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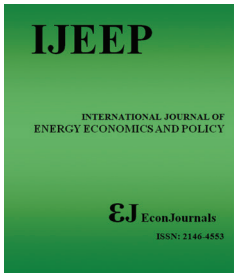

International Journal of Energy Economics and Policy

ISSN: 2146-4553

available at http: www.econjournals.com

International Journal of Energy Economics and Policy, 2020, 10(6), 713-721.

Energy Consumption and Economic Growth Nexus in Nigeria: Evidence based on ARDL Bound Test Approach

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Received: 03 June 2020 **Accepted:** 09 September 2020 **DOI:** https://doi.org/10.32479/ijeep.10021

ABSTRACT

This study examines the relationship between economic growth and energy consumption in Nigeria by using ARDL bound test regression analysis. In the investigation process energy consumption, was disaggregated into electricity, coal and petroleum with growth rate of GDP data is used from 1980 to 2017. The findings show that petroleum and electricity variables are positive and significant to growth while coal is positive but not significant. Overall outcome is that energy consumption has a positive relationship with economic growth. The coal deposit must be put in use to increase energy production and consumption and stimulate other economic activities for growth.

Keywords: Energy Consumption, Economic Growth, ARDL Test
JEL Classifications: Q32, Q044

1. INTRODUCTION

Energy demand is derived from the multiple activities (economic or non-economic) we need energy to accomplish. Such activities include industrial use, house hold, and individuals, running of equipment, cars and machines. Energy is not consumed for the sake of consuming it but for another purpose (e.g. for mobility, for producing goods and services, or for obtaining a certain level of comforts, etc.) (Hartman, 1979; Stevens, 2000; Bhattacharyya, 2006). Since the consumption of energy is derived, then we can use the activities where the energy goes to measure economic growth. After all economic growth depends upon the interaction of opportunities and choices. A country, or an entire region, may fail to grow either because there are no opportunities, or because choices are made that preclude opportunities being taken.

In this case, it is assumed the more energy is consumed the more it should explain the economic activities of a country, all things being equal (Babatunde and Adenikinju, 2016; Eggoh et al., 2011; Behmiri and Manso 2014). In general, it can be stated that economies with higher per capita energy consumption are more developed than those with low level of consumption all things being equal (Wolde-Rufael, 2009). Yes, it is necessary to add the caveat because there are countries that serve only as route to smuggle energy to other countries, such country's consumption pattern cannot be relied upon to measure energy consumption. Evidences abound of relationship between energy consumption and economic growth.

Energy demand relates to the amount of energy required in a country within a given period of time (i.e. primary energy demand) or to the amount supplied to the consumers within the same period (i.e. final energy demand). A little distinction could be made between energy consumed and energy demanded. Energy demand describes a relationship between price and what quantities will be purchased at a given price and how price changes will affect the

quantities sought (Fuinhas and Marques, 2013). While energy consumption takes place once the decision is made to purchase and consumption (i.e. it is an ex post concept). It refers to the manifestation of satisfied demand and how it can be measured.

As a growing economy, Nigeria needs stable and efficient energy supply system to move the economy forward. Regrettably, mediocre management of the economy has reduced a major oil producing country to major importer in the oil market, a fact that has made her deposed to oil shocks. Nevertheless, the Nigerian economy has witnessed significant increase in the level of energy consumption in recent years. The World Development Indicators of the World Bank give energy consumption in Nigeria as 579.096 kg oil equivalent per capita in 1971. By 2013, the level of energy consumption per capita in the economy had increased to 779.852 kg of oil equivalent. The increasing dependence of energy requirements of the Nigerian economy on fossil fuel energy sources suggests progress and industrial growth (Tobechi et al., 2019). Many studies have investigated the link between energy consumption and growth both developed and developing economies and have come out with conflicting results- whereas some observe positive relationship others are mixed or negative (e.g. Zhang and Broadstock, 2016; Mustapha and Fagge, 2015; Onakoya et al., 2013; Dantama et al., 2012; Orhewere and Machame, 2011).

