	-6.0422	1% level = -3.6289 5% level = -2.9472 10% level = -2.6118	Stationary first difference
PETROL	-5.8984	1% level = -3.6289 5% level = -2.9472 10% level = -2.6118	Stationary first difference
GAS	-3.9209	1% level = -3.6289 5% level = -2.9472 10% level = -2.6118	Stationary first difference
ELECT	-6.0477	1% level = -3.6289 5% level = -2.9472 10% level = -2.6118	Stationary first difference

Source: Author's computation

The results of the stationarity (unit root) test indicate that petroleum oil (metrics Tonnes), liquidified natural gas (million cubic metres) and electricity (Megawatts per Hour) and Real Gross Domestic Product (RGDP) were stationary at first difference. It is now referable to use Error Correction regression Model to estimate the parameters.

Engle-Granger Cointegration Results

Engle-Granger Co-integration test was used to check existence of long-run relationship among selected variables. The main theoretical argument of co-integration analysis is that even if individual variable is non-stationary, the group of variables may drift together. In support of this Engle and Granger (1987) pointed out that a linear combination of two or more non-

stationary series may be stationary. If such a stationary linear combination exists, the non-stationary time series are said to be *cointegrated*. The stationary linear combination is called the *cointegrating equation* and may be interpreted as a long-run equilibrium relationship among the variables.

Since the variables under study are integrated at the same order, there is the need to test for co-integration relationships using Engle and Granger two step procedure.

Date: 01/19/19 Time: 15:40

Series: RGDP PETRO GASOLINE ELECT

Sample: 1980 2017

Included observations: 38

Null hypothesis: Series are not cointegrated

Cointegrating equation deterministics: C

Automatic lags specification based on Schwarz criterion (maxlag=9)

Dependent	tau-statistic	Prob.*	z-statistic	Prob.*
RGDP	-2.474940	0.6973	-9.734382	0.7614
PETRO	-3.769788	0.1585	-21.17386	0.1342
GASOLINE	-2.874764	0.5073	-15.10093	0.4111
ELECT	-4.128428	0.0852	-23.29942	0.0822

*MacKinnon (1996) p-values.

Source: E-view Results

The Engle and Granger two step co-integration test identified that there were no co-integration equations in the model. The null hypothesis was that there no co-integration equations in the model. The tau test statistic and its probability value indicated no co-integrating equations at 0.05 significant level. The probability value of RGDP (0.6973), PETRO (0.1585), GAS (0.5073) and ELECT (0.0852) were greater than 0.05 significant level. It means that RGDP has no long-run relationship with PETRO, GAS, and ELECT. Hence, the energy consumption has no long-run relationship with economic growth.

Data Analysis**Empirical Results of the Multi-regression Error correction model**

Dependent Variable: D(RGDP,1)

Method: Least Squares

Date: 01/19/19 Time: 15:39

Sample (adjusted): 1981 2017

Included observations: 37 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	2308.712	15395.86	0.149957	0.8817
D(PETRO,1)	0.789223	0.256604	3.075645	0.0016
D(GASOLINE,1)	0.442120	0.090546	4.882821	0.0003
D(ELECT,1)	0.204857	0.655315	0.312608	0.4189
ECM-1	-0.220093	0.056192	-3.916803	0.0013
R-squared	0.805233	Mean dependent var		1034.120
Adjusted R-squared	0.802613	S.D. dependent var		89028.32
S.E. of regression	89322.20	Akaike info criterion		25.76298
Sum squared resid	2.55E+11	Schwarz criterion		25.98067
Log likelihood	-471.6151	Hannan-Quinn criter.		25.83972
F-statistic	14.40876	Durbin-Watson stat		1.936535
Prob(F-statistic)	0.000000			

