# ENERGY CONSUMPTION AND ECONOMIC GROWTH IN NIGERIA

**Bright Orhewere**
**Department of Economics, Western Delta University, Oghara, and**

**Machame Henry**
**Department of Economics and Statistics, University of Benin, Benin City**
**E-mail: unlebright@yahoo.com**

**Abstract**
*The relationship between energy consumption and economic growth has attracted much interest in economic literature. The views on the direction of this relationship are divergent. Empirical evidence varies, depending on the sources and pattern of energy consumption of the economy examined. This paper investigated the causality between GDP and each of the basic sub-components of energy consumption in Nigeria with a view to finding out if different sources of energy have varying impact on economic growth. The study found non-stationary and cointegrated series for both economic and energy variables in Nigeria; for the 1970 - 2005 periods. Using a vector error correction based Granger causality test, we found a unidirectional causality from electricity consumption to GDP both in the short-run and long-run. Unidirectional causality form Gas consumption to GDP in the short-run and bidirectional causality between the variable in the long-run. Although no causality was found in either direction between oil consumption and GDP in the short-run, a unidirectional causality from oil consumption to GDP is found in the long-run. Our findings imply that a policy to reduce energy consumption aimed at reducing emission will have negative impact on the GDP in Nigeria.*

**Keywords:** Energy, consumption, growth, causality

## Introduction

In recent times, there have been renewed efforts by governments across the globe to boost energy supplies due to rapidly increasing demand. Not until the "productivity shortfall" which accompanied the oil crisis in the 1970s, energy was seen as a mere "consumption good".

Stern (2003) has argued that while business and financial economists pay significant attention to the impact of oil and other energy prices on economic activity, the mainstream theory of growth pays little or no attention to the role of energy or other natural resources in promoting or enabling economic growth. More liberal financial literature argues that a causal relationship should be expected between the two variables since energy is an important factor for both demand and supply sides of the economy. On the supply side, energy is a crucial factor of production, economic growth and development, while on the demand side, customers see energy as a product to maximize their utility (Chontanawat, Hunt & Pierse, 2006).

While some scholars (Masih & Masih, 1996) attribute the growth in energy demand to the level of economic development, others argue that the increase in energy consumption would stimulate economic growth. Thus, there is lack of consensus among economic scholars on the relationship between energy consumption and economic growth. Soytas & Sari (2006) argue that the lack of consensus on the causality between energy and output might be due to the fact that different economies have different energy consumption pattern and various sources of energy; consequently, different sources might have varying impacts on the economy. This argument provides the spring board for our approach in this study.

The study investigates the causality between GDP and each of the basic sub components of energy consumption – oil consumption, electricity consumption, and natural gas consumption, in Nigeria using a vector error correction model (VECM). The first section of this article contains the introduction. The next section reviews relevant literature. Econometric methodology is contained in the third section. The fourth section contains the empirical analysis, while the final section contains the conclusion.

**Literature review**

The relationship between energy consumption and economic growth has attracted much interest in financial economics literature. The relationship has been examined for different countries and different periods using different methodologies. A pioneer study conducted by Kraft & Kraft (1978) examined the relationship between the USA's energy consumption and GNP for the period of 1947 and 1974. The study found a unidirectional causality from GNP to energy consumption. Akarea & Long (1980) using the same data for the USA for 1947 – 1972 examined the same relationship and found no relationship between the variables. Also Erol & 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 for 1952 – 1982 period. 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 & 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 suggests bi-directional Granger causality for employment-output, and employment-energy consumption, but only unidirectional causality running from energy consumption to output.

Soytas & Sari (2003) tested the causality between energy consumption and GDP in the top (10) ten emerging markets – excluding China and G-7 countries. They found out bidirectional causality in Argentina, unidirectional causality running from energy consumption to GDP in Turkey, France, Germany and Japan, and from GDP to energy consumption in Korea and Italy. Soytas, Sari & Ozdemir (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, Hunt and Pierse (2006) tested the causality between energy and GDP for 30 OECD and 78 non-OECD countries. Their findings show that causality from aggregate energy consumption to GDP and GDP to energy consumption is more prevalent in the advance 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 world.

