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# Does Domestic Energy Consumption Contribute to Exports? Empirical Evidence from Nigeria

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**ABSTRACT:** This paper examined the existence of interaction between domestic energy consumption and exports in Nigeria by using annual data from 1970 to 2009. We applied cointegration, Granger causality and impulse response functions to capture the relationship. The empirical results indicate that there is significant relationship between domestic energy consumption and exports in the long run. Granger causality tests showed that there is unidirectional causality running from energy consumption to exports. Impulse response functions indicate that shocks to the energy consumption have a positive impact on exports in the longrun. Likewise, expansions on exports were positively related to energy consumption. Therefore, significant improvement in energy production and utilization is expected to stimulate exports and engender economic growth in Nigeria.

**Keywords:** Energy; domestic energy consumption; exports; cointegration; causality; Nigeria
**JEL Classifications:** C32; Q40; Q43

## 1. Introduction

Energy is the engine that drives the economy of any nation. In the absence of reliable energy supply, efforts at socio-economic and technological development cannot yield any positive result. It is essential to the production of all goods and services and hence vital to the industrial development of any nation. The extensive use of energy and energy based inputs in the production process of nations cannot thus be overemphasized.

The era of industrial revolution and subsequent years revealed the importance of energy inputs to the production process. The increase in population and the unlimited expansion in economic activities make the constant use of energy inevitable. Bearing in mind the limited nature of these energy sources, it became imperative to increase the productivity of these sources and make new energy sources popular (Kadioglu and Tellioglu, 1996)

World economies are heavily reliant on energy and Nigeria is not an exception. Nigeria is seen as one of the greatest developing nations in Africa with highly endowed natural resources including potential energy resources. However, adequate energy supply to meet ever increasing demand in Nigeria has proved to be not only a continuous challenge but also a pressing issue with the international community. Nigeria's persistent energy crisis has weakened the industrialization process, increased the production cost and significantly undermined the effort to achieve sustained economic growth, increase competitiveness of domestic industries in domestic, regional and global markets. With adequate utilization of energy potentials to meet the demand, the nation would experience high levels of industrialization, stimulating exports and boosting economic growth (Nnaji at al, 2010).

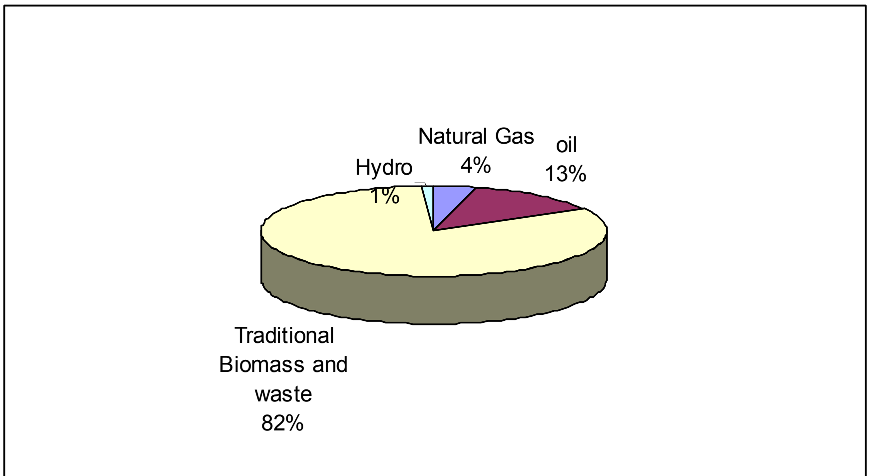
It has been proved that increase in the effectiveness and productivity principles within the frame of energy consumption stimulates exports and supports economic growth (Raghuraman and Scrivastava, 1988; Kokrady, 1992; Pant, 1989). The transmission process is explained through technology factor that is internalized among growth models. The reason lies in the possibility of producing more goods and service with low cost by using effective and productive energy input during the production process. The aim of this study is therefore to investigate the effect of domestic energy consumption on exports in Nigeria using Cointegration, Granger causality tests and impulse response functions.

