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Causality Between Energy Consumption and Economic Growth in Nigeria

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Abstract: The study investigates the causal relationship between energy consumption disaggregated into coal, electricity and oil consumption and economic growth in Nigeria. The estimated results from the application of the Hsiao's Granger causality version, revealed that energy consumption leads economic growth and vice versa. The policy implication of the findings is that energy enhancement policy will engender economic growth of Nigeria.

Key words: Energy consumption, economic growth, cointegration, Hsiao's Granger causality, Nigeria

INTRODUCTION

The importance of energy in the economic development process particularly of developing countries is well known and documented in the literature (ADB, 1996; Iwanyemi, 1983, 1993, 1998; Karekezi and Ranja, 1997; Orubu, 2003). Energy demand, supply and pricing impact positively on the socio-economic development, the living standards and the overall quality of life of the people (Iwayemi, 1998). The extensive use of energy and energy based inputs in the production process of nations cannot thus be overemphasised. Although, the positive impact of energy use is well acknowledged, its adverse effect is well professed in the literature. For instance, sharp rise in anthropogenic emissions such as carbon monoxide (CO), hydrocarbons (HCs), sulfur dioxide (SO_2), carbon dioxide (CO_2) among others are greenhouse-enhancing and part causes of global warming (Shrestha and Malla, 1996; Reddy, 1998).

The significance of energy in the growth and development process gained more prominence following the quadrupling of oil price accretion in 1973 and 1974 and further price increases in 1979 and 1980 and thereafter. Although, rapid industrialization and economic progress before the 1973 era was due to relatively cheap and abundant energy in the developed world, the rate at which energy consumption has increased, closely follow the rate at which economies have expanded globally (Iwayemi, 1998). This raises issues of relationships and causality.

The salvo on the causality between energy consumption and economic growth was first fired by the seminal paper of Kraft and Kraft (1978). Their study reported a strong causality running unidirectionally from Gross National Product (GNP) to energy consumption for the period 1947-1974 using annual data of the USA. They averred that while the level of economic activity may influence energy consumption, the level of gross energy consumption has no causal influence on economic activity. The implication being that energy conservation policies can be intimated without aggravating the side effects of economic growth. Other studies that have found unidirectional relationship running from economic growth to energy consumption are Soytas and Sari (2003) for Italy and Korea; Fatai *et al*. (2004) for New Zealand; Ghosh (2002) in Guttormsen (2004) for India (using electricity consumption), Yu and Choi (1985) for South Korea and Yang (2000a) for Taiwan (using coal consumption); Cheng and Lai (1997) in Taiwan province of China, Ageel and Butt (2001) for Pakistan among others.

Yu and Choi (1985) for the Philippines, Soytas and Sari (2003) in Turkey, France, Germany and Japan and Oh and Lee (2004) for Taiwan are some other studies that have also found unidirectional relationship; but from energy consumption to economic growth and not the other way round unlike the earlier examples.

Similar studies have also established bidirectional causality between economic growth and energy consumption. Examples are Glausure and Lee (1977) for South Korea and Singapore; Chang *et al*. (2001) in Taiwan; Soytas and Sari (2003) in Argentina; Jumbe (2004) for Malawi; Ghali and El-Sakka (2004) for Canada; Oh and Lee (2004) for Korea and Guttormsen (2004) for France, Greece, Germany, Italy, Japan, Argentina, India, Indonesia and Philippines.

In the mid and later part of the 1980s, studies by Yu and Choi (1985) for USA, UK and Poland; Erol and Yu (1987b) for USA and Yu and Hwang (1984) are other examples that confirmed the absence of any causality between economic growth and energy consumption.