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 periods. The study found that in the short run, there is 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 h 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 & Martini (2009) analyzed the causal relationship between the economy and energy by adopting a Vector Error Correction Model for non-stationary and co integrated panel data with a large sample of developed and developing countries and four distinct energy sectors. The results show that alternative country samples hardly affect the causality relations, particularly in a multivariate multi- sector 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 a bidirectional causal relationship. He also examined the relationship between non-agriculture 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 for 17 Africa countries from 1971 – 2001 periods. The study found cointegrating relationship in 9 countries and Granger causality for 12 countries. Unidirectional causality from GDP to electricity consumption was found in 6 of these countries and from electricity consumption to GDP in 3 of them. Bidirectional was found in 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) chines economy. The study found co-integration between oil consumption and GDP for 1953-1984 periods, it found no causality between the variables in the short run, however, they found bidirectional causality in the long run. Also, they found unidirectional causality from oil consumption to GDP in the short run, for 1985-2002 periods, 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 disaggregates using oil and electricity consumption for 1970-2003 periods in Turkey using the Bounds test approach to cointegration The study found that in the short run, both oil and electricity consumptions have positive 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.

**Econometric methodology**

The literature on the relationship between energy consumption and economic growth show that different methodology have been employed in the empirical studies which examined the causal relationship between Energy use and Economic growth. Early studies on this subject assumed stationarity in time series and were based on a traditional VAR methodology (Sims, 1972) Granger causality testing (Granger,1969). Subsequent studies recognized the non-stationarity of time series and therefore performed co-integration analysis in order to investigate the relationships. Other studies, based on the Granger's two-stage procedure (Granger, 1988), tested pairs of variables for co-integration and used estimated Error Correction Model (ECM) to test for Granger causality (Cheng and Lai, 1997, Nachane etal; 1988). Another set of studies employed multivariate estimators (Johansen, 1991), facilitating the estimation of systems where restrictions on co-integrating relations can be tested and at the same time, the possibilities of short run adjustment can be investigated. The Johansen's approach also allows for more than two variables in the co-integrating relationship (see Masih and Masih 1996; Stern, 2000, Asafu-Adjaye, 2000, etc). More recent studies employ Panel methods to test for unit roots, co-integration and Granger causality (Al-Iriani, 2006, Lee and Chang, 2007, 2008, etc).

In this study, we employ a three step econometric methodology to test for causal relationship between energy consumption and economic growth in a VAR frame work. First, the order of integration in the economic and energy time series is tested. This is followed by a test for co-integration and lastly Granger, causality in bivariate VECM model.

**Non-stationarity**

Non stationarity or the presence of a unit root can be tested using the Augumented Dickey-Fuller (ADF) test (1979, 1981, The Phillips Perron (PP) test (1988) and the KPSS test proposed by Kwiatkowski etal, (1992).

To test if a sequence y contains a unit root, we consider the following equation in ADF test:

$$\Delta y_t = \alpha + \O y_{t-1} + \sum_{i=2}^{p} B_i \Delta y_{t-i} + E_t \quad \ldots\ldots\ldots\ldots(1)$$

The parameter of interest in the above equation is Ø. If Ø = 0, the $y_t$ sequence has a unit root. The estimated t-statistic is compared with the appropriate critical value in the Dickey-Fuller tables to determine if the null hypothesis is valid.

We also conducted the Phillips-Perron (1988) test for a unit root mainly because the Dickey-Fuller test requires that the error be serially uncorrelated and homogeneous while the Phillips-Perron test is valid even if the disturbances are serially correlated and heterogeneous. The test statistics for the Phillips-Perron tests are modifications of the t-statistics employed for the Dickey-Fuller tests. But the critical values are precisely those used for the Dickey-Fuller tests.

**Stationarity tests**

In both the ADF and the PP test, the unit root is the null hypothesis. The most important criticism against the unit root tests is that their power is low if the process is stationary but with a root close to the non-stationary boundary. The sources of this problem is that, under the classical hypothesis testing framework, the null hypothesis is never accepted, it is simply stated that it is either rejected or not rejected. This means that a failure to reject the null hypothesis could occur either because the null hypothesis was correct, or is because there is insufficient information in the sample to enable rejection. One way to get around this problem is to carry out confirmatory data analysis which involves the joint use of stationarity and unit root tests. Stationarity tests have stationarity under the null hypothesis, thus reversing the null and alternatives under the Dickey-Fuller approach. Thus, under stationarity tests, the data will appear stationary by default if there is little information in the sample. One of such stationarity tests is the KPSS tests (kwaitkowski et al, 1992). The result of these tests can be compared with the ADF/PP procedure to see if the same conclusion is obtained. The null and alternative hypotheses under each testing approach are as follows:

| **ADF/PP** | **KPSS** |
|---|---|
| Ho: $Y_t \sim I(1)$ | Ho: $Y_t \sim I(o)$ |
| $H_1$: $Y_t \sim I(o)$ | $H_1$: $Y_t \sim I(1)$ |

