ISSN 2056-5429

IS ENERGY CONSUMPTION RELEVANT TO INDUSTRIAL OUTPUT IN NIGERIA?

Bernard, O. A[1]. & Adenuga Oludare[2]
Department of Economics, Faculty of Social Sciences
Kogi State University, Anyigba, **NIGERIA**

ABSTRACT

This paper investigates the contribution energy consumption on output of industrial sector in Nigeria. Time series data from the period of 1980 to 2013 on energy consumption and industrial output was employed. The error correction mechanism was used to analyse energy consumption (oil consumption, gas consumption, electricity consumption and coal consumption) and the output of industrial sector in Nigeria. In addition to the explanatory variable is carbon dioxide emission from the use of energy in Nigeria. The result of the ECM shows that all the variables used in the study are characterised with a positive trend. The study provides some evidence in support of long-run relationship between energy consumption and industrial output in Nigeria. The ECM result provides strong evidence in support of convergent relationship between energy consumption and industrial output in Nigeria. The study reveals that the entire variable contributed positively to industrial output in Nigeria. The estimated coefficient of carbon dioxide from the use of energy supported the view of Dasgupta (2002) and Stern (2002) that there is a proportional relationship between energy used by industry and carbon dioxide emission. The study finally recommends that government should strictly monitor the implementation of the policy of 2003 for the growth of industrial sector in Nigeria. For better policy formulation and implementation, this study recommends that government agencies responsible for data collection should improve on the collection of current data for research.

Keywords: Energy consumption, industrial output, error correction mechanism.

INTRODUCTION

Industrial development has been seen as a driving force of any economy wishing to move from a non industrial state to an industrial state. To achieve this, certain factors must be put in place to trigger the take off from non industrial economy to an industrial economy. Among these factors is the availability of energy resources to meet the demand of the industry, not only the resources should be available but to be efficiently utilised by the industrial sector.

Evidence has shown that in Nigeria, the industrial sector is grossly underperforming (see fig. 1) due to obstacles posed by infrastructural deficit, involving inefficient energy supply. Despite the abundant reservoirs of energy resources in the country, the continued malfunctioning of various energy sources also means that growth and development of the industrial sector is greatly hindered or affected. The inadequate and epileptic power supply, the high cost of fossil fuel, shortage in natural gas supply has imposed severe cost on manufacturing firms. These costs are in the form of idle workers (workforce), spoilt materials, lost of output and damaged equipment and restart cost (Adenikinju, 2005). These effects have culminated in poor output level of the industrial sector in Nigeria.

The continuous vandalization of oil pipelines within the oil producing region accounted for the lack of supply of energy sources such as petroleum product and gas. This shortage in

ISSN 2056-5429

supply affected the productivity of the industrial sector (Atoloye-Kayode, 2013). Statistical evidence has revealed that on the average, the share of the nation's industrial sector to Gross Domestic Product (GDP) was 51.4 percent in 1981; industrial contribution to GDP experienced a decrease from 51.4 percent to 49.1 percent between 1981 and 1985, while industrial share to GDP experienced a little increase to 50.1 percent in 1989 and remain sustainable till 1995. A fall was experienced from 50.3 percent in 1995 to 47.1 percent in 1999 and this fall continue to 42.8 percent in 2005 down to 39.3 percent in 2010 (CBN, 2012). This shows that industrial sector contribution to GDP over the years has not been encouraging. This dismal performance of the industrial sector suggests that all is not well with the sector. This may be attributed to several factors including infrastructural decay, particularly, energy deficiency (Elijah and Nsikak, 2013).

The industrial sector consists mainly of the primary (mining and quarrying and agriculture) and secondary (manufacturing) industries. The manufacturing sector is considered the major sector for determining the nation's economic growth and development. The sector is responsible for about 10 percent of the total GDP in Nigeria (NBS, 2010). The sector includes industries that use lots of energy as inputs such as food, chemical, refining, glass, cement, and aluminium industry (Atoloye-Kayode,2013)

Reviewing some studies aimed at ameliorating the problems associated with energy usage and industrial outputs, Sari and Ewing (2008) examined the contribution of energy consumption on industrial output, and they found that renewable energy contributed more to industrial output than the non renewable energy in U.S.A. In a similar view, Ziramba (2009) concluded that the oil consumption and natural gas consumption contributed significantly to industrial production in South Africa. Elijah and Nsikak (2013) realized that non-renewable energy in form of natural gas, coal, and petroleum and electricity consumption contribute significantly to industrial growth in Nigeria.

The core of most studies is on the relationship between energy consumption and economic growth. Few studies on energy consumption and industrial output growth can be traced to the works of Elijah and Nsikak, 2013; Sari and Soytas, 2008; and Ziramba, 2009. Most studies on Nigeria economy show that, there exist a paucity of knowledge on the nexus between aggregate energy consumption and industrial output. This issue has been utterly neglected by previous endogenous studies which have mainly focused on aggregate energy consumption and economic growth. This neglect has strong policy implication for the Nigerian economy. For instance, the Nigerian economy has witnessed some growth of about 6.5 percent since 2001 (CBN, 2011), which in no doubt is a consequence of growth in some sectors of the economy. The increase in sustained growth over the period may also imply increased energy consumption in these sectors. Therefore it is pertinent to examine the contributions of energy consumption on industrial output.