Some observations that can be deduced from the survey of studies summarized above are, firstly, the studies focused more on developed economies and Asia countries. Second, the different economies and at some different time periods reported mixed results. Thirdly, more of the surveyed studies clearly state that a relationship exists between economic growth and energy consumption, although, it is also not out of place to infer that the different methodologies may also be alluded to the different results. For instance, comparing studies on Taiwan alone, Masih and Masih (1997) employed the Johansen multiple cointegration test and vector error correction model. Their results report the existence of a long-run relationship. Cheng and Lai (1997) also used Taiwan data by employing the Hsiao's version of Granger causality technique. Cheng and Lai (1997) concluded in their study that no long-run equilibrium relationship exists. Yang (2000a) employed the 2-step Engle-Granger cointegration and Granger causality test on Taiwan's data. Their study provided evidence of bidirectional causality between energy consumption and economic growth (GDP). However, Yang (2000b) application of the 2-step Engle-Granger cointegration and Granger causality method using Taiwan's data confirmed the presence of unidirectional causality from economic growth to coal consumption. Some other causality tests explored in previous studies other than the ones so far summarised are Sims (1972) causality test and the direct Granger (1969) causality test.

Ebohon (1996) is one documented study from the literature search that has investigated the causality between energy consumption and economic growth for Nigeria. Although, Ebohon's (1996) study also investigated this causality for Tanzania, the result established a simultaneous causal relationship between energy consumption and economic growth for Nigeria (and Tanzania). The lack of more studies using Nigerian data is thus worrisome.

To begin to narrow this knowledge gap, this study modestly investigates the causal relationship between energy consumption and real GDP in Nigeria and compares the results with those of Guttormsen (2004) for India and Ageel and Butt (2001) for Pakistan. The study employs Hsiao's Granger causality test after establishing cointegration of the series since most economic time series seem to be non-stationary. Moreover, at the theoretical level, establishing causal relations between economic variables engenders better understanding of the economic phenomena and also enables the establishment of an optimized economic policy (Diebolt and Jaoul, n.d.).

Recent profile of nigeria's energy consumption: Nigeria like some other developing countries is an energy intensive growing economy. The energy consum-ption mix of the country in 2004 was dominated by oil (58%), natural gas (34%) and hydroelectricity (8%). The share of oil in Nigeria's energy mix between 1984 and 2004 decreased from 77-58% (EIA, 2007). The electricity (power) sub-sector operates below its estimated capacity with frequent power outrages. To compensate for the power deficit, the domestic, commercial and industrial sectors persistently use private operational generators. In 2006, total energy intensity increased marginally by a growth rate of 0.789% from 2004 (Table 1), while the population growth rate increased by an average of 3.5% (CBN, 2006) for the same period. Although, natural gas has been judged to be one of the cheapest and cleanest sources of energy supply, in 2004, Nigeria produced 770 Billion cubic feet (Bcf) of natural gas and consumed only 325 Bcf (EIA, 2007). Lack of infrastructure in many of the Nigeria's fields accounts for the waste through flares. It thus implies that given the developmental stage at which the Nigerian economy is, the country certainly faces energy supply constrains and demand management policy bottlenecks. This invokes interest to study energy consumption and economic growth relationship for any policy formulation in the energy sector.

Table 1: Nigeria's energy profile

Energy overview data	2004	2006	2007
Petroleum ('000 Thousand Barrels per Day)			
Total oil production		2,442.60	2,352.38
Crude Oil production		2,439.86	2,349.64
Consumption		312.06	312[e]
Natural Gas (Billion Cubic Feet)			
Production	800	791	996
Consumption	325	366	375
Proved reserves		176,000	184,660
Coal (Million Short Tonnes)			
Production	0.02	0.009	NA
Consumption	0.02	0.009	NA
Electricity (Billion Kilowatt Hours)			
Net Generation	19	22.53	NA
Net Consumption	18	16.88	NA
Installed Capacity (Gwe)		5,898	
Total Primary Energy (Quadrillion Btu)			
Production		6,546	NA
Consumption		1,068	NA
Energy Intensity (Blu per 2000 U.S. Dollars)	6,511.6	6,563	NA

http://tonto.eia.doe.gov/country/country_energy_data.cfm?fips=NI, http://G:\PRJ\NewCABS\V6\Nigeria\Full.html

MATERIALS AND METHODS

As earlier presented in the preceding section, different techniques have been used in various studies to test the relationship and direction of causality between energy consumption and economic growth. This study sets out to review some of these tests.

