International Journal of Energy Economics and Policy
Vol. 3, No. 4, 2013, pp.412-423
ISSN: 2146-4553
www.econjournals.com

Energy Consumption and Economic Growth Nexus: New Empirical Evidence from Nigeria

Bamidele P. Abalaba
Department of Economics, College of Management and Social Sciences,
Osun State University, Okuku Campus, Okuku, Osun State, Nigeria.
Email: abalabapero@yahoo.com

Matthew Abiodun Dada
PGS Department of Economics,
Obafemi Awolowo University, Ile-Ife, Nigeria.
Email: mattabey@yahoo.com

ABSTRACT: This study analysed the trend of energy consumption, real output, financial development, monetary policy rate and consumer prices and also examined the long-run relationship and direction of causality between energy consumption and economic growth with consideration for financial development, monetary policy rate and consumer prices. These were with a view to examining the relationship between energy consumption and economic growth in Nigeria during the period 1971-2010. The result showed that all the variables used in the study are characterized by a positive trend. Also, it was found that variables followed a I(1) process. The study provides weak evidence in support of long-run relationship between energy consumption and economic growth. The study further revealed that energy consumption among other variables positively and significantly influenced output growth in the short-run. Using the first three lags, we found no causal evidence one way or two way between energy consumption and economic growth. The study concluded that energy consumption only has short-run positive impact on the economy but has not enhanced long-run economic growth in Nigeria during the period under investigation.

Keywords: Error correction model; aggregated analysis; energy consumption; financial development; monetary policy rate
JEL Classifications: O13; O47; Q43

1. Introduction

Energy by classification could be renewable and non-renewable. Renewable energy is referred to as energy that comes from resources which are continually replenished such as sunlight, winds, rain, tides, waves and geothermal heat. Empirically, about 16% of global energy consumption comes from renewable sources, 10% of all energy comes from biomass which is mainly used for heating, 3.4% from hydroelectricity. New renewable sources such as modern biomass, biofuel, wind, solar, geothermal, etc. accounted for 3%. Renewable energy is growing rapidly with electric energy accounted for 19%, with 16% coming from hydro-electric source; wind energy is growing at the rate 0f 30%.

From Nigeria perspective, energy consumption includes fuel wood, coal, electricity, oil and gas. It is no gain say any longer anywhere in the world over that the demand for energy is growing faster than its supply; this trend has necessitated renewed efforts by the government both in developing and developed countries to boost energy supplies in order to meet the demand. The persistence increase in the price of energy as a commodity in the recent time in different countries across the world is an evidence that supply is not coping with demand. Various governments across the globe have taken several steps to boost energy supplies due to this rapid increase in demand. It should be recalled that energy was sometimes viewed as a mere "consumption good" just until the "productivity shortfall" which accompanied the oil crisis of 1970s.

According to Stern (2003), it was argued that while business financial economists pay significant attention to the impact of oil and other energy prices on growth, the mainstream theory of growth pays little or no attention to the role of energy or other natural resources in stimulating economic growth. More liberal financial literature argues that a causal relationship should be expected between energy consumption and economic growth. This is viewed as an important factor for both demand and supply sides of the economy. On the supply side, energy is an important input to production, hence, a catalyst to economic growth and development. On the demand side, consumers see energy as a consumable product through which utility is maximized (Chontanawat et al, 2006).

Opinion differs on the causal relation between energy consumption and economic growth. Some writers shared the view that the growth in energy demand is as a result of civilization and industrial progress experienced all over the world. If we carefully examine this view, we will see that there is no doubt the level of development a hundred years ago differs significantly from what is obtained anywhere in the world today. The level of civilization and industrial progress has gone up tremendously. This might be responsible for the increase in energy demand experienced in the recent time. Masih and Masih (1996) attribute the growth in energy demand to the level of economic development; others argue that the increase in energy consumption would cause economic growth. Thus, there is no consensus among energy economic writers on the direction of causality between energy consumption and economic growth. Soytas and Sari (2007) acknowledge this lack of consensus in the findings of most empirical studies and suggest the reason for this. They argue that different economies have different energy consumption pattern and various sources of energy; consequently, different sources might have varying impacts on the economy.

However, most of the studies have used different variables to proxy economic growth and energy consumption. This variation might affect the results. This study examines the relationship between energy consumption and economic growth in Nigeria between 1970 and 2010. This study differs from prior studies in that RGDP was used to proxy economic growth, TECONS which is read as total energy consumption was used to proxy energy consumption. Also, three key macroeconomic variables were introduced into the model as complementary explanatory variables. There is no doubt the interaction of these variables with energy consumption variable might enhance the growth-effect of energy consumption. These three complementary explanatory variables in the model are consumer prices, financial development and monetary policy rate. The inclusion of inflation rate in the model is informed by the likely influence of price dynamic in the economy on various aspect of consumption of which energy is inclusive.

The rest of this paper is organized as follows: Section 2 discusses the theoretical and empirical literature regarding the causal link between energy consumption and economic growth. Section 3 presents the data and the econometric methodology; Section 4 presents empirical analysis while section 5 concludes.