An empirical analysis of this issue is appropriate especially now that the federal government of Nigeria is facing economic challenges. Also, concerted efforts targeted at address the problem of industrial sector which is one of the major consumers of energy in a growing economy like Nigeria is necessary. Without doubt, the finding of this study is very central to addressing the challenges facing the industrial sectors of Nigeria.

Since 1970s to early 1980s, the energy crises and the continuous increase in energy prices especially oil prices have had impact on the economic activities of several developing nations like Nigeria. The reason of course is not farfetched: energy is an indispensable force driving all economic activities, that is, the greater the energy consumption, the more the economic activities in the country (Gbadebo, Odularu and Okonkwo, 2009).

As earlier mentioned in Adenikinju (2005), the industrial sector of Nigeria is grossly underperforming due to obstacles posed by infrastructural deficit which include inefficient energy supply. Statistical evidence has shown that the share of the nation's industrial sector to Gross Domestic Product (GDP) was 51.4 percent in 1981. The Industrial sector experienced a decrease from 51.4 percent in 1981 to 45.7 percent in1984. As compared with 1981, industrial contribution to GDP was not encouraging between 1984 and 1988. But from 1989 to 1992, the share of industrial contribution in total GDP experienced an upward growth from 53.1 percent to 58.9 percent respectively. But from 1992, the share of industry in total GDP continued on the downward trend except in 1996 and 2000. The industrial sector share to GDP between the year 2000 and 2012 was highly insignificant (see figure 1). These periods experienced the greatest decline even in the face of the most sustainable democratic dispensation in Nigeria. The fitted regression line in figure 1 supported the view of a down ward trend of industrial contribution to GDP. This is shown by the negative slope coefficient of -0.409. The coefficient of determination (R^2) also revealed a very weak contribution over time. This statistical evidence shows that industrial sector contribution to GDP over the years has not been encouraging and this dismal performance may be attributed to several factors which include infrastructural decay, particularly energy deficiency.

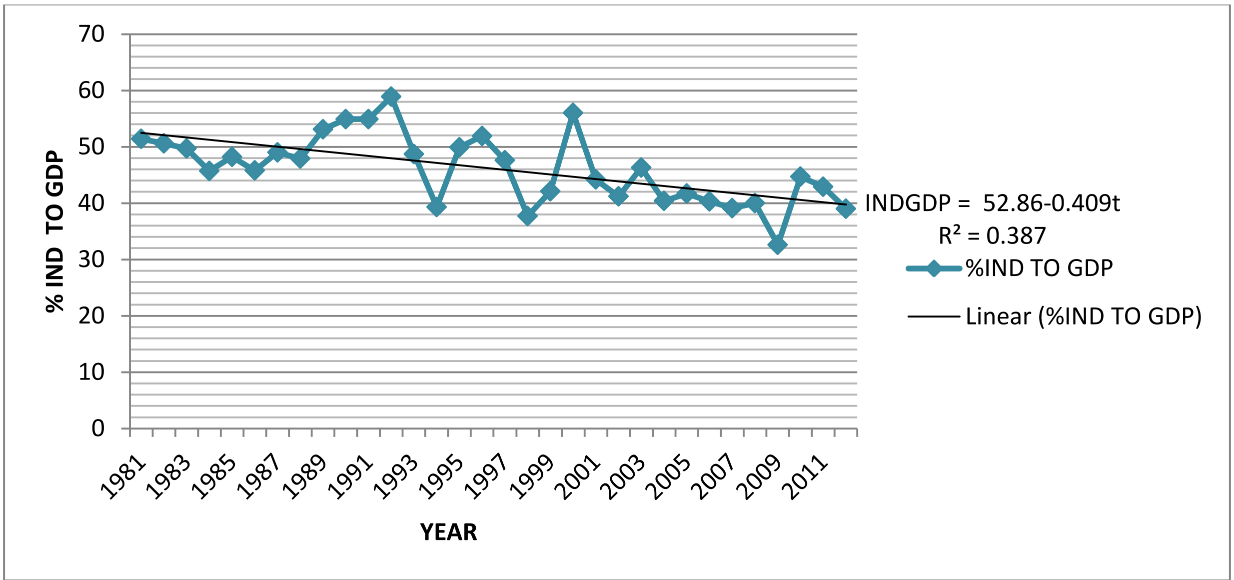


Figure 1: **Share of Industrial Sector to Gross Domestic Product in Nigeria.**
Source: Computed from CBN Statistical Bulletin Vol. 24. December, 2013

In addition to the observed problems, most studies on energy and industrial sector are majorly in developed countries like U.S.A and Germany. Few studies can be traced to South Africa, Vienna, Pakistan and Nigeria. Such studies could be traced to Isakson,(2009); Knetch and Molzhan (2009); Qazi, Ahmed and Mudassar (2012); Titilpoe (2013) and Elijah and Nsikak (2013).

Most of these studies are on international countries little or no study exist in Nigeria, therefore, there is need to contribute to existing literatures by looking at Nigeria as a case study. Conclusively, industrial sector activities emit carbon dioxide arising from the use of energy. This study examined the claim of some ecological economists like Dasgupta et'al

(2002) and Stern (2002) that increase in carbon dioxide is caused by increase in industrial activities within a country.

The findings of this study serve as a prelude towards developing the industrial sector and the need to develop the energy sector of this country. Most countries in Asia, America and Europe have resorted to the development of alternative energy that can drive a sustainable industrial activity. Therefore, there is need for Nigeria to look inward and discover alternative energy other than over relying on petroleum.