## 2. Overview of Energy Consumption in Nigeria

Nigeria like some other developing countries is an energy intensive growing economy. Energy serves as an input into the production of goods and services in the nation's industry, transport, agriculture, health and education sectors. It also plays a significant role in the nation's international diplomacy and serves as a tradable commodity for earning the national income, which is used to support government development programmes.

Nigeria is rich in energy resources and is currently Africa's largest producer and exporter of petroleum and gas. The country's major energy resources include crude petroleum and gas, as well as coal, bitumen, hydropower and fuel wood. According to the Energy Information Administration (EIA), in 2010, total energy consumption in Nigeria was 4.4 Quadrillion Btu (111,000 kilotons of oil equivalent). Of this, combustible renewables and waste accounted for 82 percent of total energy consumption (figure 1). This high percent share represents the use of biomass to meet off-grid heating and cooking needs, mainly in rural areas (EIA, 2012) (figure 1). This high percent share represents the use of biomass to meet off-grid heating and cooking needs, mainly in rural areas.

**Figure1. Total Energy Consumption in Nigeria (2010)**

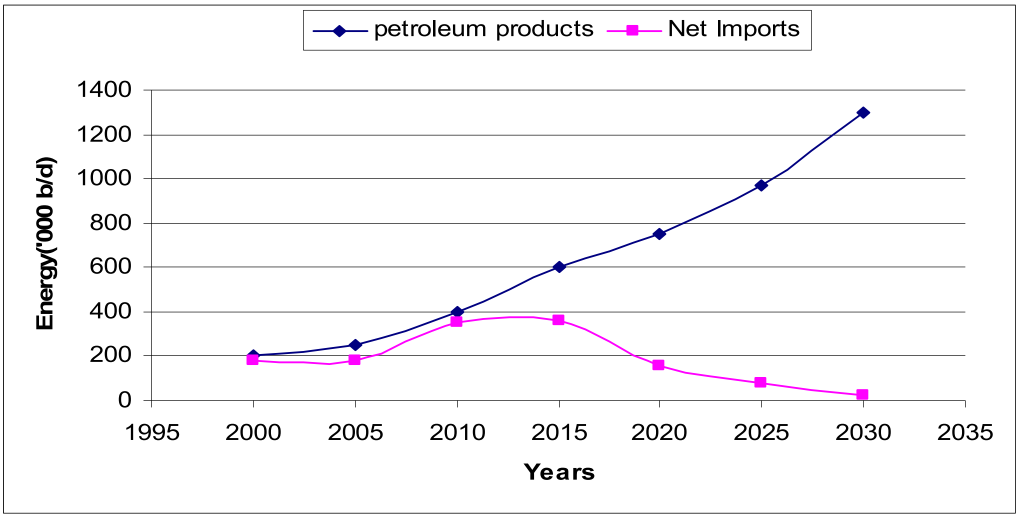



Note: Nigeria consumed about 9,000 short tons of coal in 2010. Source: (EIA)

From 2007 to 2010, the share of oil in total energy consumption increased from 9.4 percent to 13 percent. Natural gas consumption decreased from 9.9 percent to 4 percent. Hydroelectricity increased slightly from 0.5 percent to about 1 percent (EIA, 2012). The abundant alternative energy resources in the country such as solar and wind are yet to make any significant contributions while coal and nuclear are not making any contributions presently. The alternative energy sources are projected to make some contributions in the future.