2. Literature Review

Several empirical studies have been carried out on the examination of relationship between energy consumption and economic growth (see Ozturk, 2010). This study reviewed some of this study in order to gain an insight into the state of discussion on this topical issue. The relationship has been examined for different countries at different periods using different methodologies. A pioneer study conducted by Kraft and Kraft (1978) examined the relationship between the USA's energy consumption and GNP for the period of 1947and 1974. The study found a unidirectional causality from GNP to energy consumption.

Akarca and Long (1980) used the same data for the USA for 1947-1972 to examine the relationship between energy consumption and economic growth, the study found no causal evidence between the two variables. Erol and Yu (1987) using bivariate models tested the relationship between energy consumption and GDP for six selected developed economies, namely; Canada, England, France, Germany, Italy and Japan, with data from period 1952–1982. The study found a bidirectional causal relationship for Japan, unidirectional from energy consumption to GDP for Canada and unidirectional from GDP to energy consumption for Germany and Italy. They found no causality for France and England.

Stern (2000) also examined the causal relationship between energy consumption and GDP in USA for 1948 – 1994 periods, using multivariate model. The study found no relationship between the variables. Masih and Masih (1996) using a cointegration analysis and vector auto regressive model examined the causal relationship among energy consumption, employment and output for Taiwan from 1982–19997. The result showed that bi-directional causality existed for employment-output, and employment-energy consumption, but only unidirectional causality running from energy consumption to output.

Soytas and Sari (2003) examined the causal link between energy consumption and GDP in the top (10) ten emerging markets – excluding China and G-7 countries. The study found out that bidirectional causality existed in Argentina, unidirectional causality running from energy consumption to GDP was found for Turkey, France, Germany and Japan, and from GDP to energy consumption for Korea and Italy. Soytas, et al. (2001) examined the relationship between energy consumption and GDP for Turkey for the period between 1960 and 1995 and found a unidirectional relationship from energy consumption to GDP for the period.

Chontanawat et al. (2006) investigated the causal relation between energy consumption and GDP for 30OECD and 78 non-OECD countries. Their findings showed that causality ran from aggregate energy consumption to GDP and GDP to energy consumption is more prevalent in the advanced OECD countries compared to the developing non-OECD countries. Those findings imply that a policy to reduce energy consumption aimed at reducing emission is likely to have greater impact on the GDP of the developed rather than the developing countries. Ozun and Cifter (2007) believe that methodology has crucial effects on the degree and direction of the causality between energy consumption and economic growth. They argue that in emerging financial markets, the test results of economic time series are mostly methodology dependent. Ozun and Cifter, using a wavelet analysis as a semi parametric model, test for multi scale causality between electricity consumption and economic growth from 1968-2002 period. The study found that in the short run, there was a feedback relationship between GNP and energy consumption, while in the long run, GNP leads to energy consumption. Wavelet correlation between GNP and energy consumption is maximum at 3rd time scale (5-8years) and this shows that GNP affects electricity consumption maximally around 5-8 years later in the long-run. They also found that the magnitude of the wavelet correlation changes based on time-scale for GNP and energy consumption and this indicates that GNP and energy consumption are fundamentally different in the long run. Costantini and Martini (2009) analysed the causal link between economic growth and energy consumption by adopting a Vector Error Correction Model for nonstationary and co integrated panel data with a large sample of developed and developing countries and four distinct energy sectors. The results showed that alternative country sample sharply affect the causality relations, particularly in a multivariate multi-sectoral framework. Besides studies which examined energy as a whole, some studies examine energy by separating it into its sub-component such as electricity and petroleum. Ghosh (2002) examined economic growth and electricity in India between 1950 and 1997. He found a unidirectional causality from economic growth to electricity consumption. Also Jumbe (2004) examined the relationship between electricity consumption and GDP for Malawi for the period between 1970 and 1999 and found bidirectional causality. The study also examined the relationship between non-agricultural GDP and electricity consumption. He found a unidirectional causality relationship from GDP to energy consumption. Rufael (2006) investigated the relationship between electricity consumption and GDP for17 Africa countries from 1971-2001 periods. The result showed that there was cointegrating relationship in nine countries and causality for twelve countries. Unidirectional causality from GDP to electricity consumption was found in six of these countries and from electricity consumption to GDP in 3 countries. The study found a two-way causality for 3 countries. Zou and Chau (2005) examined the relationship between oil consumption and GDP in the pre-liberalization (1953-1984) and post-liberation (1985-2002) Chinese economy. The study found co-integration between oil consumption and GDP, it found no causal link between the variables in the short run, however, the study found bidirectional causality in the long run. Also, they found unidirectional causality from oil consumption to GDP in the short run, for1985-2002 period, and bidirectional causality between the variables in the long run, for the same period. The study, however, found no cointegration between oil consumption and GDP for the entire period of 1953-2002.