LITERATURE REVIEW

Studies on energy consumption and economic activities took it roots from the works of Kraft and Kraft (1978), Yu and Choi (1985), Erol and Yu (1987), among others. But few studies on energy consumption and industrial output exist in literature. This study however, reviews the recent studies in this regard.

Erbaykal (2008) examined the relationship between disaggregated energy consumption and economic growth with evidence from Turkey. A time series data on energy consumption and economic growth was analysed using the Auto Regressive Distributed Lag (ARDL) Bounds test developed by Pesaran at al (2001). The bounds test revealed the existence of co integration relationship between the variables. Employing the same method, Olusegun (2008), analyse the relationship between energy consumption and economic growth in Nigeria from 1970 to 2005. The result shows a long run relationship between total energy consumption, oil consumption and economic growth while no long run relationship is found between gas consumption, electricity consumption and economic growth.

Gbadebo and Okonkwo (2009) investigate the contribution of energy consumption on economic performance in Nigeria. Cointegration and error correction technique was employed. The results revealed that along run relationship exists between energy consumption and economic growth. The result further shows that a positive relationship exist between crude oil consumption, electricity consumption and real Gross Domestic Product in Nigeria. Noor and Siddiqi (2010) employed cointegration and Ordinary Least Square techniques to analyse the relationship between per capita energy consumption and per capita GDP in Nigeria (1971 to 2006). The cointegration result shows a strong long run relationship between variables in the model. The long run estimated equation shows a negative relationship between the per capita energy consumption and per capita GDP, while the causality test reveals a unidirectional causality running from GDP to electricity consumption in the short run.

Shaari, Hussein and Ismail (2012) studied the relationship between energy consumption and economic growth in Malaysia using the time series data between 1980 and 2010.The estimation technique employed are co integration and Ganger causality test. The result of the study indicates a long-run relationship between variables. The causality test revealed a unidirectional causality running from GDP to electricity consumption, Gas to GDP in Malaysia.

Akomolafe, Danladi and Babalola (2012) employed Granger causality test approach to examine the relationship between electricity consumption and economic growth in Nigeria. Time series data between 1971-2010 on GDP per capita, electricity consumption, per capita foreign direct investment and total energy used in the country was used. The result shows two

ISSN 2056-5429

way causality between electricity consumption and GDP, a one way causality running from foreign direct investment to GDP, electricity consumption to foreign direct investment and energy used to foreign direct investment.

Shahbaz, Muhammad and Talat (2012) examine how energy consumption spur economic growth in Pakistan. The ARDL bounds testing approach was used to analyse the relationship between renewable energy consumption and non-renewable energy consumption, capital, labour, and economic growth. The result shows the existence of co integration between variables. The causality analysis using the VECM confirms the existence of feedback hypothesis between renewable and non-renewable energy consumption and economic growth in Pakistan.

Baghedo and Atima (2013) examined the impact of petroleum on economic growth in Nigeria using time series data between 1981 to 2011. The variables employed were GDP, oil revenue, corruption perception index and foreign direct investment in Nigeria. The error correction result revealed that all the explanatory variables contributes significantly to GDP in Nigeria.

Olumuyiwa (2013) examined the interaction between economic growth, domestic energy consumption and energy prices in Nigeria. The error correction method was employed to measure the interaction between per capita energy consumption, per capita real Gross Domestic Product and domestic energy prices. The three variables were specified as endogenous variables. The models were specified having each variable influencing the other in a system of equations. The result revealed strong interactions between variables.

Aguegboh and Madueme (2013), examined the nexus between energy consumption and economic growth with evidence from Nigeria. The vector auto regression model and the co integration technique were adopted. Their study contradicts other study on energy consumption and economic growth in Nigeria. A unidirectional causality was observed between petroleum consumption to GDP, gas consumption to GDP and capital to GDP. Also, the impulse response result shows that energy consumption do not contribute to economic growth in Nigeria. On the contrary, capital formation contributes to economic growth as oppose to labour force that does not contribute to GDP in Nigeria.

Bamidele and Mathew (2013) examine energy consumption and economic growth nexus in Nigeria. The error correction mechanism was used to analyse the influence of total energy consumption, consumer price index, monetary policy rate, credit available to private sector on economic growth in Nigeria. The result of the study revealed that all the explanatory variables significantly influence output growth in the short run.

Sari, Ewing and Soytas (2008), employed time series data on energy consumption and industrial production in the United State to examine the relationship between disaggregated energy consumption and industrial production. The Auto Regressive Distributed Lag model was used. Variable employed in the model are both renewable and non-renewable energy sources in the form of fossil fuel, conventional hydroelectric power, solar, waste and wind energy, coal, natural gas and industrial output.

Ziramba (2009) investigate the relationship between energy consumption and industrial output and employment in South Africa using annual time series data from 1980 to 2005. The co integration and Toda-Yamamota (1995) technique to Granger causality test was used. The co integration result revealed that industrial output and employment are strong force for driving electricity consumption in South Africa. A bi-directional causality was observed between oil consumption and industrial output. Causality was shown between employment and electricity consumption as well as coal consumption and employment in South Africa.