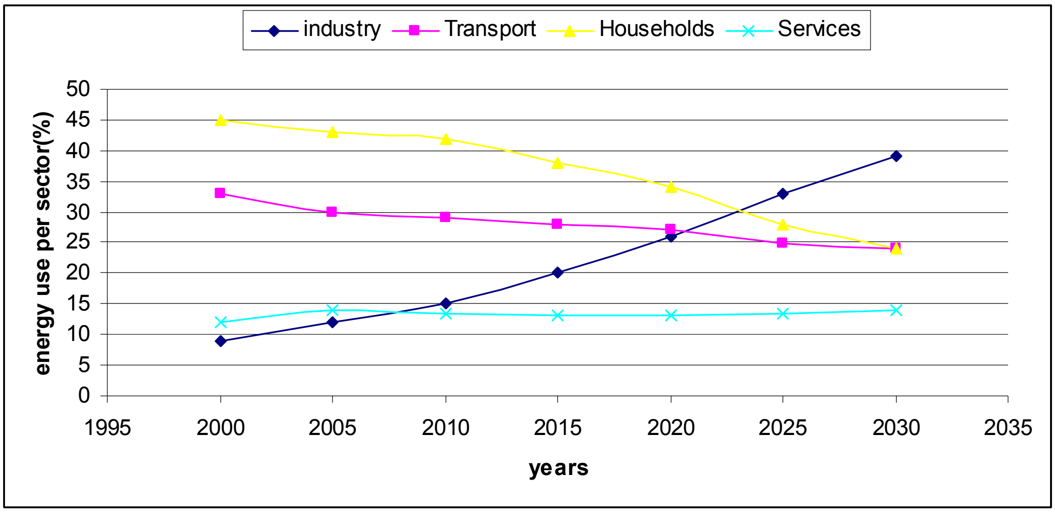
The alternative energy sources are projected to make some contributions in the future. Even though Nigeria is an oil exporting country, it imports secondary energy sources, such as petroleum motor spirit (gasoline), automotive gas oil (diesel) and kerosene (Figure 2). Oil import will decrease with the rehabilitation of the existing refineries and construction of new ones. In 2000 Nigeria imported about 90% of its petroleum products that is 20% of the total energy demand due to collapse of its 450,000 b/d capacity refineries. Energy import is projected to increase until after 2015 when new refineries will come on board (Sambo et al., 2009). Figure 3 depicts the sectoral composition of energy consumption in Nigeria with the industrial sector indicating a steady increase in energy consumption, while other sectors reflect unsteady pattern in energy consumption. This signifies the overwhelming importance of energy as an indispensable input in the production process. With continuous expansion in industrial operations, energy use will continue to be on the increase.

**Figure 2. Indigenous Energy Production and Net Energy Import**




Source: ECN 2008

**Figure 3. Percent Historical and Projected Total Energy Consumption by Sector.**




Source: ECN 2008

Electricity is the dominant form of modern energy for telecommunications, information technology, manufacturing and services. Electricity supply in the country has adversely affected the optimal performance of industrial operations. IEA data for 2008 indicate that electrification rates for Nigeria were 47 percent for the country as a whole. The electricity sector in Nigeria is presently characterized by chronic power shortages and poor power quality supply. Nigeria's electricity market, dominated on the supply side by the state-owned Power Holding Company of Nigeria (PHCN) formerly called the National Electric Power Authority (NEPA) has been incapable of providing minimum acceptable international standards of electricity service reliability, accessibility and availability for the past three decades. To compensate for the power deficit, the domestic, commercial and industrial sectors persistently use private operational generators.

In a survey conducted by Adenikinju (2005), 82.7% of the respondent reported electricity to be the most threatening obstacle to their business. This scenario has led to high cost of operations, adversely affecting the competitiveness of Nigerian firms. With an approximated installed capacity of

6000 MW of electricity (EPIC, 2004), it was stated that the country consumes about half its capacity. With an increased population coupled with diversification of economic activities, energy demand is rising but yet, electricity supply is relatively stagnant. It is therefore obvious that electricity demand is way above its supply thereby showing signs of potential industrial expansion and economic growth.

Effective and productive use of energy, considered as one of the indispensable inputs for industry will affect output level positively because of the fact that it takes more places in production process. It is seen that numerous empirical studies on energy focus on the mentioned relation. However, since the amount of items and service related to exports will increase depending on the amount of input, the institutional dimension of the issue can be explained in relation to economic growth. Generally, endogenous growth models are used for this purpose as evidenced in the literature. The survey of literature has shown there are not many studies in theory and application that deal with the relation between energy consumption and exports.