Erbaykal (2008) investigated the relationship between Economic growth and Energy consumption using disaggregated data namely oil and electricity consumption for 1970-2003 period for Turkey employing the Bounds test approach to cointegration. The study found that in the short-run, both oil and electricity consumptions have positive and significant effects on economic growth. In the long run, however, oil consumption has positive but insignificant effect on economic growth while electricity consumption has a negative and insignificant effect on economic growth. The study infers that both electricity and oil consumption have short run effect on economic growth.

Bright and Machame (2011) examined the causality between GDP and each of the basic subcomponents of energy consumption in Nigeria between 1970 and 2005, the result showed that unidirectional causality running from electricity consumption to GDP existed both in the short-run and long-run. They also found unidirectional causality from Gas consumption to GDP in the short-run while bidirectional causality was found to exist in the long-run. The study also revealed that there was no causal evidence in either way round between oil consumption and GDP in the short-run while unidirectional causality running from oil consumption to GDP was found in the long-run.

Hazuki (2012) analysed cointegration and causality between fossil fuel consumption and economic growth in the world over the period 1971-2008. The results indicate that fossil fuel consumption and GDP are cointegrated and there exists long-run unidirectional causality from fossil fuel consumption to GDP. The study also found no causal link between non fossil energy consumption and GDP

Sahbi and Jaleleddine (2012) conducted a study on the relationship between Energy Consumption, GDP and CO2 emissions for 15 MENA countries covering the annual period1973-2008. The study reveals that there is no causal evidence between GDP and Energy consumption in the short-run. Similar result was found for CO2 emissions and EC. However, in the long run, there is a unidirectional causality running from GDP and CO2 emissions to Energy Consumption.

Mehdi and Maamar (2012) investigated the causal relationship between energy consumption and energy performance for the aggregated and disaggregated economy within the time frame 1980-2007 using Vector Error Correction Modelling. The study found mixed evidence on causality directions at aggregated and disaggregated levels. The conclusion drawn from their study is that energy consumption has no impact on economic performance at sectorial level.

From the literature survey all over, it is observed that there has been no consensus on the findings of prior studies. In all, empirical findings are mixed on energy consumption-economic growth nexus. This inconclusive state of research on this subject matter has inspired the authors of this paper to think of a new way of exploring the relationship between energy consumption and economic growth, hence this study.

3. Data and Methodology

The study begins by specifying a model showing a functional relationship between RGDP and TECONS. This implies that changes in RGDP might be as a result of changes in TECONS as well as variables such as consumer prices, M2DIV and CPSDIVGDP. This model captures the effect of changes in energy consumption on real GDP via the price changes and changes in financial development and monetary policy rate in the economy.

$$\boldsymbol{InRGDP = f(InTECONS, \mathbf{InCPI}, \mathbf{InM2DIV}, \mathbf{InCPSDIVGDP})} \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots.\ldots (1)$$

We obtain the exact linear form of the model as:

$$\boldsymbol{InRGDP = \beta_0 + \beta_1\, InTECONS + \beta_2 \mathbf{InCPI} + \beta_3 \mathbf{InM2DIV} + \beta_4 \mathbf{InCPSDIVGDP}} \ldots\ldots\ldots\ldots (\mathbf{2})$$

We progress by obtaining the stochastic form of equation 2, this becomes

$$\boldsymbol{InRGD = \beta_0 + \beta_1 InTECONS + \beta_2 \mathbf{InCPI} + \beta_3 \mathbf{InM2DIV} + \beta_4 \mathbf{InCPSDIVGDP} + \mathbf{U_t}} \ldots\ldots.(\mathbf{3})$$

The issue of spurious result associated with non-stationary Time Series data was given serious attention in this study. Empirical literature suggest that regression involving two or more nonstationary variables produce a reliable result only if the I(1) variables cointegrate. Thus, if the variables ($InRGDP$, $InTECONS$, InCPI, InM2DIV, InCPSDIVGDP) are considered as stochastic trends and if they follow a common long-run equilibrium, then these variables should be cointegrated. According to Engle and Granger (1987), cointegrated variables must have an ECM representation. The main reason for the popularity of cointegration analysis is that it provides a formal background for testing and estimating short-run and long run relationships among economic variables. Furthermore, the ECM strategy provides an answer to the problem of spurious correlation. The regression in equation 3 is only meaningful and free from being spurious if and only if variables ($InRGDP$, $InTECONS$, InCPI, InM2DIVGDP, InCPSDIVGDP) are stationary that is,I(0). However, if these variables are I(1), the regression in equation 3 is spurious. From equation 3, U_t is derived as:

$$\boldsymbol{\mathbf{U_t} = InRGDP - \beta_0 - \beta_1\, InTECONS - \beta_2 \mathbf{InCPI} - \beta_3 \mathbf{InM2DIV} - \beta_4 \mathbf{InCPSDIVGDP}} \ldots\ldots (\mathbf{4})$$

Equation 5 is referred to as cointegrating equation which connects the dependent and the explanatory variables in the long-run.