Qazi, Ahmed and Mudassar (2012) investigated the relationship between energy consumption and industrial output in Pakistan. Annual time series data on disaggregated energy consumption and industrial output from 1972 to 2010 was analysed using Vector Auto Regressive method. The co integration test result revealed that a long run equilibrium relationship exist between the variables in the model. The long run coefficient of the model shows that disaggregated energy consumption has positive and significant effect on industrial output in Pakistan.

Most studies were on energy consumption and economic growth. Few studies on energy consumption and industrial sector can only be traced to the work of Sari, Ewing and Soytas (2008), Ziramba (2009), Titilpoe (2013) and Elijah and Nsikak (2013). The major emphasis of their studies is on the relationship rather than their contributions. They did not consider the structural effect of most national energy policy on industrial output in their area of study. There is no doubt; energy policies may have affect output of industrial sectors in those countries. These gaps were filled in this study.

Theoretical Framework of the Study

Building on the second law of thermodynamics, they state that a minimum quantity of energy is required to carry out the transformation of matter. Therefore there must be limits to the substitution of other factors of production for energy (Stern, 2012). Since all production involves the transformation of inputs into output in some way, it therefore means that all such transformations require energy. In this way, ecological economists also consider energy as an essential factor of production. Therefore, this study employed neoclassical growth theory in the form of the frequently used Cobb-Douglas production function as used by Elijah and Nsikak (2013):

$$Y = K^{\propto} L^{\beta} \qquad - \qquad - \qquad - \qquad 1$$

Where: K is the stock of capital, L is the stock of labour and A is technological progress. And since A is endogenously determined in the new growth model, it is thought to relate to energy in some way. This is because the amount of technology per unit of time requires some level of energy to work. Technology in this regard refers to plants, machinery and equipment and without adequate supply of energy; this technological stock will be obsolete. This is justified through the law of thermodynamics which holds that no production can occur without conversion of energy. Thus, from the theoretical perspective of the endogenous growth model, energy can enter the equation as one of the factors of production. Based on this theoretical exposition, the empirical model for this study can be specified as follows:

$$Y=F\ (K,L,E) \qquad - \qquad - \qquad - \qquad 2$$

Where: Y= total output, K=capital stock, L=labour stock and E=index of energy infrastructure.

However, since the specific objective of this study is to examine the relationship between energy consumption and industrial growth, the empirical model in equation (1) is modified slightly with industrial output replacing total output and human capital replacing labour stock. We used human capital instead of labour because human capital reflects the extent to which labour force (L) is capable of using available stock of knowledge and skills in operating more complicated tasks and producing output. The energy index (E) is disaggregated into various sources (Natural Gas, Electricity, Coal and Oil) and used as independent variables alongside capital stock and human capital. In addition to the above variables, we also include Carbon Dioxide (CO^2) to justify the claims of Dasgupta et'al (2002) and Stern (2002) that increase in CO^2 from the use of energy is coursed by increase in industrial activities. Therefore, the empirical model in its functional form can be specified as follows:

$$INDQ= f\,(KAPT, HUCT, OIL, GAS, ELEC, COAL, CO^2) \quad - \quad - \quad - \quad 3$$

Where:

INDQ=Industrial output, KAPT=Physical capital, represented by gross fixed capital formation, HUCT=Human capital, measured by investment in education, Oil= Petroleum products consumption, GAS=Natural gas consumption, ELEC=Electricity consumption, COAL=Coal consumption, CO^2 = Carbon Dioxide emission from industrial activities and the model in its econometric linear form can be expressed as:

$$INDQ =\alpha_o+ \alpha_1KAPT + \alpha_2HUCT + \alpha_3OIL + \alpha_4GAS + \alpha_5ELEC + \alpha_6COAL + \alpha_7CO^2 +\varepsilon \quad - - - \quad 4$$

Where: α_o to α_7 =the parameters to be estimated and ε =the error term.

The theoretical expectations about the signs of the coefficients of the parameters are as follow:

$\alpha_{1,}\ \alpha_{2,}\ \alpha_{3,}\ \alpha_{4,}\ \alpha_{5,}\ \alpha_{6,\ >\ 0}$ and $\alpha_{7>}\ 0$

It is theoretically established that the larger the amount of physical capital an economy is capable of accumulating, the larger will be the output produced. Thus the coefficient of capital stock is expected to be positive. In similar vein, an improvement in human capital leads to an improved productivity both in sectors and the economy as a whole. Also, technology transfer requires that domestic firms have high human capital levels; hence, we expect a positive relationship between human capital and industrial output. As far as energy infrastructure is concerned, ecological economists have strongly considered energy as an essential factor of production. According to the law of thermodynamics, no mechanized production can occur without the conversion of energy. For this reason, we expect the respective energy source to have a positive relationship with industrial output. It is popularly argued by ecological economist (see: Dasgupta et'al, 2002 and Stern, 2002) that environmental pollution arising from industrial activities is attributed to industrial growth in most developing countries and these industries employed energy as inputs in the production process. Therefore, we expect a positive relationship between CO^2 emission and industrial output.