However, Sami (2011) in his article titled "Multivariate Cointegration and Causality between Exports, Electricity Consumption and Real Income per Capita: Recent Evidence from Japan" applied bounds testing procedure to investigate the relationship between exports, electricity consumption and real income per capita in Japan using time series data from 1960-2007.The findings established the presence of cointegration among the variables as well a long run causality from exports and real GDP per capita to electricity consumption.

Lan (2010) in his paper titled "An Empirical Analysis of Relationship between Export and Energy Consumption in Shandong Province" utilized cointegration and causality method to analyse the relation between the energy consumption and the export of Shandong province. The empirical results indicated a positive relationship between export and energy consumption. On the other hand, the growth of the export was found to cause increase of energy consumption. He concluded that increase of Shandong's export promotes energy consumption and also is restricted by its energy consumption.

Erkan et al, (2010) utilized cointegration, Granger causality tests and impulse response functions to determine the impact of domestic energy consumption on exports in Turkey by using annual data from 1970 to 2006. The results of their study showed a significant relationship between domestic energy consumption and exports in long term. While Granger causality test showed a unidirectional causality running from energy consumption to exports. Impulse-response functions revealed that shocks to the energy consumption had a positive impact on exports. They concluded that energy is an important factor for economic growth in Turkish economy.

Narayan and Smyth (2009) in their paper titled "Multivariate granger causality between electricity consumption, exports and GDP: Evidence from a panel of Middle Eastern countries" examined the causal relationship between electricity consumption, exports and gross domestic product (GDP) for a panel of Middle Eastern countries and found a statistically significant feedback effects between these variables. They suggested that for the panel as a whole promoting exports, particularly non-oil exports, is a means to promote economic growth and that expansion of exports can be realized without having adverse effects on energy conservation policies.

Halicioglu (2010) applied the bounds testing cointegration procedure and causality analysis to examine empirically the dynamic causal relationships between aggregate output, energy consumption, exports, capital and labour in Turkey for the period of 1968-2008.The empirical results revealed the existence of a long-run relationship between the variables in which the dependent variable is aggregate output. Causality was found to run interactively through the error correction term from labour, capital, exports and energy consumption to aggregate output. In the short- bilateral causalities were identified between energy consumption and aggregate output and between exports and aggregate output. The short-run causality testing revealed the existence of a unilateral causality running from exports to energy consumption.

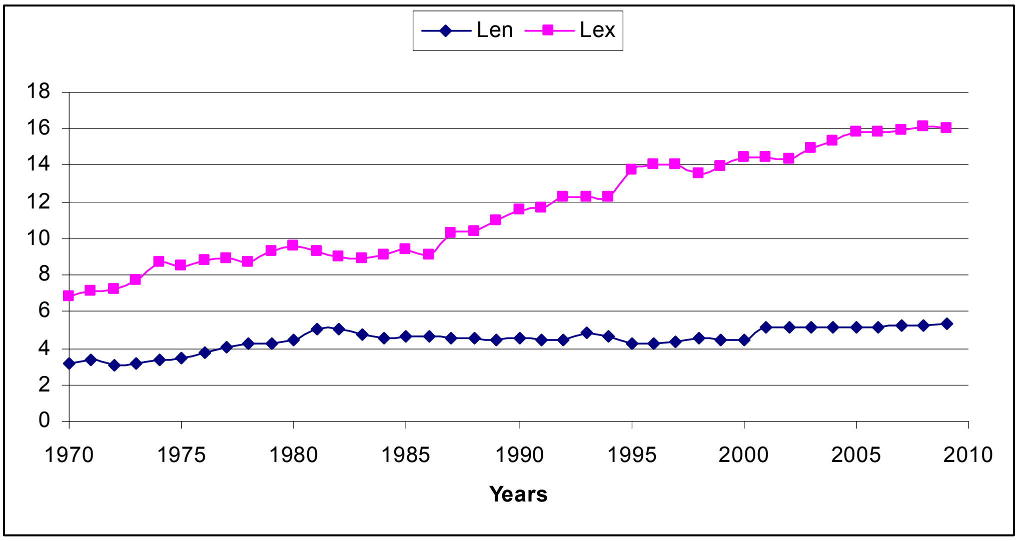
Several authors have examined the energy -environment- economy linkage in Nigeria while other studies carried out on Nigeria also focus on environment and sustainable development (Nnaji et al, (2013), Orhewere and Henry (2011), Okafor (2012) Omotor, (2008) Omisakin, (2009) Gbadebo and Okonkwo, (2009) Dantama et al. (2012), Olusanya, (2012), Jerome (2001), Garba and Garba (2001), Chukwu and Ndifreke (2011) ).However, so far there seems to be no clear empirical work carried out which seeks to investigate the dynamic relationship between domestic energy consumption and exports under the same integrated framework in Nigeria. This paper, therefore, seeks to fill this lacuna by investigating the dynamic relationship between domestic energy consumption and exports.