Source: E-view Results

Error correction mechanism was carried out to examine parameters estimates. In testing this hypothesis, petroleum oil (PETRO), liquidified natural gas (GAS) and electricity (ELECT) were regressed against Real Gross Domestic Product (RGDP). The result of the regression analysis was summarized and it shows that the model for the effect of energy consumption on economic growth. The empirical result shows that the coefficient of petroleum oil has 78% positive significant effect on Real Gross Domestic Product (RGDP) because observed values of t – statistics was greater than its P-values. The Liquidified natural gas (GAS) has 44% positive significant effect on Real Gross Domestic Product (RGDP) because observed values of t – statistics was greater than its P-values. The electricity (ELECT) has 20% positive insignificant effect on Real Gross Domestic Product (RGDP) because observed values of t – statistics was less than its P-values. The results of the F – statistical test show that the overall regression of the variables was statistically significance. This is because observed values of the F – statistics (14.40879) was greater than its P-value. The ecm statistic showed that the model has 22% of the error is corrected every year from short-run to long-run. Again, our empirical result shows that the adjusted R-squared (R^2) is 0.8050. Explanatory powers of the variables were very high.

Econometric /Second Order Test

Table 2

Result of Durbin-watson Autocorrelation Test

Model	Observed value of Durbin – Watson (Dw)	Critical value of Durbin – Watson $Du(3 - du)$	Test Result
Model 1	1.9365	1.58	AA

AA = Autocorrelation Absent

The Durbin-watson test was used to identify whether the model suffer from autocorrelation problem. The autocorrelation problem violates of ordinary least square assumption that says there is no correlation among error terms of different observation. Durbin- Watson statistics (d^*) was carried to test randomness of the residuals and the assumption of ordinary least square was not violated. The result of Durbin–Watson test (1.885) carried out at five percent level of significance shows that the model is free from Autocorrelation problem was greater than upper critical value of Durbin-watson (1.58). This denotes that prediction base of the Ordinary Least Square estimates were efficient and unbiased.

Result of Heteroscedasticity White Test

White Heteroskedasticity Test:

F-statistic	5.156091	Probability	0.000000
Obs*R-squared	3.120105	Probability	0.000001

Source: E-view Results

This second order test checks whether the model of the study suffers Heteroscedasticity problem. Heteroscedasticity is violation of ordinary least square (OLS) assumption that error terms have unequal variance which results to biasedness and inconsistency in OLS estimators and the model can no longer be best linear unbiased estimator (BLUE). The null hypothesis; there is heteroscedasticity. The White test showed that there was no heteroscedasticity because Probability value of F-statistic was less than 0.05 significant level.

Result of Ramsey Reset Test

Ramsey RESET Test:

F-statistic	7.204614	Probability	0.000000
Log likelihood ratio	3.235831	Probability	0.000003

Source: E-view Results

This second order test checks whether the model of the study suffers model specification error. The Ramsey reset test showed that there was no specification error because Probability value of F-statistic was less than 0.05 significant level. It means that model include core variables in the model, does not include superfluous variables, the functional form of the model was very well chosen, there is no error of measurement in the regressand and regressor.

Conclusion/ Recommendations

The study concluded that there is impact of energy consumption on Economics growth in Nigeria. The empirical result shows that the coefficient of petroleum oil has 78% positive significant effect on Real Gross Domestic Product (RGDP), Liquidified natural gas (GAS) has 44% positive significant effect on Real Gross Domestic Product (RGDP) and the electricity (ELECT) has 20% positive insignificant effect on Real Gross Domestic Product (RGDP). The RGDP has no long-run relationship with PETRO, GAS, and ELECT. Hence, the energy consumption has no long-run relationship with economic growth.

This study therefore recommends that companies in charge of oil refining and transportation should increase petroleum supply around the country by connecting the major towns with petroleum pipelines. Nigeria Government should formulate policy that encourages crude oil drilling companies to use sophisticated technology that will not cause crude oil spillage in the oil drilling environment. Nigeria Government should be constructed and installed Natural gas infrastructures throughout the country. Availability of such facilities will increase the gas production and consumption and possibly economic growth. Nigeria Government should encourage research and development in the energy Sector in order to fully exploit other energy sources. There is need to increase research and development in the energy sector so that innovation can be fostered. Research and development into renewable sources of energy could be fostered and this could enhance economic growth. The Citizens of Nigeria should be educated on how limited electricity supply should be use wisely. Nigeria government should enforce law directing private operators in distribution electricity to provide prepaid metering system to public institutions, private institutions and the remaining households of the country.

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