Johansen cointegration and granger causality: The Johansen test for cointegration and its application in causality test shall be briefly reviewed in this study after a brief summary of its counterpart-the Engel-Granger Representation Theorem which is based upon an error correction representation of a VAR (q) model with a Gaussian error term:

$$\Delta L_t \alpha + \sum_{k=1}^{q-1} \beta_k \Delta L_{t-k} + \delta \Delta L_{t-q} + \mu_i \quad (1)$$

where,

L_t : An m⊗1 vector of I (0) variables (in this case, m = 2).

β_k and δ : m⊗m matrices of unknown parameters.

μ_i : A Gaussian error term.

Equation 1 can be estimated by a maximum likelihood procedure under the hypothesis of a reduced rank r < m of δ,

$$G(r): \delta = -\Gamma\Omega' \quad (2)$$

where, Γ and Ω are m⊗r matrixes and as demonstrated by Johansen (1988), that under certain conditions, the rank condition of matrix implies stationarity of $\Omega' L_t$. Moreover, the existence of cointegration between the variables implies a framework within which causality can be examined. For instance, Granger (1988) has shown that in the presence of cointegration, there must be at least one direction of ‘Granger-causality’.

Under the cointegration and causality relationship, the first stage in establishing the existence and direction of causality is to establish the order of integration and the existence or otherwise of cointegration. Depending on the order of integration therefore, three procedures can be used to establish the direction of causality.

If the variables are integrated of order 1, that is I (1) and cointegrated, the hypothesis of non-causality can be tested at levels of the variables vis-à-vis Eq. (3) and (4).

$$LY_t = \alpha + \sum_{i=1}^{k} \lambda_i LY_{t-i} + \sum_{j-1}^{l} \varphi_j LZ_{t-j} + \varepsilon_t \quad (3)$$

$$LZ_t = \psi + \sum_{ii=1}^{r} \chi_i LZ_{t-i} + \sum_{j-1}^{s} \gamma_j LY_{t-j} + \eta_t \quad (4)$$

where, the null-hypothesis of non-causality is determined by the significance of φ and γ.

If the variables are I (1) and cointegrated, an alternative form of testing the hypothesis of non-causality is to first-differenced the variables (denoted Δ) and add the error-correction term (ECM) from the cointegrating regression as:

$$\Delta LY_t = \alpha + \sum_{i=1}^{k} \lambda_i \Delta LY_{t-i} + \sum_{j-1}^{l} \phi_j \Delta LZ_{t-j} + \xi ECM_{t-1} + \varepsilon_t \quad (5)$$

$$\Delta LZ_t = \psi + \sum_{i=1}^{r} \chi_i \Delta LZ_{t-i} + \sum_{j-1}^{s} \gamma_j \Delta LY_{t-j} + \varphi ECM_{t-1} + \eta_t \quad (6)$$

In the case of Eq. (5) and (6), other than the significance of φ and γ, the significance of λ and χ can establish the direction of causality.

Alternatively, if the variables are I(1) and not cointegrated, the variables must be differenced to establish stationarity as in Eq. (5) and (6). However, in this case, the test of causality should not include the lagged ECM term:

$$\Delta LY_t = \alpha + \sum_{i=1}^{k} \lambda_i \Delta LY_{t-i} + \sum_{j-1}^{l} \phi_j \Delta LZ_{t-j} + \varepsilon_t \quad (7)$$

$$\Delta LZ_t = \psi + \sum_{i=1}^{r} \chi_i \Delta LZ_{t-i} + \sum_{j-1}^{s} \gamma_j \Delta LY_{t-j} + \eta_t \quad (8)$$

The initial lags of k, l, r and s are chosen for Eq. 3-8, using the Akaike Information Criteria. The Wald and LM tests are then used to test the direction of causality.