There are four possible outcomes

1. Reject Ho and Do not reject Ho.
2. Do not reject Ho and reject Ho.
3. Reject Ho and reject Ho.
4. Do not reject Ho and do not reject Ho

For the conclusion to be robust, the results should fall under outcomes 1 or 2, which would be the case when both tests concluded that series is stationary or non-stationary, respectively; outcomes 3 or 4 implies conflicting results.

Thus, three tests, ADF, PP and KPSS tests are used to test for the presence of a unit root. The KPSS test, with the null of stationarity, helps to resolve conflicts between ADF and PP tests. If two of these three tests indicate non stationarity for any series, we conclude that the series has a unit root. If variables are non stationary, we test for the possibility of a cointegrating relationship using the Johansen and Juselius (1990) methodology.

**Cointegration and Granger causality**

The possibility of a cointegrating relationship between the variables is tested using the Johasen and Juselius (1990, 1992) methodology. If the variables are indeed cointegrated, we can construct a vector error-correction model that captures both the sort-run and the long-run dynamics.

Consider a VAR of order P:

$$y_t = A_1 y_{t-1} + A_2 y_{t-2} + \ldots + A_p y_{t-P} + \Box\chi_t + E_t \text{ --- (2)}$$

Where $y_t$ is a K-vector of non-stationary I(1) variables, $\chi_t$ is a d-vector of deterministic variables, and $E_t$ is a vector of innovations.

In order to use the Johansen test, the VAR {eqn (2)} above needs to be tuned into a vector error correction model (VECM) of the form:

$$\Delta y_t = \prod y_{t-1} + \sum_{i=1}^{p-1} \Gamma_i \, \Delta y_{t-1} + \Box\chi_t + E_t \ldots\ldots\ldots(3)$$

Where:

$$\prod = \sum_{i=1}^{p-1} A_i - I, \qquad \Gamma_i = -\sum_{j=i+1}^{p} A_j, \ i = 1, \ldots p-1,$$

We have assumed that $y_t$ contains non-stationary I(1) time series components. Then, in order to get a stationary error term $E_t$; $\prod y_{t-1}$ should also be stationary. Therefore $\prod y_{t-1}$ must contain $r \angle k$ cointegrating relations. If the VAR(p) process has unit roots, then $\prod$ has reduced rank ($\prod$)= r < k. Effectively, testing for cointegration is equivalent to checking out the rank of the matrix $\prod$. If $\prod$ has a full rank, then all time series in $y_t$ are stationary. If the ranks of $\prod$ is zero, then there are no cointegrating relationships.

If $0 \angle$ rank($\prod$) = r $\angle$ k. This implies that $y_t$ is I(1) with r linearly independent vectors and K-r non-stationary vectors. Since $\prod$ has rank r, it can be written as the product

$$\underset{(kxk)}{\prod} = \underset{(kxr)}{\alpha} \underset{(rxk)}{\square'},$$

Where $\alpha$ and B are k x r matrices with rank ($\alpha$) = rank (□) = r. The matrix □ is a matrix of long-run coefficients and $\alpha$ represents the speed of adjustment to disequilibrium. The VECM model becomes

$$\Delta y_t = \alpha \square' y_{t-1} + \sum_{i=1}^{p-1} \Gamma_i \Delta y_{t-1} + \square \chi_t + E_t \quad \text{---} \quad (4)$$

With $\square' y_{t-1} \sim I(0)$.

Johansen and Juselius (1990, 92) suggest the LR test based on the maximum eigen value ($\Lambda_{max}$.) and trace ($\Lambda_{trace}$) statistics to determine the number of the cointegrating vectors.