### 3. Research Methodology

### 3.1 Study Scope, Data Sources and Definition

To investigate the casual relationship between domestic energy consumption (En) and exports (Exp) and its effect on the Nigerian economy, the study applied the logarithmic values of the annual data obtained from Central Bank of Nigeria Statistical bulletin for 1970- 2009 period (figure 4). For the analysis, cointegration test, Granger causality test and impulse-response functions were used.

**Figure 4. Domestic energy consumption and exports performance in Nigeria**




### 3.2 Model Specification

Taking inference from the conceptual framework and then making energy central to the equation, a model will be drawn up to determine export growth in the Nigerian context. If energy is taken as an independent variable then the model can be stated as:

Lex = f (Len)

Where;

Lex=Log of exports

Len=Log of domestic energy consumption

### 3.3 Unit Root Test

The characteristics of the time series data used for the estimation of the model will be examined to avoid spurious regression, which results from the regression of two or more non-stationary series. Unit root tests are important in examining the stationarity of a time series because a non-stationary regressor invalidates many standard empirical results and thus requires special treatment. Granger and Newbold (1974) have found by simulation that the F-statistic calculated from the regression involving the non-stationary time-series data does not follow the Standard distribution. Thus, the significance of the test is overstated and a spurious result is obtained. The variable of this study shall be subjected to stationary test and made stationary using the Augmented Dickey Fuller (ADF) test because it eliminates the problem of autocorrelation by including enough terms so that the error term is serially uncorrelated .(Dickey and Fuller 1979, 1981)

The equation estimated for the ADF test is as follows

$$\Delta Xt = \alpha_0 + \beta_1 X_{t-1} + \delta t + \sum_{[t-1]}^{[m]} \theta i \Delta X_{t-1} + e t \text{ ........(1)}$$

Where $\Delta$ is the first difference operator, t is the time trend, e is the stationary random error, and m is the maximum lag length. X= variable, $\alpha_0$ =intercept, $\delta$ and $\theta$ are coefficients The null hypothesis is that the series contains a unit root which implies that $\beta = 0$. The null hypothesis is rejected if $\beta$ is negative and statistically significant.

**3.4 Cointegration Tests**

To determine the longrun relationship between energy consumption and exports, the Johansen cointegration procedure is utilized (see Johansen 1988, and Johansen and Juselius 1990). The procedure involves the estimation of a Vector Error Correction Model (VECM) in order to obtain the likelihood – ratios (LR). The VECM used in the study is as follows:

$$\Delta Y_t = \theta_o + \sum_{i=1}^{k-1} \theta i \Delta Y_{t-1} + \alpha\beta' Y_{t-k} + e_t \qquad (2)$$

Where $\Delta$ is the difference operator, Yt is ($Lex_t$, $Len_t$ ), $\theta_0$ represents the intercept, and e represents the vector of white noise process. The Johansen cointegration technique produces two likelihood ratio test statistics namely the trace test and the maximum eigen value ( $\lambda$ max) test. The number of significant non zero eigen values determines the number of cointegrating vectors in the system.