If our postulation is correct that energy consumption could be used to gauge the health of an economy, then it suffices that an undulating figure of energy consumption will certainly translate to a cyclical growth. A cursory look at the energy consumption of Nigeria since 1980-2017 will show a rising and falling consumption pattern. What does this pattern connote? It's neither progressive nor retrogressive. According to past studies, energy consumption has an impact on economic growth in many countries whether positive or negative (Michael et al., 2019; Belke et al., 2011). Energy is important to achieve the interrelated economic, social and environmental aims of sustainable development. The debate on the impact of energy consumption and growth has not been settled empirically (Dogan and Deger, 2016; Ozturk and Uddin, 2012; Ozturk, 2015; Solarin et al., 2017) thus the need for further studies especially in Nigeria. Nigeria should present a case study as a developing nation and at the same time an oil producing country. No doubt some studies have been done in this area but with a new data base, our findings will add to knowledge.

This paper is out to examine the impact of energy consumption on economic growth in Nigeria, evaluate the contributions of petroleum, electricity and coal energy on economic growth in Nigeria, and to verify the direction of causality between petroleum, electricity, coal energy and economic growth in Nigeria.

2. LITERATURE REVIEW

The electric power consumption and economic growth nexus in Africa (particularly Nigeria) has been a subject of interests for decades because of low production activities in Africa. Energy is not consumed for the sake of consuming it but for another purpose (e.g. for mobility, for producing goods and services, or for obtaining a certain level of comforts, etc.) (Hartman, 1979; Stevens, 2000). In other words energy consumption is a derived demand. Wolde-Rufael (2006) took a panel of 17 African countries and found that past values of economic growth had a predictive ability in determining present values of electricity consumption in some countries; while for other countries; past values of electricity consumption had a predictive ability in determining the present values of economic growth.

Nevertheless, the empirical literature is dominated by conflicting evidences with respect to the nature of relationship between energy consumption and economic growth (Ozturk, 2010; Leit, 2014; Kapusuzoglu and Karan, 2013; Zafar and Alkhateeb, 2019). For instance Udah (2010) examined the relationship between electricity supply, industrialization and economic development in Nigeria from the period of 1970-2008. He used the Granger causality test and ARDL bounds test to invest their relative impact on economic performance in Nigeria. The result indicate a 1% rise in industrial output, capital, technology and energy supply leads to about 3.8, 1.1, 4.1 and 4.5% rise in real output respectively. He also conducted error correction model which shows index of the independent variables and their significant determinants of economic development.

Moreover, this test suggests that economic growth has a significant positive long-run impact on energy consumption in these countries before 1988 and this effect becomes negative after 1988 in Ghana and South Africa. Furthermore, causality tests suggest bidirectional causality between energy consumption and real GDP in Cote d'Ivoire and unidirectional causality running from real GDP to energy usage in the case of Congo and Ghana. Also Ouédraogo, (2010) for Burkina Faso by using the ARDL bounds testing approach to cointegration and Granger-Causality within the VECM framework. Sarkar and Alam (2010) for Bagladesh, found positive impact between electricity generations to economic growth.

The early works of Akinlo (2008) in a study of the relationship between energy consumption and economic growth for eleven countries in sub-Saharan Africa got similar result. They used the autoregressive distributed lag (ARDL) bounds test. The study finds that energy consumption is co-integrated with economic growth in Cameroon, Cote d'Ivoire, Gambia, Ghana, Senegal, Sudan and Zimbabwe. Furthermore, this test suggests that energy consumption has a significant positive long run impact on economic growth in Ghana, Kenya, Senegal and Sudan. Granger causality test based on vector error correction model (VECM) shows a bi-directional relationship between energy consumption and economic growth for Gambia, Ghana and Senegal. However, Granger causality test shows that economic growth Granger causes energy consumption in Sudan and Zimbabwe.