METHODOLOGY AND DATA

To contribute to existing literature, the study adopted the Error Correction Mechanism (ECM) to examine the contribution of energy consumption on industrial output in Nigeria. The following (ECM) is estimated as:

$$\Delta INDQ_t=\alpha_o+\sum_{i=1}^{k}\beta_i\Delta INDQ_{t-i} + \sum_{i=1}^{k}\emptyset_i\,\Delta KAPT_{t-i} + \sum_{i=1}^{k}\theta_i\,\Delta HUCT_{t-i} + \sum_{i=1}^{k}\pi_i\,\Delta OIL_{t-i} + \sum_{i=1}^{k}\gamma_i\,\Delta GAS_{t-i} + \sum_{i=1}^{k}\varphi_i\,ELEC_{t-i} + \sum_{i=1}^{k}\tau_i\,COAL_{t-i} + \sum_{i=1}^{k}\theta_i\,CO^2{}_{t-i} + \rho ECM_{t-1} + \mu_t \quad - - - \quad 3.1$$

Where: ECM is the error correcting factors and μ_t is the white noise error term.

The ECM is used because it allows the estimation of both short run and long run effects of explanatory time series variables. The linkage between cointegration and ECM stems from the Granger representation theorem. According to this theorem, two or more integrated time series that are error correcting are cointegrated (Engle and Granger 1987). Any discussion of how to statistically model integrated data of the same order must make reference to ECM. In short, the two concepts are isomorphic. That is integrated time series implies ECM estimation. This study tested the long run and short run relationship using both cointegration and ECM.

This study employs time series data collected on annual basis from 1980-2013. The relevant data for this study were obtained from the Central Bank of Nigeria's Statistical Bulletin, Annual Reports and statement of Accounts and the U. S Energy Information Administration.

DATA ANALYSIS

To test formally for the presence of a unit root for each variable in the model, Augmented Dickey Fuller (ADF) test for unit root was conducted. The Schwarz Information Criterion (SIC) is used to determine lag order of each variable under study. Mackinnon's (1996) tables provided the cumulative distribution of the ADF.

The test for stationarity as revealed in table 4.1 indicate that the null hypothesis of a unit root cannot be rejected at the level of the variables. Using differenced data, the computed ADF suggest that the null hypothesis could be rejected for the individual series at the 5 percent significant level and the variables are integrated of order one, I(1).

Table 4.1 Result of the Unit Root Test

Variable	ADF Statistic at level	Mackinnon Critical Value (5%)	ADF Statistic at First Difference	Mackinnon Critical Value (5%)	Order of Integration
LNINDQ	-1.174560	-2.963972	-5.549245	-3.562882	I(1)
LNKAPT	-0.168485	-2.960411	-4.280059	-3.562882	I(1)
LNHUCT	-0.924408	-2.967767	-5.010277	-3.574244	I(1)
LNOIL	-2.885767	-2.954021	-6.726270	-3.557759	I(1)
LNGAS	-2.422858	-2.960411	-4.765508	-3.562882	I(1)
LNELEC	-1.014305	-2.954021	-7.494553	-3.557759	I(1)
LNCOAL	-2.574600	-2.954021	-4.793945	-3.574244	I(1)
$LNCO^2$	-2.365884	-2.963972	-4.580069	-3.603202	I(1)

Source: Author's Computation using E-Views 7.0, 2015

To confirm the evidence in support of long-run equilibrium relationship between energy consumption and industrial output in Nigeria, we employed Johansen multivariate cointegration approach. The result as presented in table 4.2 shows that Trace test and Maximum Eigenvalue provided support for long-run equilibrium relationship between variables.

Table 4.2. Johansen Cointegration Rank test

Unrestricted Cointegration Rank Test (Trace)

Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	0.05 Critical Value	Prob.**
None *	0.921446	298.8875	187.4701	0.0000
At most 1 *	0.850419	217.4806	150.5585	0.0000
At most 2 *	0.820151	156.6832	117.7082	0.0000
At most 3 *	0.768025	101.7829	88.80380	0.0042
At most 4	0.566185	55.02688	63.87610	0.2212
At most 5	0.375333	28.30249	42.91525	0.6039
At most 6	0.274448	13.24534	25.87211	0.7189
At most 7	0.088893	2.979040	12.51798	0.8790

Trace test indicates 4 cointegrating eqn(s) at the 0.05 level
* denotes rejection of the hypothesis at the 0.05 level
**MacKinnon-Haug-Michelis (1999) p-values

Unrestricted Cointegration Rank Test (Maximum Eigenvalue)

Hypothesized No. of CE(s)	Eigenvalue	Max-Eigen Statistic	0.05 Critical Value	Prob.**
None *	0.921446	81.40689	56.70519	0.0000
At most 1 *	0.850419	60.79738	50.59985	0.0032
At most 2 *	0.820151	54.90033	44.49720	0.0027
At most 3 *	0.768025	46.75599	38.33101	0.0043
At most 4	0.566185	26.72438	32.11832	0.1976
At most 5	0.375333	15.05715	25.82321	0.6293
At most 6	0.274448	10.26630	19.38704	0.5904
At most 7	0.088893	2.979040	12.51798	0.8790

Max-eigenvalue test indicates 4 cointegrating eqn(s) at the 0.05 level
* denotes rejection of the hypothesis at the 0.05 level
**MacKinnon-Haug-Michelis (1999) p-values

Source: Author's Computation using E-Views 7.0

The results of the ECM model as presented in table 4.3 shows that energy consumption variables such Oil, Gas, Electricity and Coal and other additional variables (capital, human capital and carbon dioxide) contributed positively to the growth of industrial output in Nigeria in both at their levels and first difference. Except capital, human capital development and CO^2, other variables did not pass the significant test. However, this positive relationship is not sustainable in the long-run as the ECM co-efficient, even though significant; it's positively signed against a priori expectation. This situation, as described by Bamidele and Matthew (2013) shows that a convergence relationship exist between the variables in the short-run. That is, the coefficient of ECM of (-1.03) shows a high speed of adjustment from short-run fluctuation to long-run equilibrium.