**3.5 Granger Causality Test**

Causality test that was developed by Granger (1974) is among the most used techniques to define the way of the relation among the variables. For this test, the following two formulas are used:

$$Y = \alpha_0 + \sum_{k=1}^{m} \alpha_{1t} Y_{t-1} + \sum_{k=1}^{n} \alpha_{2t} X_{it-1} + e_1 \qquad (3)$$

$$X = \beta_0 + \sum_{k=1}^{m} \beta_{1t} X_{t-1} + \sum_{k=1}^{n} \beta_{2t} \Delta Y_{t-1} + \mu_1 \qquad (4)$$

$\alpha_0$ and $\beta_0$ are constants, m and n are the numbers of lags, $\alpha$ 's and $\beta$ are parameters to be estimated, $e_1$ and $\mu_1$ are vectors of white noise process. X and Y are variables. In the models above it has been tested whether coefficient of lagging values equal to zero. In Eq.3, it is decided that if the hypothesis is rejected using F test, then Y granger causes X; in case of rejecting the hypothesis in equation 4, it means X granger causes Y.

**3.6 Impulse Response Functions**

The impulse response function allow us to study the dynamic behaviour of each variables of the system by determining whether an exogenous shock causes short-run or long-run changes in the variables chosen and other variables in the VECM. An impulse response function traces the effect of a one standard deviation shock to one of the innovation on current and future values of the endogenous variables. In other words, it traces out the response of the dependent variables in the VAR system to the shocks in the error terms (Gujarati, 2003). Diagrammatically impulse-response functions can be drawn as reactions of two variables, {yt} and {zt} series against different shocks (Gujarati, 2003).

**4. Empirical Results**

**4.1 Results of Unit Roots**

The results for the ADF unit roots test for EC and GDP are reported in Table 1.

**Table 1. Results of ADF Test for Unit Roots**

| Variables | Level | First Difference | 1% Critical value |
|---|---|---|---|
| Lex | 2.8422 (1) | -3.4568** (1) | -2.628 |
| Len | 1.1661 (1) | -4.4475** (1) | -2.628 |

** indicates significant at 1 percent level
Numbers in parenthesis represent lag length

The Augmented Dickey Fulle*r (ADF)* test was applied to the data in level and first differences. In the level form, the data were found to be non-stationary and the null hypothesis was not rejected. However, the test rejects the null hypothesis of non-stationary for both Lex and Len variables when they are used in the first differences. This shows that, all the series are stationary in the first differences, and integrated of order I (I).

Having found that the variables are integrated of the same order, the next step was to test for cointegration using Johansen's maximum likelihood procedure. The results of the Johansen maximum likelihood cointegration tests are summarised in Table 2.

**Table 2. Results of Johansen's Cointegration Test**

| $H_1$: (Alternative hypotheses) | $H_0$: (Null hypotheses) | $\lambda$ max test | $\lambda$ max(0.95) | Trace test | Trace(0.95) |
|---|---|---|---|---|---|
| R = 1 | R = 0 | 19.41 | 14.26460 | 28.52 | 15.49471 |
| R = 2 | R ≤ 1 | 15.05 | 3.841466 | 13.02 | 3.841466 |

The results of the Johansen maximum likelihood cointegration tests indicate that for r=0, the maximal Trace Statistics is 28.52, which is greater than the 95 per cent critical value of 15.49. On the other hand, the $\lambda$ max statistics of 19.41 is greater than the critical value of 14.26.Likewise, the same is applicable to where $r \leq 1$.Hence the null hypothesis of r=0 and $r \leq 1$ is rejected at the 5 per cent level of significance, suggesting the presence of two cointegrating vectors as well as a longrun relationship between Lex and Len. This indicates that energy consumption and exports acted together for a long time.

**4.2 Results of Granger Causality test**

The results of the tests on causality are presented in Table 3. A significance level of 5% is used for the causality tests. Since the P-value of 0.04039 is less than the test value of 0.05 or 5%, we therefore conclude that unidirectional causality is found to run from energy consumption to export. But the reverse does not exist since 0.37591 is greater than 0.05.This indicates that energy consumption plays an effective role on exports in the Nigerian economy.