If, then, variables $(InRGDP,\ InTECONS, \text{InCPI}, \text{InM2DIV}, \text{InCPSDIVGDP})$ are cointegrated by definition $\mathbf{U_t \backsim I(0)}$, then we express the relationship between the dependent and independent variables with an ECM specification as:

$$\Delta InRGD = \beta_0 + \beta_1 \Delta InTECONS + \beta_2 \Delta \text{InCPI} + \beta_3 \Delta \text{InM2DIV} + \beta_4 \Delta \text{InCPSDIVGDP} - \beta_5 ECM_{t-1} + \varepsilon_t \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots..(5)$$

Equation 5 has the advantage of including long-run and short-run information in this model, β_1 captures the short-run effect of energy consumption on output growth in the economy while β_5 captures the long-run response, that is the feedback effect which shows how much of the disequilibrium is being corrected for each period. It shows the extent to which any disequilibrium in the previous period affects the dependent variable.

The study used annual data covering 1971-2010 on such variables as real GDP, aggregated energy consumption, consumer prices, monetary policy rate and financial development. The data were sourced from the CBN Statistical Bulletin, 2010 Edition augmented with CBN Annual Report and Statement of Accounts (Various Years) and World Development Indicators (WDI) of the World Bank's CD-ROM. Data were analysed using descriptive and econometric techniques.

4. Empirical Analysis

To test formally for the presence of a unit root for each variable in the model, Augmented Dickey-Fuller (ADF) and Phillips-Perron (PP) tests of the type given by regression equations (6) and (7) were conducted. The ADF test was conducted using the regression equation of the form:

$$\Delta h_t = \phi_0 + \phi_{1t} + \rho h_{t-1} + \sum_{i=1}^{k} \Omega_i \Delta h_{t-i} + u_{5t} \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots(6)$$

Where Δh_t represents the first differences of the series h_t, k represents the lag order and t stands for time. Equation (6) is specified with intercept term and time trend.

Phillips-Perron (PP) tests involve computing the following OLS regression:

$$h_t = \psi_0 + \psi_1 h_{t-1} + \psi_2 [t - \frac{T}{2}] + u_{6t} \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots.(7)$$

where ψ_0, ψ_1, ψ_2 are the conventional least-squares regression coefficients. The hypotheses of unit root to be tested are H_0: $\psi_1 = 1$ and H_0: $\psi_1 = 1, \psi_2 = 0$.

Akaike's Information Criterion (AIC) is used to determine the lag order of each variable under study. Mackinnon's (1991) tables provide the cumulative distribution of the ADF and PP test statistics.

Table 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**
LOG(RGDP)	-2.8383*	-3.5331	-5.1398	-3.5366	I(1)
LOG(TECONS)	-0.2852*	-3.5298	-5.7792	-3.5331	I(1)
LOG(CPI)	-0.9183*	-3.5331	-4.3227	-3.5331	I(1)
LOG(M2DIV)	-1.0244*	-3.5684	-4.6868	-3.6123	I(1)
LOG(CPSDIVGDP)	-0.5818*	-3.5684	-4.4482	-3.5742	I(1)
Variable	**PP Statistic At Level**	**Mackinnon Critical Value (5%)**	**PP Statistic At First Difference**	**Mackinnon Critical Value (5%)**	**Order of Integration**
LOG(RGDP)	-2.4186*	-3.5298	-6.4333	-3.5331	I(1)
LOG(TECONS)	0.6235*	-3.5298	-7.2407	-3.5331	I(1)
LOG(CPI)	-0.9802*	-3.5298	-4.3893	-3.5331	I(1)
LOG(M2DIV)	-1.2470*	-3.5684	-5.6154	-3.5742	I(1)
LOG(CPSDIVGDP)	-0.8785*	-3.5684	-4.6179	-3.5742	I(1)

(*) denotes rejection of the hypothesis of no unit root at the level of the variables at 5% significance level.

Tests for stationarity as revealed in Table 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 and PP tests suggested that the null hypothesis could be rejected for the individual series, at the one or five percent significant level and the variables ($InRGDP$, $InTECONS$, InCPI, InM2DIV, InCPSDIVGDP) are found to be integrated of order one, I(1).

We conducted an OLS-Based regression at the level of the variables with real GDP as dependent variable and energy consumption as explanatory variable amidst other variables used as complementary explanatory variables in the model. The results were presented in Table 2.