Table 4.3. The Parsimonious Error Correction Model
Dependent Variable: D(LNINDQ)

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.009157	0.067235	0.136196	0.8938
D(LNKAPT)	0.706806	0.177130	3.990315	0.0015
D(LNHUCT)	0.119513	0.041719	2.864723	0.0133
D(LNGAS)	0.182621	0.152789	1.195244	0.2533
D(LNELEC)	0.484659	0.316822	1.529750	0.1500
D(LNCOAL)	0.058310	0.062058	0.939606	0.3646
D(LNCO2)	0.950861	0.287099	3.311957	0.0056
D(LNKAPT(-1))	0.629941	0.200911	3.135427	0.0079
D(LNHUCT(-1))	0.060360	0.037130	1.625640	0.1280
D(LNOIL(-1))	0.485230	0.501902	0.966782	0.3513
D(LNGAS(-1))	0.282848	0.154217	1.834093	0.0896
D(LNKAPT(-2))	0.536934	0.154604	3.472953	0.0041
D(LNHUCT(-2))	0.074013	0.037093	1.995370	0.0674
D(LNOIL(-2))	0.787500	0.446497	1.763730	0.1012
D(LNELEC(-2))	0.501392	0.292688	1.713060	0.1104
D(LNCOAL(-2))	0.078638	0.066831	1.176669	0.2604
D(LNCO2(-2))	0.787870	0.437251	1.801872	0.0948
ECMT	-1.026125	0.176465	-5.814877	0.0001

R-squared	0.892639	Mean dependent var	0.182485
Adjusted R-squared	0.752243	S.D. dependent var	0.285716
S.E. of regression	0.142216	Akaike info criterion	-0.770690
Sum squared resid	0.262929	Schwarz criterion	0.061948
Log likelihood	29.94569	Hannan-Quinn criter.	-0.499270
F-statistic	6.358023	Durbin-Watson stat	1.538982
Prob(F-statistic)	0.000805		

Source: Author's Computation using E-Views 7.0, 2015

By implication, approximately, about 100 percent convergence from the previous year's shock to the equilibrium in the current year can be observed.

Diagnostic Test

According to Davidson and Mackinnon (1999), it is important to conduct some diagnostic test while building and estimating a model. The above estimated error correction model was further subjected to normally test, serial correlation test, heteroskedsticity test and stability test.

The result of the serial correlation test in table 4.4, revealed the presence of no serial correlation in the model. The result supported the absence of autocorrelation observed in the ECM result in table 4.3 above. This was observe from the p-value of Breusch-Godfrey Serial correlation with a p-value greater than 0.05.

Table 4.4 .Breusch-Godfrey Serial Correlation LM Test

F-statistic	0.465305	Prob. F(2,11)	0.6398
Obs*R-squared	2.418057	Prob. Chi-Square(2)	0.2985

Source: Author's Computation using E-Views 7.0, 2015

The heteroskedasticity test in table 4.3.2 shows the presence of homoskedasticity in the model. The Glejser test is used because it regress the absolute residuals on the original regressors. The null hypothesis of no heteroskedasticity was accepted because the probability values are greater than 0.05.

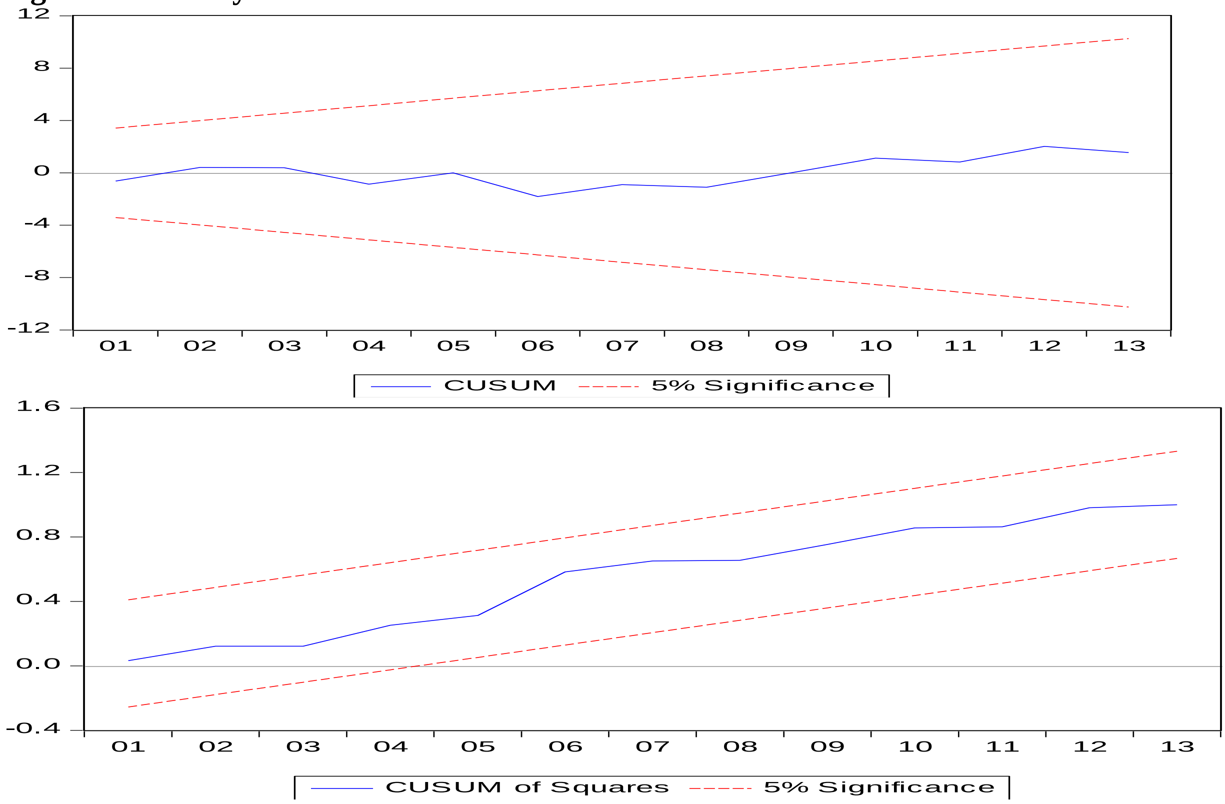
Table 4.3.2 Heteroskedasticity Test: Glejser test