Literature abound of positive relationship between energy consumption and economic growth; Zafar and Alkhateeb (2019) found positive relationship in India, Khobai et al. (2017) found unidirectional causal relation from output to energy direction in the case of BRICS countries suggesting energy conserving policy may be encouraged without adversely affecting the growth of the countries. Wen-Cheng (2016) examined the effect of electricity

consumption on GDP was analyzed using the sample of 17 industries in Taiwan. Their finds was categorized into four groups; while the first group indicates that energy consumption is essential for growth and there is a one-way relationship, the second group finds that energy consumption affects economic growth, the third group argues that there is bidirectional causality between them, and the last group finds that there is no causality relationship between energy consumption and economic growth. Kasperowicz (2014) found bidirectional relationship between electricity consumption and economic growth in Poland.

Again, we have numerous studies that found conflicting results, for example; Elfaki et al. (2018) investigated the force of electric energy supply on industrial sector productivity in Nigeria, from the period of 1970 to 2010 using multiple regression analysis. The finding shows that energy supplies have no significant impact on industrial productivity in Nigeria. The studies by (Masih and Masih, 1996) for the case of Thailand said there is no causality between energy consumption and real income, for Turkey (Begum et al., 2015), for Malaysia (Rafiq, 2008), for Malaysia (Behmiri and Manso, 2014). While studying the link between energy use and income growth of 119 countries belonging to different income groups Yasar (2017) has found different results for different groups. He observed that, for low income countries, no long run relationship existed during the sample period. For upper middle-income group, unidirectional relationship from growth to energy use has been found, thus supporting energy conservation hypothesis for these countries.

3. DATA AND ESTIMATION TECHNIQUES

The study employed monthly time series data (1980-2017) within the periods under review. The data used in this study were sourced from World development indicators of World Bank 2018, Central Bank of Nigeria Statistical Bulletin Volume 28 December 2017 (Soft copy), CBN Annual Report and Statement of Accounts Various Issues, National Bureau of Statistics (NBS) of various years and Ministry of Petroleum Resources Data Base (Appendix 1).

The study used ex-post facto research design because it is suitable for the assessment of large data group which are the characteristics of this study. Again, it used the Augmented Dickey-Fuller (ADF) unit root test to confirm stationary status of all the series and Autoregressive Distributed Lag (ARDL) model to determine the co integrating variable(s) both at the short run and at the long run. The ARDL bounds model offers several desirable statistical features that overcome the limitations of other cointegration techniques and it has become increasingly popular among researchers in recent years (Islam et al., 2013; Keho, 2016; Mahalik et al., 2017). Unlike other cointegration techniques, the ARDL model provides consistent and unbiased empirical results in small and large sample sizes whether the variables are I(0) or I(1) or mutually integrated [I(0) and I(1)] and allows for simultaneous testing of the long-run and short-run relationships even when the explanatory variables are endogenous (Pesaran et al., 2001). The ARDL model for testing the existence of a long-run relationship between the variables in the log-linear empirical relationship established in Equation (1) is specified as:

3.1. Model Specification

The study used a simple model relating all the variables under investigation. In order to investigate the impact of electricity consumption on economic growth in Nigeria, a simple theoretical framework of the Cobb Douglas production function with constant returns to scale was adopted similar to Ahmed et al. (2012). The simple model is as stated as follows;

$$Y = AK\alpha L\beta \quad (1)$$

Where; Y is the total production (output), L is the Labor input, K is capital input and A is the total factor productivity, α and β are the output elasticity of labor and capital respectively. Incorporating the variables of the study into equation (2) as stated thus;

$$Y = f(E, C, P) \quad (2)$$

Where: the growth rate of GDP, E = the Electricity consumption.
C = The coal consumption and
P = The Petroleum consumption

Energy consumption is decomposed into electricity consumption, coal consumption and petroleum consumption, and economic growth is proxied by growth rate of GDP and the study followed after Udah (2010), which showed that petroleum, electricity, and the aggregate energy consumption have significant and positive relationships with economic growth in Nigeria.

Stating the model in its explicit form gives credit to equation (3) as shown below;

$$GDPgr = \alpha + \beta 1ECNP + \beta 2CCNP + \beta 3PCNP + ut \quad (3)$$

Where all variables are as previously defined, $\beta 1$-$\beta 3$ are the parameter estimate, while ut is the white noise. A priori, it is expected that all variables would be non-negative.