If the presence of Cointegration is established, the concept of Granger causality can also be tested in the VECM framework. For example, if two variables are cointegrated i.e. they have a common stochastic trend, then causality in the Granger (temporal) sense must exist in at lest one direction (Granger 1986, 1988). Thus, in a two variable (x and y) vector error correction model, we say that the first variable (x) does not Granger cause the second (y), if the lags of variable x and the error correction term are jointly not significantly different from zero. This is tested by a joint F or wald $x^2$ test.

If cointegration exists between variables, vector error correction model (Engel and Granger, 1987) should be applied as follows:

**Model 1**

$$\Delta GDP_t = \alpha_{1o} + \sum_{i=1}^{n} \beta_{1i} \Delta GDP_{t-1} + \sum_{i=1}^{n} \gamma_{1i} \Delta ELTCONS_{t-i} + \sum_{i=1}^{n} \square_1 EC_{t-n} + E_{1t} \quad - - - - - - - - \quad (5)$$

$$\Delta ELTCONS_t = \alpha_{2o} + \sum_{i=1}^{n} \beta_{2i} \Delta ELTCONS_{t-1} + \sum_{i=1}^{n} \gamma_{2i} \Delta GDP_{t--i} + \sum_{i=1}^{n} \square_2 EC_{t-n} + E_{2t} \quad - - - - - - - - \quad (6)$$

Where:
ELTCONS = energy consumption proxied by electricity consumption.
$EC_{t-n}$ parameter = error correction term.
$B_{1i}$, $B_{2i}$ $\gamma_{1i,}$ and $\gamma_{2i}$ parameters are short-run parameters. From equations (5) and (6), the null hypothesis that GDP/ELTCONS DOES

NOT Granger cause ELTCONS/GDP in the short run would be rejected if the lagged coefficients $B_i$s and $\gamma_i$s were jointly significant based on a standard wald test.

The presence ( or absence ) of long-run causality can be reviewed by examining the significance of of the speed of adjustment □ $_{1,2}$ ( namely the coefficients of $EC_{t-n}$ which represent how fast deviations from long-run equilibrium are eliminated following changes in each variable).

The significance of □ $_{1,2}$ determines the long-run relationship in the cointegrating process and movements along this path can therefore be considered permanent. Optimal lag length of the cointegration and ECM is determined by schartz information criteria.

If we use oil consumption as proxy for energy consumption instead of electricity consumption, we get the following model:

**Model II**

$$\Delta GDP_t = \alpha_{3o} + \sum_{i=1}^{n} \beta_{3i}\, \Delta GDP_{t-1} + \sum_{i=1}^{n} \gamma_{3i}\, \Delta OILCONS_{t-i}$$

$$+ \sum_{i=1}^{n} □_3 EC_{t-n} + E_{3t} \quad - \; - \; - \; - \; - \; - \; - \; - \qquad (7)$$

$$\Delta OILCONS_t = \alpha_{4o} + \sum_{i=1}^{n} \beta_{4i}\, \Delta OILCONS_{t-1} + \sum_{i=1}^{n} \gamma_{4i}\, \Delta GDP_{t--i}$$

$$+ \sum_{i=1}^{n} □_4 EC_{t-n} + E_{4t} \quad - \; - \; - \; - \; - \; - \; - \; - \qquad (8)$$

OILCONS = crude oil consumption.
Thirdly, when we use gas consumption as proxy for en ergy consumption, our model becomes:

**Model III**

$$\Delta GDP_t = \alpha_{5o} + \sum_{i=1}^{n} \beta_{5i}\, \Delta GDP_{t-1} + \sum_{i=1}^{n} \gamma_{5i}\, GASCONS_{t-i}$$

$$+ \sum_{i=1}^{n} □_5 EC_{t-n} + E_{5t} \quad - \; - \; - \; - \; - \; - \; - \; - \qquad (9)$$

$$\Delta GASCONS_t = \alpha_{6o} + \sum_{i=1}^{n} \beta_{6i}\, \Delta GASCONS_{t-1} + \sum_{i=1}^{n} \gamma_{6i}\, \Delta GDP_{t--i}$$

$$+ \sum^{n} □_6 EC_{t-n} + E_{6t} \quad - \; - \; - \; - \; - \; - \; - \; - \qquad (10)$$

i=1
GASCONS = gas consumption.