F-statistic	0.947554	Prob. F(17,13)	0.5498
Obs*R-squared	17.15521	Prob. Chi-Square(17)	0.4439
Scaled explained SS	9.238107	Prob. Chi-Square(17)	0.9325

Source: Author's Computation using E-Views 7.0, 2015

The CUSUM test presented in figure 2 shows that the parameters of the model are relatively stable over the study period. This is evidence as the cumulative sum does not go outside the area between the two critical lines. From the results of the diagnostic test, we therefore conclude that the specified error correction model in equation 3.1 is correctly specified with the appropriate variables.

Figure 2. Stability Test



Source: Author's Computation using E-Views 7.0

CONCLUSION

This study investigated the contribution of energy consumption on industrial output in Nigeria between 1980 and 2013. Energy consumption was disaggregated in Oil consumption, Gas consumption, Electricity consumption and Coal consumption in Nigeria. The effect of Carbon dioxide emission (CO^2) from the use of energy was also examined. Other variables specified (KAPT and HUCT) were as suggested by the theoretical framework. The study employed secondary data from CBN, Annual Reports and statement of Accounts and US Energy Information Administration. Data collected were analysed using Error Correction Mechanism.

The result of the ECM shows that all the variables used in the study are characterised with a positive trend. The study provides some evidence in support of long-run relationship between energy consumption and industrial output in Nigeria. The ECM result provides strong evidence in support of convergent relationship between energy consumption and industrial output in Nigeria. The study reveals that the entire variable contributed positively to industrial output in Nigeria. The estimated coefficient of carbon dioxide from the use of energy supported the view of Dasgupta (2002) and Stern (2002) that there is a proportional relationship between energy used by industry and carbon dioxide emission.

To enhance the contribution of energy consumption in the short-run and in the long-run on industrial output, the government of Nigeria should pursue the effective implementation of the energy policy of 2003 towards making energy available and affordable to industrial sector. Also some stringent measure such as pollution tax should be put in place to control the effect of carbon on the environmental. For better research, policy formulation and implementation, this study recommends that government agencies responsible for data collection should improve on the collection of current data for research.

REFRENCES

Abosedra, S. and Baghestani, H. (1989). “New evidence on the causal relationship United State energy consumption and gross national product”. *Journal of Energy and Development* 14, 285-292.

Adenikinju, A. (2005) “Analysis of the cost of Infrastructure failures in a developing economy. The case of the electricity sector in Nigeria.” *AERC Research paper* 48, Nairobi. AERC.

Aguegboh, S. E. and Mudueme, S. I. (2013). “Energy consumption and economic growth nexus: Empirical evidence from Nigeria”. *Proceedings of the 2013 NAEE/IAEE conference on energy resource management in a federal system, challenges, constraint, and strategies.* Pp 305-332.

Akomolafe K. J., Danladi, J. D. and Babalola, D. (2012). “Electricity Consumption and Economic Growth: A Causality Test in Nigeria”. *Proceedings of the 2012 NAEE/IAEE Conference on Energy Technology and Infrastructure for Development.* Pp 509-517.

Atoloye Kayode O. (2013) “Historical review of energy in Nigeria. Some determinants of energy trend”. *Proceedings of the NAEE/IAEE conference on energy resource management in a federal system, challenges, constraint, and strategies, Nigeria.* Pp 53-73.

Babatope O., Taiwo O., and Patrick E.E. (2012). “Disaggregated Analysis of Energy Consumption and Economic Performance in Nigeria”. *Proceedings of the*

NAEE/IAEE Conference on Energy and Infrastructure for Development, Nigeria. Pp 385-396.

Baghebo. M., and Atima T. O. (2013). "The impact of petroleum on economic growth in Nigeria (1980-2011)". *Global Business and Economic Research Journal*. Vol. 2. (5) 102 – 115.

Bamidele, P. A. and Mathew, A.D. (2013). "Energy consumption and economic growth nexus: Empirical evidence from Nigeria". *Proceedings of the NAEE/AEE conference on energy resource management in a federal system, challenges, constraint, and strategies, Nigeria.* Pp 241 257.