The variables included in this study were the growth rate of Gross Domestic Product (GDPgr), the electricity consumption (ECNP), the coal consumption (CCNP) and the petroleum consumption (PCNP). The Table 1 gives the full description of the variables under study.

3.1.1. Estimation procedure

The study first examined the stationarity or non-stationarity of the variables and the order of integration by employing the ADF and unit root tests, to determine stationarity of the variables. Therefore, the ADF test is based on the following regression:

$$GDPgrt = t + \alpha GDPgrt\text{-}1 + ECNP\ GDPgrt\text{-}2 + CCNP\ GDPgrt\text{-}3 + PCNP\ GDPgrt\text{-}4 + \mu t \quad (4)$$

Where μt is a white noise error term, yt-1 = yt-1 - yt-2; yt-2 = yt-2 - yt-3 and so on and as previously defined. Equation (4) tested the null hypothesis of a unit root against a trend stationary alternative.

If the study justifies that the series are stationary, the study would then proceeds for further tests. The decision rule is to reject the null hypothesis if the ADF statistic value exceeds the critical value at a chosen level of significance, either 1%, 5% or 10%. The summary of the results of the unit root tests are as shown in Table 2, while the detailed results can be seen in appendix. The next step is to test for ARDL as specified below.

In this study, the ARDL model is specified thus;

$$GDPgrt = \alpha + GDPgrt\text{-}1 + ECNPt\text{-}1\ CCNPt\text{-}1 + PCNPt\text{-}1 + ut \quad (5)$$

Where; GDPgrt-1 = endogenously lag of growth rate of GDP, and ECNPt-1, CCNPt-1, PCNPt-1 = exogenously lag of electricity consumption, coal consumption and petroleum consumption respectively. Thus, the above ARDL specification showed that there is AR (3) since all the three regressors were lagged in the model. Thus, the study further examined the Granger causality test to ascertain the direction of causality between the electricity, coal, petroleum consumption and economic growth in Nigeria within the periods under review. Again, the test procedure as described by Granger (1969; 1988) is as specified thus:

$$GDPgrt = t\text{-}1 + ENCNPt\text{-}1 + \mu 1t \quad (6)$$

$$ENCNPt = ENCNPt\text{-}1 + GDPgrt\text{-}1 + \mu 2t \quad (7)$$

Table 1: Description of variables

Variables	Definition	Source
GDPgr	The growth rate of gross domestic product (GDP) is the rate at which a nation's GDP changes or grows from 1 year to another. On the other hand, Nigeria GDP is the market value of all the goods and services produced in Nigeria over a given time period.	WDI, 2018
ECNP	Electricity energy consumption is the form of energy consumption that uses electric energy. It is the actual energy demand made on existing electricity supply.	CBN, 2017 Bulletin
CCNP	Coal energy consumption is the quantity of coal burned for the generation of electric power (in short tons) including fuel used for maintenance of standby service.	WDI, 2018
PCNP	Petroleum consumption is the rate at which an engine uses petrol, expressed in units such as miles per gallon or liters per kilometer.	

Source: Researchers computation

Where; GDPgr variable is as previously defined and ENCNP is energy consumption, proxied by electricity, coal and petroleum consumption. Apriori expectation is such that GDPgr and ENCNP will be non-negative.

4. RESULTS

4.1. Unit Root Tests

From the Table 2, only GDPgr variable were stationary at level I(0). However, ECNP CCNP and PCNP were stationary after differencing them once, that is: I (1) (Table 2). Thus, the above results ustified the application of Autoregressive Distributed Lag (ARDL) since the variables were integrated at different levels and the result of the ARDL co-integration test is as shown in Table 3;

4.2. Result of ARDL Co-integration Test

This test is basically in line with the first specific objective of the study, which tries to establish the long run relationship between electricity, coal and petroleum consumption and economic growth in Nigeria. Two statistic tests engaged were the trace test and maximum eigen value test, which test the hypothesis of no co integrating relation against the alternative of full rank of co integration. Thus, the result of the ARDL co integration tests .is as reported in Table 3.