**Empirical results**
Empirical estimates are based on annual data from 1970 – 2006. We first test for non stationarity of all the variables. The results of the three unit root tests as summarized in Tables 1 and 2 show that all he variables can be treated as non stationary. Testing for stationarity of differences of each variable confirms that all variables are treated of order one at the 5% level of significance.

Table 1 : Unit root test at levels

| VARIABLES | ADF – TEST | | | PP – TEST | | | KPSS - TEST | | | CONCLUSION |
|---|---|---|---|---|---|---|---|---|---|---|
| | ADF - STAT. | ADF-CRITICAL VALUES 5% | RESULT : UNIT ROOT PRESENT | PP-STAT | CRITICAL VALUES 5% | RESULT: UNIT ROOT PRESENT | TEST STAT | CRITICAL VALUES 5% | RESUT UNIT ROOT PRESENT | |
| GDP | -2.019 | -2.9434 | YES | 5.180 | -2.938 | NO | 0.5531 | 0.463 | YES | YES |
| ELTCONS | 0.703 | -2.948 | YES | 0.685 | 2.948 | YES | 0.8105 | 0.43 | YES | YES |
| OILCONS | -1.430 | -2.948 | YES | -1.511 | 2.946 | YES | 0.6883 | 0.463 | YES | YES |
| GASCONS | 3.242 | -2.976 | NO | 1.514 | -2.946 | YES | 0.5894 | 0.463 | YES | YES |

Table 2: Unit root test: first difference

| VARIABLES | ADF – TEST | | | PP – TEST | | | KPSS - TEST | | | CONCLUSION |
|---|---|---|---|---|---|---|---|---|---|---|
| | ADF - STAT. | ADF-CRITICAL VALUES | RESULT : UNIT ROOT PRES | PP-STAT | CRITICAL VALUES | RESULT: UNIT ROOT | TEST STAT | CRITICAL VALUES | RESUT UNIT RO | |

| | | 5% | ENT | | 5% | PRESENT | | 5% | OT PRESENT | |
|---|---|---|---|---|---|---|---|---|---|---|
| GDP | 6.664 | -2.9677 | NO | -3.598 | 3.533 | NO | 0.517 | 0.463 | YES | NO |
| ELTCONS | 5.575 | -2.9511 | NO | -5.588 | -2.951 | NO | 0.189 | 0.463 | NO | NO |
| OILCONS | -8.832 | -2.948 | NO | -11.326 | -2.9484 | NO | 0.138 | 0.463 | NO | NO |
| GASCONS | -7.363 | -2.9484 | NO | -7.252 | -2.948 | NO | 0.383 | 0.463 | NO | NO |

Johansen's technique (Johansen 1988, and Johansen and Joselius 1990) was used to test for cointegration between GDP and each of the three variables (Electricity consumption, oil consumption and Gas consumption) used as proxies for energy consumption. After ascertaining that the variables are integrated of the same order, we select the order of the VAR using AIC and Sschwarz criteria that suggest an optimal lag length of 1.

The next step is the selection of the deterministic terms in VAR. Since most macro-economic data exhibit a linear trend (and not quadratic trend) which can be captured by an intercept, we select an intercept in VAR but not trend.

Table 3. Test for cointegration: $\Lambda_{trace}$ test

| $H_0$ | $H_1$ | Statistics | Critical Values | Result | No. of C.V. |
|---|---|---|---|---|---|
| GDP and ELTCONS | | | | | |
| r = 0 | r = 1 | 31.889 | 15.495 | Reject null hypothesis | 1 |
| r ≤ 1 | r = 2 | 2.653 | 3.842 | Do not reject null hypothesis | |
| GDP and OILCONS | | | | | |
| r = 0 | r = 1 | 37.517 | 15.495 | Reject null hypothesis | 1 |
| r ≤ 1 | r = 2 | 1.958 | 3.842 | Do not reject null hypothesis | |
| GDP and GASCONS | | | | | |
| r = 0 | r = 1 | 34.883 | 15.495 | Reject null hypothesis | 1 |
| r ≤ 1 | r = 2 | 0.237 | 3.842 | Do not reject null hypothesis | |