**Table 3. The Result of Granger Causality Test**

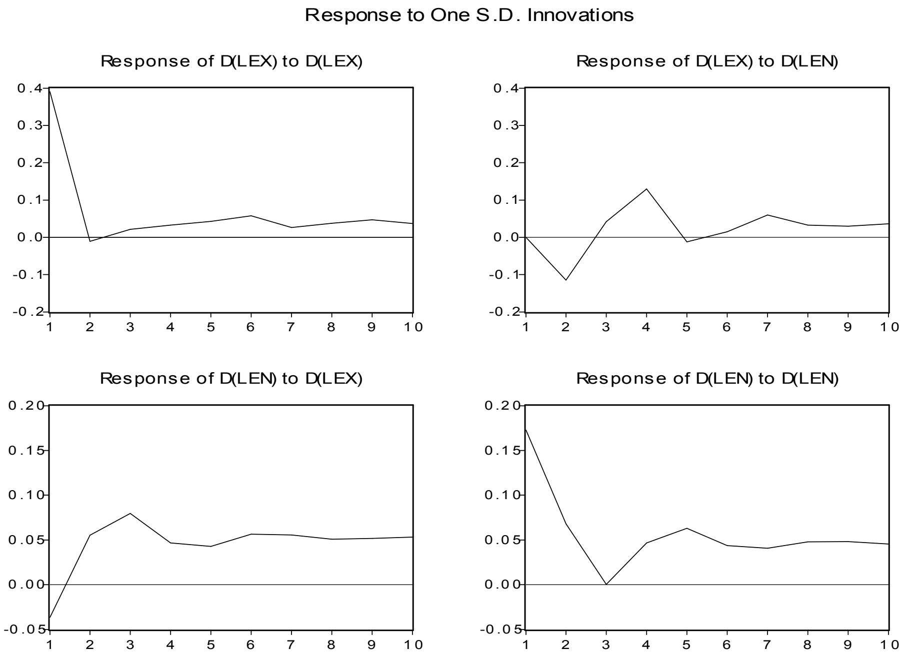
| Null Hypothesis | F-Statistics | Probability |
|---|---|---|
| D(LEN) does not Granger Cause D(LEX) | 3.55372 | 0.04039* |
| D(LEX) does not Granger Cause D(LEN) | 1.00894 | 0.37591 |

* Denotes the rejection of the null hypothesis at 5% level of significance

**4.3 Results of impulse response**

Fig. 5 depicts the impulse response functions. According to the functions, shocks to energy consumption initially had a negative impact on exports in the short-term but turns positive in the longrun. Same is applicable to response of energy to shocks or variations on export. This result reflects the fact that energy that is considered as input during the production process bears similar importance in terms of foreign trade balance. Therefore, the effective and productive usage of energy sources creates positive effect both on exports and economic growth over time through exports.

**Figure 5. Impulse response functions**




## 5. Conclusion and Policy Implications

This paper employed cointegration theory, causality analysis and impulse response functions to investigate the interaction between domestic energy consumption and export growth in Nigeria. Annual data for the period of 1970-2006 was used for the study. We used Augmented Dickey-Fuller test to test stationarity of the energy consumption and exports series. According to this result it was seen that the variables were not stationary at the original levels. In order to determine whether energy consumption and exports that were seen to be stationary at the first differences act together or not, Johansen and Juselius cointegration test was employed. The findings indicated that there is a long term relationship between these variables. Granger causality test and impulse-response functions showed that energy consumption contributed positively to exports over time.

The foregoing indicates that energy is critical to the socio-economic development of the country. This finding has serious policy implication for a country like Nigeria which has current deficit especially in the electricity sector that has caused economic crisis and crippled the industrial sector over the years. Energy should be supplied to the productive sectors to support exports in terms of foreign trade balance and economic growth. Therefore, energy prices should be kept lower with price and taxing policies. Since the foreign dependency in fossil fuel is quite high, investments on alternative energy production should be supported.

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