Table 2. Result of OLS-Based Regression at the level of the variables

Dependent Variable: LOG(RGDP)				
Method: Least Squares				
Sample: 1971- 2010				
Included observations: 40				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
LOG(TECONS)	7.585268	0.987818	7.678814	0.0000
CPSDIVGDP	0.012031	0.025228	0.476893	0.6364
LOG(CPI)	-0.490818	0.136340	-3.599959	0.0010
M2DIV	0.014523	0.025200	0.576311	0.5681
C	-71.94966	10.54414	-6.823665	0.0000
R-squared	0.950553	Mean dependent var		11.94280
Adjusted R-squared	0.944901	S.D. dependent var		1.424545
S.E. of regression	0.334385	Akaike info criterion		0.763419
Sum squared resid	3.913458	Schwarz criterion		0.974529
Log likelihood	-10.26838	Hannan-Quinn criter.		0.839750
F-statistic	168.2057	Durbin-Watson stat		1.154727
Prob(F-statistic)	0.000000			

Table 3. Result of the unit root test on the residuals obtained from the level regression in Table 2

Null Hypothesis: RESID has a unit root				
Exogenous: Constant				
Lag Length: 0 (Automatic based on SIC, MAXLAG=9)				
			t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic			-3.988221	0.0037
Test critical values:	1% level		-3.610453	
	5% level		-2.938987	
	10% level		-2.607932	
*MacKinnon (1996) one-sided p-values.				
Augmented Dickey-Fuller Test Equation				
Dependent Variable: D(RESID03)				
Method: Least Squares				
Sample (adjusted): 1972- 2010				
Included observations: 39 after adjustments				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
RESID03(-1)	-0.589072	0.147703	-3.988221	0.0003
C	0.007641	0.046788	0.163306	0.8712
R-squared	0.300645	Mean dependent var		0.007478
Adjusted R-squared	0.281744	S.D. dependent var		0.344765
S.E. of regression	0.292188	Akaike info criterion		0.427085
Sum squared resid	3.158842	Schwarz criterion		0.512396
Log likelihood	-6.328160	Hannan-Quinn criter.		0.457694
F-statistic	15.90590	Durbin-Watson stat		1.739561
Prob(F-statistic)	0.000302			

The study progressed by conducting a unit root test on the residual obtained from the OLS-Based level regression in Table 2. This is to confirm whether the residual is stationary or nonstationary. The result as shown in Table III showed that the residual obtained is stationary that is, it is a I(0) process. This suggests that cointegration exists among the group of integrated variables in the system. For further information on the behaviour of the residuals and trends in the data series check Figures 1, 2 and 3 as well as Table 7 in the Appendix.

The study proceeded by including the residual obtained from the level regression in Table 3 as one of the explanatory variables in the error correction model. The result of the error correction model as presented in Table 4 showed that energy consumption among other variables positively and significantly influenced output growth in the short-run. In addition, the negative coefficient of ECM (-0.5573) which is significant at 1% critical level indicates that about 55% of disequilibria in the real output in the previous year are corrected for in the current year. The significance of the ECM is an indication of the existence of a long-run equilibrium relationship between energy consumption and real output. The coefficient of determination R^2 is about 0.336. This indicates that about 34% of total variation in the growth rate of real output is explained by the variation in the underlying explanatory variables. The significance of F-statistic at 5% level indicates the overall significance of the error correction model. The Durbin-Watson statistic of around 1.75 shows the absence of serial autocorrelation.

Table 4. Result of the error correction model

Dependent Variable: DLOG(RGDP)				
Method: Least Squares				
Sample (adjusted): 1972 -2010				
Included observations: 39 after adjustments				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
DLOG(TECONS)	4.762508	2.438582	1.952982	0.0593
D(CPSDIVGDP)	-0.004461	0.024102	-0.185101	0.8543
DLOG(CPI)	-0.376926	0.316921	-1.189336	0.2428
D(M2DIVGDP)	0.020681	0.021083	0.980926	0.3338
ECM(-1)	-0.557367	0.154637	-3.604352	0.0010
C	0.066847	0.096411	0.693359	0.4929
R-squared	0.336463	Mean dependent var		0.130455
Adjusted R-squared	0.235927	S.D. dependent var		0.344007
S.E. of regression	0.300700	Akaike info criterion		0.575234
Sum squared resid	2.983886	Schwarz criterion		0.831167
Log likelihood	-5.217066	Hannan-Quinn criter.		0.667061
F-statistic	3.346692	Durbin-Watson stat		1.747886
Prob(F-statistic)	0.014868			

In order to confirm further the evidence in support of long-run equilibrium relationship between energy consumption and economic growth in Nigeria, we employed Johansen multivariate cointegration approach. The result as presented in Table 5 showed that both the Trace test and the Maximum Eigenvalue test provided no evidence in support of long-run equilibrium relationship between energy consumption and output growth in Nigeria since the hypothesis of no cointegration cannot be rejected from both the Trace test and the Maximum Eigenvalue test at 5% level.

After the controversial evidence in support of cointegration, the study thereafter conducted a bivariate Granger causality test using the first differences of the variables. This aimed at determining the direction of short-run causality between energy consumption and real GDP. Using the first three lags, the result showed that there was no short-run causal evidence one-way or two-way between energy consumption and economic growth. This is shown in the result presented in Table 6.