N.B : C.V. denotes Cointegrating Vectors

Table 4. Test for cointegration: $\Lambda_{max.}$ Test

| $H_0$ | $H_1$ | Statistics | Critical Values | Result | No. of C.V. |
|---|---|---|---|---|---|
| GDP and ELTCONS | | | | | |
| r = 0 | r = 1 | 29.236 | 14.265 | Reject null hypothesis | 1 |
| r ≤ 1 | r = 2 | 2.653 | 3.842 | Do not reject null hypothesis | |
| GDP and OILCONS | | | | | |
| r = 0 | r = 1 | 35.559 | 14.265 | Reject null hypothesis | 1 |
| r ≤ 1 | r = 2 | 1.958 | 3.842 | Do not reject null hypothesis | |
| GDP and GASCONS | | | | | |
| r = 0 | r = 1 | 34.646 | 14.245 | Reject null hypothesis | 1 |
| r ≤ 1 | r = 2 | 0.237 | 3.842 | Do not reject null hypothesis | |

Trace test and maximum eigen value test statistic (see tables 3 and 4) show GDP and each of the three proxies for energy consumption are cointegrated. Therefore a long- run relationship exists between economic growth and energy variables. This results show that at least one directional causality exits between GDP and Electricity consumption, GDP and oil consumption as well as GDP and GAS consumption

Vector Error Correction Based Causality Tests

Table 5 : Short run causality

| Null Hypothesis | No.of lags | Wald test | Conclusion |
|---|---|---|---|
| OILCONS does not granger cause GDP | 2 | 0.33182 (0.8465) | Do not reject null hypothesis |
| GDP does not granger cause OILCONS | 2 | 2.898538 (0.2347) | Do not reject null hypothesis |
| GASCONS does not granger cause GDP | 2 | 6.159449 ( 0.0460 ) | Reject null hypothesis* |
| GDP does not granger cause GASCONS | 2 | 1.496130 ( 0.4733 ) | Do not reject null hypothesis |
| ELTCONS does not granger cause GDP | 2 | 4.6965 ( 0.0955) | Reject null hypothesis ** |
| GDP does not granger cause ELTCONS | 2 | 0.468553 ( 0.7911 ) | Do not reject null hypothesis |

Note: *, ** represent at 5% and 10% level of significance respectively.

( ) represents p values.

Table 6 : Long run causality.

| Null Hypothesis | No.of lags | $EC_{t-1}$ | Conclusion |
|---|---|---|---|
| OILCONS does not granger cause GDP | 2 | 0.31965 [3.62626] | Reject null hypothesis |
| GDP does not granger cause OILCONS | 2 | 0.006551 [1.05629] | Do not reject null hypothesis |
| GASCONS does not granger cause GDP | 2 | 0.171059 [4.37622] | Reject null hypothesis |
| GDP does not granger cause GASCONS | 2 | 0.000852 [2.55464] | Reject null hypothesis |
| ELTCONS does not granger cause GDP | 2 | 0.301628 [ 3.95596] | Reject null hypothesis |
| GDP does not granger cause ELTCONS | 2 | 2.750 [ 0.01201] | Do not reject null hypothesis |

Note: [ ] represent t- values.

The results from the vector error correction based causality test show that in the short run ( see table 5), there exist causality from gas consumption to GDP that is significant at the 5% level, and from electricity consumption to GDP that is significant at the 10% level, but no causality in opposite directions and no causality was found between oil consumption and GDP in either direction.

However, In the long run, the results found a unidirectional causality running from oil consumption to GDP as well as from electricity consumption to GDP, while a bidirectional causality was found between gas consumption and GDP.

**Conclusion**

The relationship between energy consumption and economic growth has attracted much interest in financial economic literature. The views on the directional of this relationship are divergent. Empirical evidence varies, depending on the sources and pattern of energy consumption of the economy examined. This paper investigated the causality between GDP and each of the basic sub-components of energy consumption in Nigeria with a view to finding out if different sources of energy have varying impact on economic growth.

The study found non-stationary and cointegrated series for both economic and energy variables in Nigeria; for the 1970 - 2005 periods. Using a vector error correction based Granger causality test, we found a unidirectional causality from electricity consumption to GDP both in the short-run and long-run. Unidirectional causality form Gas consumption to GDP in the short-run and bidirectional causality between the variable in the long-run. Although no causality was found in either direction between oil consumption and GDP in the short-run, a unidirectional causality from oil consumption to GDP is found in the long-run. Our findings imply that a policy to reduce energy consumption aimed at reducing emission will have negative impact on the GDP in Nigeria.

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