From Table 3 it is observable that the trace statistic showed the presence of one co-integrating equation at 0.05 critical values, which suggests that the variables are co-integrated. Therefore the null hypothesis of no co-integration is rejected while the study upholds the alternative. The implication of this findings revealed that there is existence of a stable long run relationship between energy consumption (electricity, coal and petroleum) and economic growth in Nigeria. We move on to conduct the ARDL Bound Test as presented in Table 4.

4.3. ARDL Bounds Test

ARDL bounds test		
Date: 03/16/20 Time: 05:49		
Sample: 1983 2017		
Included observations: 35		
Null hypothesis: No long-run relationships exist		
Test statistic	**Value**	**k**
F-statistic	3.881053	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

Table 2: Summary result of ADF and PP unit root tests

Variables	1% Critical	5% Critical	10% Critical	T-stat	Order	Prob.
GDPgr	3.621023	−2.943427	−2.610263	−4.774284	I (0)	0.0004
ECNP	−3.626784	−2.945842	−2.611531	−7.689578	I (1)	0.0000
CCNP	−3.626784	−2.945842	−2.611531	−5.887297	I (1)	0.0000
PCNP	−3.632900	−2.948404	−2.612874	−6.977779	I (1)	0.0000

Source: Author's computation, 2019. The ADF critical values at 1%, 5% and 10% are respectively−2.577190, −1.92508 and−1.615589 while the PP critical values are−2.577125, −1.942499 and−1.165594 respectively. *Not stationary at any %, **Stationary at 1%, 5% and 10%. Sources: Author's compilation. Source: E-View 9.00

In performing the bounds testing procedure, the study estimated equation (4) using the ARDL approach to co integration as shown below;

$$GDPgr = 3.208605 + 0.168495ECNP - 0.054839CCNP - 0.001016PCNP + \varepsilon t$$

$$(0.230124) \quad (0.628541) \quad (-1.562763) \quad (0.017534) \qquad (14)$$

However, under the ARDL approach, the calculated F-statistics are compared against the critical values, which were extracted from the work of Narayan (2004). The value of F-statistics when GDP growth rate is taken as endogenous variable is 4.359834, which is greater than the upper bounds critical value of 3.79 at 5% level of significant. Therefore, the null hypothesis of no co integration relationship can be rejected. This indicated that electricity consumption, coal consumption and petroleum consumption and economic growth in Nigeria exhibited a stable long-run relationship within the period under review.

The Table 5 shows the ARDL regression output and the results indicated that all variable in the model were statistically significant though some of them exhibited negative value. Overall, the study concluded that there is a statistical significant relationship between electricity consumption, coal consumption, petroleum consumption and economic growth in Nigeria.

4.4. Granger Causality Test

The study used the Granger causality test to determine whether 1 time series is useful in forecasting another reflected by measuring the ability of predicting the future values of a time series using past values of another time series. In order to capture the causal effect, the granger causality was employed and the result is presented Table 6.

From the above computed result in Table 6, the first hypothesis is electricity consumption does not Granger cause growth rate of GDP in Nigeria. From the empirical result, the study accepted the above hypothesis since the probability value (0.2952) is more than 0.05 showing that electricity consumption does Granger cause GDP growth rate in Nigeria within the period under review. But the second hypothesis is that growth rate of GDP does not Granger Cause electricity consumption, which is also accepted going by the probability estimate (0.3212), which is also >0.05. This means that growth rate of GDP does not Granger Cause electricity consumption at 5% level of significance. In conclusion, by the probabilities of all the hypotheses postulated above, the study accepted that there are bidirectional causalities among all the series under investigation.