Table 5. Result of Johansen Multivariate Cointegration Test

Sample (adjusted): 1973- 2010					
Included observations: 38 after adjustments					
Trend assumption: Linear deterministic trend					
Series: LOG(RGDP) LOG(TECONS) LOG(CPI) LOG(M2DIVGDP) LOG(CPSDIVGDP)					
Lags interval (in first differences): 1 to 1					
Unrestricted Cointegration Rank Test (Trace)					
Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	0.05 Critical Value	Prob.**	
None *	0.537714	69.16176	69.81889	0.0563	
At most 1	0.363756	39.84206	47.85613	0.2282	
At most 2	0.318205	22.65951	29.79707	0.2632	
At most 3	0.128117	8.104500	15.49471	0.4543	
At most 4	0.073347	2.894682	3.841466	0.0889	
Trace test indicates no cointegratingeqn(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	0.537714	29.31969	33.87687	0.1590	
At most 1	0.363756	17.18256	27.58434	0.5643	
At most 2	0.318205	14.55501	21.13162	0.3213	
At most 3	0.128117	5.209818	14.26460	0.7152	
At most 4	0.073347	2.894682	3.841466	0.0889	
Max-eigenvalue test indicates no cointegration at the 0.05 level					
* denotes rejection of the hypothesis at the 0.05 level					
**MacKinnon-Haug-Michelis (1999) p-values					

Table 6. Result of Standard Granger Causality Test

Null hypothesis	No of Obs	No of lags	F-Value	Prob.	Decision Rule
DLOG(TECONS) does not Granger Cause DLOG(RGDP)	38	1	1.3443	0.2541	Do not reject
DLOG(RGDP) does not Granger Cause DLOG(TECONS)	38	1	1.3572	0.2519	Do not reject
DLOG(TECONS) does not Granger Cause DLOG(RGDP)	37	2	0.9315	0.4044	Do not reject
DLOG(RGDP) does not Granger Cause DLOG(TECONS)	37	2	0.6829	0.5124	Do not reject
DLOG(TECONS) does not Granger Cause DLOG(RGDP)	36	3	0.6810	0.5708	Do not reject
DLOG(RGDP) does not Granger Cause DLOG(TECONS)	36	3	0.5019	0.6839	Do not reject

While most of the findings of this study are in conflict especially with most of the recent studies which include Ighodaro (2010), Mehdi and Maamar (2012), Shahbaz and Hooi (2011) and Ogunleye (2012) who employed a disaggregated analysis, they confirm the findings of Hazuki (2012), Akinlo (2008) and Shahiduzzaman and Alam (2012). More importantly, most of the studies cited employed a disaggregated analysis and did not jointly include or consider financial development, consumer prices and monetary policy rate together in their models.

5. Summary, Recommendations and Conclusion

This study investigated the relationship between energy consumption and economic growth with consideration for consumer prices, monetary policy rate and financial development in Nigeria between 1971 and 2010. The study employed secondary data sourced from CBN Statistical Bulletin augmented with World Development Indicators (WDIs) and CBN Annual Reports (Various Years). Data collected were analysed using Times Series econometric techniques such as unit root test, cointegration test, error correction mechanism and standard Granger causality test.

The result showed that all the variables used in the study are characterized with a positive trend. Also, the variables were found to have followed a I(1) process meaning that variables are nonstationary in their level form but they become stationary after first differencing. The study also provides some evidence in support of long-run relationship between energy consumption and economic growth. The result of the error correction model showed that energy consumption among other variables positively and significantly influenced output growth in the short-run. In addition, the result also showed that the coefficient of ECM is negatively signed and significance in line with a priori expectation. This indicates that variables adjust after a short-run deviation from equilibrium. However, the result of Johansen multivariate cointegration test provides no evidence in support of long-run relationship between energy consumption and economic growth. This makes the long-run equilibrium relationship established in this study to be weak and hence cannot be taken far.

After the controversial evidence of long-run relationship between energy consumption and real output, we adopted standard Granger causality test using the first three lags. The results provided no causal evidence one way or two way between energy consumption and economic growth in Nigeria since the hypothesis of no causality was upheld in both directions. Government should ensure adequate supply of energy needed to stimulate economic growth in Nigeria. Energy is required both as input to further production from producer side and also as a complementary demand from demand side. Government should make energy affordable to all to enhance further production and utility maximising ability of the final consumers. Government should also raise an enlightenment campaign on prudence use of energy to avoid wastage. Unproductive consumption should be checked most especially from demand side.

The study therefore concluded that energy consumption only has short-run positive impact on the economy but has not enhanced long-run economic growth in Nigeria during the period under investigation.

References

Akarea, A.T., Long, T.V. (1980) On the relationship between energy and GNP: a re-examination. Journal of Energy and Development, 5, 326-331.

Akinlo, A.E. (2008). Energy Consumption and Economic Growth: Evidence from 11 Sub-Sahara African countries. Energy Economics, 30(5), 2391-2400.

Aliero, H.M., Ibrahim, S.S. (2012) The Relationship between Energy Consumption and Economic Growth In Nigeria: A Causality Analysis, International Journal of Marketing and Technology, 2(3), 1-13.

Al-Iriani, M.A. (2006) Energy-GDP revisited: an example from GCC countries using panel causality. Energy Policy, 34(17), 3342-3350.