Central Bank of Nigeria (2011). *Annual Report*, 31st December

Central Bank of Nigeria (2012). *Annual Report*, 31st December

Central Bank of Nigeria (2013). *Statistical Bulletin*, Vol. 24. December

Davidson, R., and Mackinnon, J. G. (1999). *Econometric Theory and Method*. New York: Oxford University Press.

Elijah, U. and Nsikak, J. (2013). "Energy requirements and industrial Growth in Nigeria": An ARDL approach. *Proceedings of the NAEE/AEE conference on energy resource management in a federal system, challenges, constraint, and strategies. Nigeria.* Pp. 74-96.

Engle, R. F. and W. J. Granger (1987). "Cointegration and error correction representation, estimation, and testing". *Econometrica*, Vol. 55, No. 2. Pp. 251-276.

Erbaykal, E. (2008). "Disaggregate energy consumption and economic growth: Evidence from Turkey": *International Research Journal of Finance and Economics.* Vol. 20, pp. 172-179.

Erol, U., Yu, E. S. H. (1987). "On the causal relationship between energy and income for industrialized countries". *Journal of Energy and Development* 13, 113-122.

Gbadebo, O. and Okonkwo, C. (2009). "Does energy consumption contribute to economic performance: Evidence from Nigeria". *Journal of Economics and Business*. Vol. XII No. 2, pp. 43-79.

Gujarati, D. N. (2003). *Basic Econometrics.* Fourth edition, Tata McGraw-Hill, New Delhi.

Isakson, A. (2009) "Energy infrastructure and industrial development". *UNIDO working paper*, No. 12, Vienna.

Iwayemi A., Diji, C., Awotide, B., Adekinju., A. and Obute P. (2014). Towards sustainable universal electricity access in Nigeria. *CPEEL monograph series*, vol. 1, No. 2.

Knetch, T. M. (2009). "Supply side effects of strong energy price hikes in German industry and transportation". *Discussion paper series 1*; Economic Studies No. 26/2009.

Kraft, J., Kraft, A. (1978). "On the relationship between energy and GNP". *Journal of Energy and Development.* 3, 401-403.

Mackinnon, J.G. (2010). Critical values for cointegration test. *Queen's Economic Department Working Paper* No. 1227.

Masih. A., Masih, R. (1996). "Energy consumption, real income and temporal causality: Results from a multi- country study based on cointegration and error-correction modelling techniques". *Energy Economics.* 18, 165-183.

National Energy Comission (2003). Energy Policy. Federal Republic of Nigeria.

Noor, S. and Siddiqi M. (2010). "Energy consumption and economic growth in South Asian countries: A co-integrated panel analysis". *International Journal of Human and Social Sciences.* 5(14), pp. 921-926.

Olumuyiwa, O. (2013). "The interaction between economic growth, domestic energy consumption and domestic energy prices in Nigeria: An Econometric Analysis". *Proceedings of the NAEE/IAEE conference on energy resource management in a federal system, challenges, constraint, and strategies.* Pp 37-52.

ISSN 2056-5429

Pesaran, M. H., Shin, Y., and Smith, R. J. (2001) "Bounds testing approaches to the analysis of level relationships". *Journal of applied econometrics* 16, 289-326.

Qazi, A., Ahmed K. and Mudassar M. (2012). Disaggregate Energy Consumption and Industrial Output in Pakistan: An Empirical Analysis. *Discussion paper* No. 2012 to 2029. Kiel Institute for the World Economy.

Sari, R., Ewing B. and Soytas U. (2008). "The relationship between disaggregated energy consumption and industrial production in the United State: an ARDL approach, 2001.1 – 2005.6". *Energy Economics* 30, 2302-2313.

Shaari, M. S., and Hussain N.E. and Ismail, M. (2012). "Relationship between energy consumption and economic growth: Empirical evidence for Malaysia". *Business System Review*, Volme 2, Issue 1, pp. 17-28.

Shahbaz, M., Muhammed Z. and Talat A. (2012). "Is energy consumption effective to spur economic growth in Pakistan? New evidence from Bounds Test to level Relationships and Granger Causality Tests". *MPRA Paper* No. 39734.

Soytas, U. and Sari, R. (2003). "Energy consumption and GDP: Causality relationship in G-7 countries and emerging markets". *Energy Economics*. 25, 33-37.

Stern, D. I. (2012). "Economic growth and energy". *Encyclopedia of Energy*, Vol. 2, pp. 35-51.

Titilope, O. (2013). "Electricity challenges, power sector reforms and performance of the Nigerian manufacturing sector". *Proceedings of the NAEE/AEE conference on energy resource management in a federal system, challenges, constraint, and strategies.* Pp 143-190

U. S. Energy Information Administration. Retrieved from www.eia.gov/consumption

Wolde-Rufael, Y. (2005). "Energy demand and economic growth: The Africa experience countries". *Journal of policy modelling*, 27, 891-903.

Yu, E. S. H., Choi, J.Y. (1985). "The causal relationship between energy and GNP: An international comparison". *Journal of Energy and Development.* 10, 249-272.

Ziramba, E. (2009). "Disaggregated Energy consumption and Industrial Production in South Africa 1980-2005". *Energy Policy* Vol. 37, 6 2214-2220.