Table 3: ARDL cointegrating and long run form

Included observations: 35				
Cointegrating Form				
Variable	**Coefficient**	**Standard error**	**t-Statistic**	**Prob.**
D (GDPGR(−1))	0.139714	0.169775	0.822939	0.4180
D (ECNP)	0.555326	0.824812	0.673276	0.5067
D (ECNP(−1))	−2.104614	1.058620	−1.988073	0.0574
D (ECNP(−2))	1.570934	0.857117	1.832812	0.0783
D (CCNP)	−0.068848	0.026281	−2.619705	0.0145
D (PCNP)	0.014389	0.052138	0.275968	0.7848
CointEq(−1)	−1.074800	0.243769	−4.409090	0.0002
Cointeq=GDPGR − (0.2397*ECNP−0.0641*CCNP+0.0134*PCNP−0.1627)				
Long run coefficients				
ECNP	0.239656	0.231316	1.036055	0.3097
CCNP	-0.064056	0.023229	-2.757583	0.0105
PCNP	0.013387	0.047891	0.279532	0.7820
C	-0.162670	11.341943	-0.014342	0.9887

Source: E-View 9.00

Table 4: ARDL bound test equation

Dependent variable: D (GDPGR)				
Method: Least squares				
Date: 03/16/20 Time: 05:49				
Sample: 1983 2017				
Included observations: 35				
Variable	**Coefficient**	**Standard error**	**t-Statistic**	**Prob.**
D (GDPGR(−1))	0.114434	0.187554	0.610141	0.5471
D (ECNP)	0.670381	0.861812	0.777875	0.4437
D (ECNP(−1))	−0.485307	0.920013	−0.527500	0.6023
D (ECNP(−2))	1.672800	0.918596	1.821039	0.0801
C	3.208605	13.94293	0.230124	0.8198
ECNP(−1)	0.168495	0.268074	0.628541	0.5351
CCNP(−1)	−0.054839	0.035091	−1.562763	0.1302
PCNP(−1)	0.001016	0.057942	0.017534	0.9861
GDPGR(−1)	−1.007677	0.270658	−3.723063	0.0010
R-squared	0.572921	Mean dep var	0.055429	
Adjusted R-squa	0.441512	S.D. dep var	9.046308	
S.E. of regress	6.760491	Akaike info crit	6.877102	
Sum sqr resid	1188.310	Schwarz crit	7.277049	
Log likelihood	−111.3493	Hannan-Quinn	7.015164	
F-statistic	4.359834	Durbin-Watson	1.970477	
Prob.(F-statistic) 0.001948				

Source: E-view 9.0. R2=0.57; Adj R2=0.44; F-test=4.35; Prob. (F stat) = 0.0000; DW stat. = 1.97. Source: (E-view 9.0)

Table 5: ARDL regression output

Maximum dependent lags: 4 (Automatic selection)				
Model selection method: Akaike info criterion (AIC)				
Dynamic regressors (4 lags, automatic): ECNP CCNP PCNP				
Fixed regressors: C				
Number of models evalulated: 500				
Selected model: ARDL (2, 3, 0, 0)				
Note: Final equation sample is larger than selection sample				
Variable	**Coefficient**	**Standard error**	**t-Statistic**	**Prob.***
GDPGR(−1)	0.064914	0.182984	0.354751	0.7256
GDPGR(−2)	−0.139714	0.169775	−0.822939	0.4180
ECNP	0.555326	0.824812	0.673276	0.5067
ECNP(−1)	−0.831425	0.991974	−0.838152	0.4096
ECNP(−2)	2.104614	1.058620	1.988073	0.0574
ECNP(−3)	−1.570934	0.857117	−1.832812	0.0783
CCNP	−0.068848	0.026281	−2.619705	0.0145
PCNP	0.014389	0.052138	0.275968	0.7848
C	−0.174838	12.19918	−0.014332	0.9887
R-squared	0.411086	Mean dependent		4.006000
Adjusted R-squar	0.229881	S.D. dependent v		7.148741
S.E. of regression	6.273478	Akaike info crite		6.727573
Sum squared resid	1023.270	Schwarz criterion		7.127520
Log likelihood	−108.7325	Hannan-Quinn c		6.865635
F-statistic	2.268630	Durbin-Watson		1.920232
Prob. (F-statistic)	0.054659			

*P-values and any subsequent tests do not account for model selection. Source: E-View 9.00