Asafu, A. (2000) The relationship between energy consumption, energy prices and economic growth: Times series evidence from Asian developing countries. Energy Economic, 22, 615-625.

Azlina A.A., (2011). On the causal links between Energy Consumption and Economic Growth in Malaysia. International Review of Business Research Papers, 7(6), 180-189.

Belke, A., Dobnik, F., Dreger, C. (2011). Energy Consumption and Economic Growth: New Insights into The Cointegration Relationship. Energy Economics, 33(5), 782–789.

Bright O., Machame, H. (2011). Energy Consumption and Economic Growth in Nigeria. JORIND 9(1), 153-161.

Cheng, L. (1997) An investigation of cointegration and causality between energy consumption and economic activity in Taiwan province of China. Energy Economics, 19, 435-444.

Chontanawat, J., Hunt, L.C., Pierse, R. (2006). Causality between energy consumption and GDP: Evidence from 30 OECD and 78 non-OECD countries. Surrey Energy Economics Discussion Papers, SEEDS No. 113. Surrey Energy Economics Centre (SEEC), University of Surrey.

Costatini, V., Mattini, C. (2009) The causality between energy consumption and economic growth: a multi-sectoral analysis using non stationary cointegrated panel data. Department of Economics Roma Tre University, working paper 102.

Erbaykal, E. (2008) Disaggregate Energy consumption and Economic Growth: Evidence from Turkey. International Research Journal of Finance and Economics, 20, 172-179.

Erol, U, Yu, E.S.H. (1987). Time Series Analysis of the Causal Relationships between US Energy and Employment, Resources Energy, 9, 75-89.

Ghosh, S. (2002) Electricity consumption and Economic growth in India. Energy Policy, 30, 125-129.

Granger, C.W.J. (1969) Investigating causal relations by Econometrics models and cross-spectral methods. Econometrica, 37, 424-438.

Granger, C.W.J. (1988) Causality, Cointegration and control. Journal of Economic Dynamics and Control, 12, 551-559.

Hazuki, I. (2012). Fossil Fuel Consumption and Economic Growth; Causality relationship in the World. arXiv: 1201.4551 V2 [Stat.AP].

Ighodaro, C.A. (2010). Co-Integration and Causality Relationship Between Energy Consumption And Economic Growth: Further Empirical Evidence For Nigeria. Journal of Business Economics and Management, 11(1), 97-111.

Johansen, S, (1991) Estimation and hypothesis testing of Cointegration vectors in Gaussian vector autoregressive models. Econometrica, 59, 1551-1580.

Jumbe, C.B.L. (2004) Congregation and Causality between Electricity Consumption and GDP: Empirical Evidence from Malawi. Energy Economics 26, 61-68.

Kozhan, R. (2010). Financial Econometric with E-views. Ventus Publishing, APS. ISBN 978-87-7681-427-4.

Lee, C.C., Chang, C.P. (2007) Energy Consumption and GDP revisited: a panel analysis of Developed and Developing countries. Energy Economics, 29, 1206-1223.

Lee, C.C., Chang, C.P. (2008) Energy Consumption and Economic growth in Asian economics: A more comprehensive analysis using Panel Data. Resource and Energy Economics, 30, 50-65.

Masih, A.M.M., Masih, R. (1996) Energy consumption, real income and temporal causality result from a multi-country study based on Cointegration and error correction modelling techniques. Energy Economics, 18,165-183.

Mehdi, A., Maamar, S. (2012). Energy Consumption and Economic Growth Nexus; Does the Level of Aggregation Matter? International Journal of Energy Economics and Policy, 2(2), 55-62.

Nachane, D.M., Nadkarni, R.M., Karnik, A.N. (1988) Cointegration and causality testing of the Energy and GDP relationship: a cross country study. Applied Economics, 20, 1511-1533.

Ogunleye, E.O., Ayeni, R.K. (2012). Energy Demand in Nigeria: A Disaggregate Analysis. International Research Journal of Finance and Economics, 86, 52-62.

Ozturk, I. (2010), A Literature Survey On Energy-Growth Nexus. Energy Policy, 38(1), 340–349.

Ozun, A., Cifter, A. (2007) Multiscale causality between Energy Consumption and GNP in emerging markets: Evidence from Turkey. Investment management and financial innovations, 4(2), 60-70.

Rufael, W. (2006) Electricity consumption and Economic growth: A Time series experience for 17 African countries. Energy Policy, 34, 1106-1114.

Shahbaz, M., Hooi, H.L. (2011). Does financial development increase energy consumption? The role of industrialization and urbanization in Tunisia. Energy Policy, 40, 473-479.

Sahbi, F., Jaleleddine B.R. (2012). "Energy Consumption, Economic Growth and CO2 Emmissions; Evidence from Panel Data for MENA Region. International Journal of Energy Economics and Policy, 2(2), 71-81.