Some drawbacks of the Granger test have been identified in the literature. According to Granger (1986), the Granger test is valid only if the variables are not cointegrated. Second, Granger causality results are sensitive to lag length. Thus, if the chosen lag length is more, the irrelevant lags could make the estimates to be inefficient. On the other hand, if the lag length is less than the true lag length, this can cause bias (Ageel and Butt, 2001). To overcome these problems, Hsiao (1981) developed a synergic method that combines Granger causality and Akaike’s Fiscal Prediction Error (FPE), defined as the mean square prediction error. The Hsiao method is a systematic autoregressive approach applied in the choice of optimum lag length for each variable in a model.

Hsiao’s granger causality: The Hsiao’s Granger causality test has been applied in many studies (Hsiao, 1981; Chang and Lai, 1997; Cheng, 1995; Ageel and Butt, 2001) with robust results and preferred in relation to other causality methods. The steps in the application of this technique follow the lead of Ageel and Butt (2001) are:

Step 1: State a series of autoregressive regressions on the dependent variables. In the initial regression, the dependent variable is lagged once; while in each succeeding regression, one more lag of the dependent variable is added as Eq. 9 show:

$$d(Y_t) = \alpha + \sum_{i=1}^{p} \beta d(Y_{t-i}) + \varepsilon_{1t} \quad (9)$$

where, i = 1, … m; the choice of lag length is based on the sample size and underlying economic process. It is advisable to select a large m. For instance, given that the energy sector has a long gestation period in developing countries, a lag length of m = 8 can be set.

Step 2: Compute the Aikaike's Fiscal Prediction Error (FPE) for each regression as in Eq. 10:

$$FPE(m) = \frac{N + m + 1}{N - m - 1} ESS(m)/N \quad (10)$$

where, N is the sample size and ESS is the sum of squared errors.

Step 3: Obtain the optimal lag length (m*). The optimal lag length (m*) is the lag length that produces the lowest FPE.

Step 4: Estimate the regressions with the lags on the other variable added sequentially in the same manner used to determine the optimal lag length (m*) as Eq. 11 shows:

$$d(Y_T) = \alpha + \sum_{i=1}^{m^*} \beta d(Y_{t-1}) + \sum_{j=1}^{n} \gamma d(X_{t-j}) + \varepsilon_{2t} \quad (11)$$

where, j ranges from say 1-8, as earlier suggested.

Step 5: Compute FPE for each regression in Eq. 11 as Eq. 12 shows:

$$FPE\ (m^*, n^*) = \frac{N + m^* + 1}{N - m^* - 1} ESS\ (m^*, n)/N \quad (12)$$

Choose the optimal lag length for X, n* as the lag that produces the lowest FPE.

Step 6: Test for causality FPE (m*) which excludes the X variable and compare with FPE (m*, n*) which contains the X variable in the model.

Decision rule:

- If FPE (m*) < FPE (m*, n*); X_t does not Granger cause Y_t.
- If FPE (m*) > FPE (m*, n*); X_t Granger causes Y_t.

Note that once the test is performed with Y_t as the dependent variable, a similar test is repeated with X_t as the dependent variable.

Data: In this study so far, the terms 'economic growth' and 'energy consumption' have been used without sufficient definition. In the literature, the most commonly used proxies for economic growth are gross domestic product (GDP), gross national product (GNP) and Industrial Production (IP). In relation to energy consumption; common proxies are electricity use, coal, gas and oil.

In this study, in order to illustrate the relationship between electricity use and GDP by applying the Hsiao's Granger causality tests, GDP at 1984 factor cost is used as proxy for economic growth. Other variables used as proxies for energy consumption are electricity consumption (megawatt per Hours), coal (tone) and domestic oil consumption ('000 barrels). Yearly (annual) data from 1970-2005 was collected from the publications of the Central Bank of Nigeria: Statistical Bulletin (Vols. 14 and 17 of 2003 and 2006, respectively) and Annual Report and Statement of Accounts (2006). All data are transformed to natural logarithms.