Table 6: Pairwise granger causality tests

Sample: 1980-2017 Lags: 2			
Null hypothesis	**Obs.**	**F-Statistics**	**Prob.**
ECNP does not granger cause GDDPGR	36	1.26930	0.2952
GDPGR does not granger cause ECNP		0.68677	0.5107
CCNP does not granger cause GDDPGR	36	1.07649	0.3532
GDPGR does not granger cause CCNP		0.17561	0.8398
PCNP does not granger cause GDDPGR	36	2.12972	0.1359
GDPGR does not granger cause PCNP		1.17848	0.3212
CCNP does not granger cause ECNP	36	0.28890	0.7511
ECNP does not granger cause CCNP		1.62911	0.2124
PCNP does not granger cause ECNP	36	0.07134	0.9313
ECNP does not granger cause PCNP		1.74161	0.1919
PCNP does not granger cause CCNP	36	0.16874	0.8455
CCNP does not granger cause PCNP		0.05706	0.9446

Source: E-view 9.00

5. DISCUSSION

The result of the ARDL co-integration estimate is quite remarkable as can be seen in Table 3. The null hypothesis stipulates that there is "a random walk" which was rejected at 0.05 critical values, indicating that electricity consumption (ECNP), coal consumption (CCNP) and petroleum consumption (PCNP) were co-integrated. However, in the ARDL regression output, the F*(Stat.) is 12.26, suggesting that there exists a long-run relationship or co integration among all the series. Having established the co integration relationship, the next step was to estimate the long-run coefficients by estimating an ARDL of order Γ and Π in the first part of equation, which were the short-run dynamic elasticities of the model's convergence to long-run equilibrium. After the estimation, the result showed that the long-run overall model is well fitted as the exogenous variables explained over 57% movement in the endogenous variable. The long run coefficients showed that electricity consumption and petroleum consumption exhibited a positive and significant relationship with economic growth in Nigeria while coal consumption showed a negative relationship with growth though significant. This evidence coincides with the economic apriori expectations partly. This is so because, a 1.0% increase in one period lag of electricity consumption increases economic growth by 0.55% point. Also, a 1.0% rise in petroleum consumption causes economic growth to rise by 0.014%. Contrary to the above, a 1.0% increase in coal consumption reduces economic activities by 0.06% point within the periods under investigation

This empirical evidence aligns with the work of Udah, 2010; Bilal, 2014; Zafar and Alkhateeb, 2019; and the work of Wen-Cheng (2016) in Taiwan, and is in variance with (Masih and Masih 1996) for the case of Thailand said there is no causality between energy consumption and real income, for Turkey (Begum et al., 2015), for Malaysia (Rafiq, 2008), for Malaysia). In the study of Onakoya et al. (2013) on the causal relationship between energy consumption and economic growth is considered for the period 1975-2010 in Nigeria, using secondary time-series data which was analyzed using co-integration and ordinary least square techniques.

Their results of co-integration showed a long-run relationship among the variables used, which is in line with the results obtained in this study. Their results showed that petroleum, electricity, and the aggregate energy consumption have significant and positive relationships with economic growth in Nigeria, which is the idea of the current study.

From the results of the ARDL regression output and the Granger causality test estimate, the study accepted the null hypotheses judging by the probability criteria and concluded as follows;

a. There is a significant relationship between energy consumption and economic growth in Nigeria.
b. There is a significant relationship between the contributions of petroleum, electricity and coal energy and economic growth in Nigeria.
c. There is a significant causal relationship between petroleum, electricity, coal energy and economic growth in Nigeria.
d. The growth rate of GDP does not Granger Cause electricity consumption at 5% level of significance.

The implication of the above tests suggests that there is positive relationship between energy consumption and economic growth in Nigeria within the periods under review.