Shahiduzzaman, M., Alam, K. (2012). Cointegration and Causal Relationships Between Energy Consumption And Output: Assessing The Evidence From Australia. Energy Economics, 34(6), 2182-2188.

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

Soytas, U., Sari, R. (2007) Relationship between energy and production: Evidence from Turkish manufacturing Industries. Energy Economics. 29(5), 1151-1165.

Soytas, U., Sari, R., Ozdemir, O. (2001) Energy consumption and GNP Relation in Turkey. A Cointegration and Vector Error Correction Analysis", Global Business and Technology Association,. 838-844.

Stern, D.I. (2000) Multivariate Cointegration analysis of the role of energy in the US macroeconomy. Energy Economics, 22, 267-283.

Stern, D.I. (2003) Energy and Economic Growth, Rensselaer working paper.

Zou, G., Chau, K.W. (2005) "Short and long-run effects between oil consumption and Economic growth in China. Energy Policy, 34, 3644-3655.

Appendix

Table 7. Result of Trend analysis on the study variables.

Model	Dependent variable	Co-efficient	R^2	Adj.R^2	t-value	p-value 5%	Decision rule
1	Log(RGDP)	0.108368	0.790885	0.785382	11.98825	0.0000	Reject H_0
2	Log(TECONS)	0.026436	0.954385	0.953184	28.19667	0.0000	Reject H_0
3	log(CPI)	0.199544	0.978052	0.977475	41.15086	0.0000	Reject H_0
4	Log(M2DIVGDP)	0.044188	0.503613	0.059299	3.470520	0.0014	Reject H_0
5	Log(CPSDIVGDP)	0.060586	0.535746	0.504796	4.160520	0.0008	Reject H_0

Figure 1. Trend in the data series in log form – Single graph approach

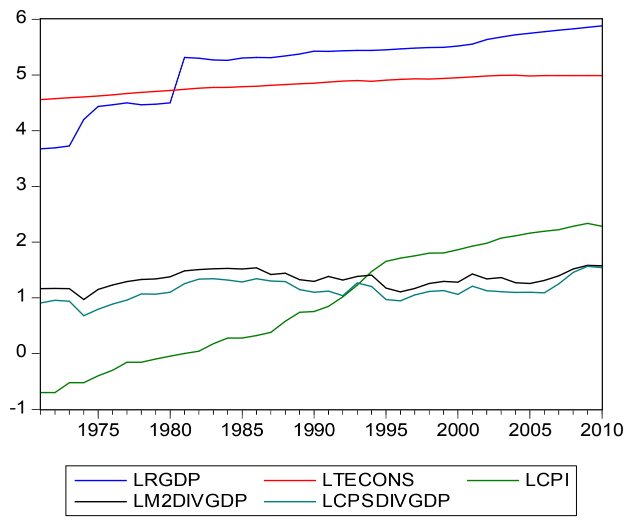

Figure 2. Trend in the data series in their absolute form – Multiple graph approach

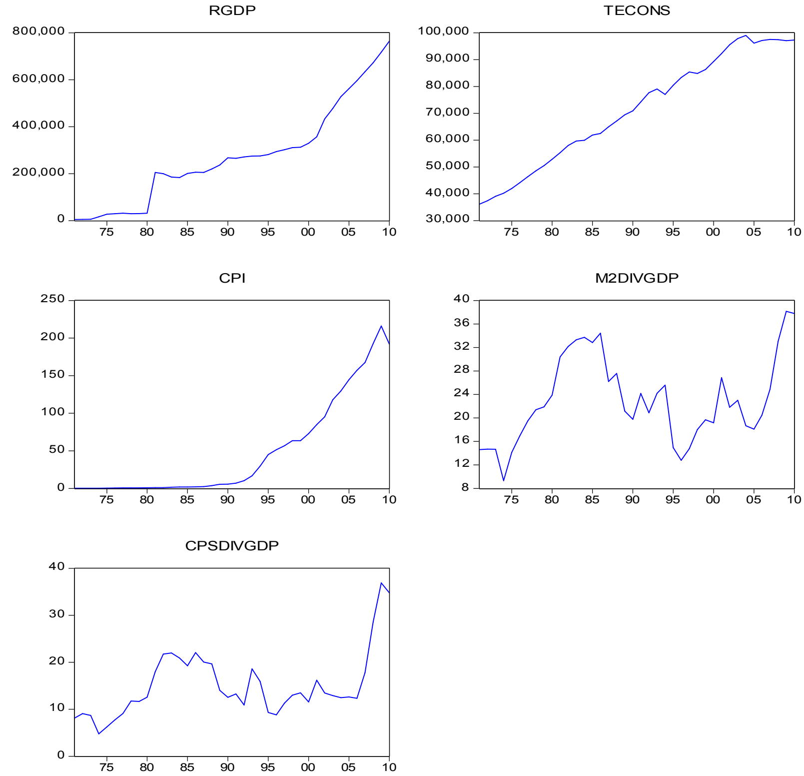

Figure 3. Trend in the data series in their log form with the residual series – Multiple graph approach