6. CONCLUSION AND RECOMMENDATIONS

This study has examined the impact of energy consumption on economic growth in Nigeria using time series data spanning from 1980 to 2017. The energy consumption was dis-aggregated into electricity consumption, coal consumption and petroleum consumption while economic growth was proxied by growth rate of gross domestic product (GDP). The various diagnostic tests conducted in this study were consistent with the objective of the study. However, empirical model was developed in the light of recent development in econometric modeling starting with an analysis of the unit root properties of the relevant series, ARDL co integration test, ARDL bound test, and Granger causality test. Thus, the following interesting results were found;

a. Electricity consumption was positively related to economic growth in Nigeria.
b. Coal consumption exerted negatively to economic growth in Nigeria'.
c. Petroleum consumption was found to have exhibited a positive impact on economic growth in Nigeria.
d. The ARDL bound test showed that the F*(Stat.) was 12.26, which was greater than the critical values of 3.79, suggesting that there exists a long-run stable relationship among all the series under investigation.
e. Electricity consumption does Granger cause GDP growth rate in Nigeria within the period under review.

Nigeria is blessed with natural resources especially natural gas and petroleum but mismanagement and non-diversification of the economy has left the country industrially in the cold. Nevertheless, in this study we have established positive relationship between energy consumption and economic growth. It must be said that the cost of energy in Nigeria is still high compared to other oil producing countries and one reason for that is the cost of importation of finished product. Again, Nigeria is confronted with inefficient usage of energy in the country, due mainly to a focus on one aspect of energy resources. Consequently, there is an urgent need to encourage the evolvement of an energy mix that will emphasize the conservation of petroleum resources in such a manner enabling their continued exportation for foreign earnings for as many years as possible, and diversify other sectors of the economy to preserve energy usage in Nigeria.

The recommendations of the study were results based, and the following were recommended;

1. Electricity consumption was found to be positively related to economic growth in Nigeria, the study therefore recommended that government should sustain the amount of electricity provided in order to promote economic growth in Nigeria.
2. Government should establish more refinery industries and renewable energy funding/financing agency such as India's Indian Renewable Energy Agency, and make it more efficient in order to drive growth.
3. You will recall that since 1970, the coal deposit in Nigeria is virtually abandoned. Government should give more attention to coal production and its consumption for a better economy.
4. Government, as a matter of urgency should establish and implement the existing renewable biomass as a fuel in highly efficient cook stoves and proficient production of charcoal as a fuel in homes and small and medium enterprises.

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APPENDIX

Appendix 1: Raw data used for computation and analysis

Years	GDPgr	ECNP	CCNP	PCNP
1980	4.2	4.69	89	170
1981	−13.1	5.69	94	200
1982	−1.1	5.95	76	215
1983	−5.1	6.06	67	202
1984	−2	6.04	94	210
1985	8.3	6.45	112	222
1986	−8.8	8.33	122	208
1987	−10.8	7.25	132	218
1988	7.5	7.26	58	234
1989	6.5	8.35	61	244
1990	12.77	8.03	74	251
1991	−0.62	8.19	72	259
1992	0.43	8.43	57	265
1993	2.09	8.27	44	271
1994	0.91	8	28	252
1995	−0.31	7.91	22	284
1996	4.99	7.63	9	286
1997	2.8	7.88	11	277
1998	2.72	8.55	13	260
1999	0.47	8.36	18	252
2000	5.32	11.16	3	246
2001	4.41	11.71	33	306
2002	3.78	16.32	47	304
2003	10.35	15.27	25	268
2004	33.74	18.35	9	277
2005	1.44	17.81	9	312
2006	8.21	17.41	9	284
2007	6.83	18.46	27	269
2008	6.27	16.96	36	269
2009	6.93	15.85	37	243
2010	7.84	20.96	42	283
2011	4.89	21.65	35	287
2012	4.78	22.98	53	279
2013	5.39	23.11	49	283
2014	6.31	24.3	51	277
2015	2.65	25.14	52	300
2016	−1.62	24.72	193	315
2017	0.84	26.21	191	320

Sources: (1) World development indicators of World Bank 2018, (2) Central Bank of Nigeria Statistical Bulletin Volume 28 December 2017 (Soft copy), (3) CBN Annual Report and Statement of Accounts Various Issues, (4) National Bureau of Statistics (NBS) of various years