RESULTS AND DISCUSSION

This study presents the results of the estimations. First, the results of the unit roots of the individual variables, second the cointegration results and lastly the Hsiao's causality results.

Test for unit roots: Table 2 reports the results of the unit roots. The degree of integration of each variable has been determined in the analysis using the Augmented Dickey Fuller (ADF) tests and the Philip-Peron (P-P) tests. In the level form, both the ADF and P-P tests indicate that all the series are nonstationary. However, they are all stationary in the first difference and integrated of order I (1).

Test for cointegration: Since, all the series were found to be non-stationary at levels, the analysis further proceeded to investigate the possibility of cointegration between the individual variables in relation to the GDP. The cointegration analysis uses the Engle and Granger (1987), two step procedure by applying the ADF test statistic on the residual series. Table 3 reports the results of the ADF test applied to the residuals of the series at levels. The absolute values of the calculated ADF test statistics for all the residuals are less than critical values at 1 and 5% levels. It is thus concluded that the individual series are not cointegrated. The implication is that standard Granger (1969) test is appropriate. The next sub-section thus presents results of the Hsiao's version of Granger causality test.

The critical values for ADF at 1 and 5% are -4.2505 and -3.5468, respectively the absolute values of the calculated ADF statistics are less than the critical values which indicates acceptance of the null hypothesis of no-cointegration.

Hsiao's version of granger causality test: The analysis of the Hsiao's version of Granger causality is based on equations 9-12. The results are reported in Table 4. The results from the estimation indicate that there is a bidirectional relationship between coal consumption and economic growth given that F(m*) > F(m*, n*) for economic growth to coal consumption and from coal consumption to economic growth; F(m*) > F(m*, n*). From further observation of both the electricity equation and economic growth equation, it can be discern that economic growth leads electricity consumption and vice versa. The results reported for domestic oil consumption and economic growth also follows the same suite.

As for the optimum lag of 5 reported for the electricity equation, it may imply the capital intensity of the electricity sector and its gestation period. In addition, the lag of 8 reported for economic growth equation in relation to electricity, may mean that the impact lead from electricity consumption to economic growth and vice versa is longer than the lead impact on economic growth in respect of coal consumption and oil consumption. An additional inference that can be drawn from the above results is that generally, total energy consumption and economic growth are bidirectionally related in Nigeria. This is in conformity with the results of Ebohon (1996) for Nigeria and in opposition to the neutrality hypothesis, which proposes that the cost of energy is a small proportion of GDP (Guttormsen, 2004) in developing countries and as such cannot lead economic growth. In addition, the results like those of Ghosh (2002) in Guttormsen (2004) India and Ageel and Butt (2001) for Pakistan contradict the Granger (1986) postulate that there cannot be causality between nonstationary variables that are not cointegrated.

Table 2: Unit root tests

	Levels		First difference	
	ADF	P-P	ADF	P-P
GDP	-1.66495	-2.289123	-3.578832**	-5.614591*
COAL	-1.93867	-1.902028	-4.91227*	-5.084633*
ELECT	-2.48189	-2.956686	-4.88487*	-8.504212*
OIL	-3.2852		-6.280499*	

GDP = Gross Domestic Product; COAL = Coal Consumption ELECT = Electricity Consumption; OIL = Domestic Oil Consumption; All variables are in log form* Significant at 1%**, Significant at 5%

Table 3: Cointegration results

	ADF
GDP, COAL	-1.617442
GDP, ELECT	-1.76124
GDP, OIL	-1.454672

Table 4: Results of Hsiao's version of causality tests

	F (m*)		F (m*, n*)	
The GDP Equation	0.5719×10^2		0.4684×10^2	
	(4)	>	(1)	Coal consumption cause economic growth
The Coal Equation	0.44413×10^1		0.37954×10^1	
	(2)	>	(3)	Economic growth cause coal consumption
The GDP Equation	0.5719197×10^2		0.305375×10^2	
	(4)	>	(8)	Electric consumption cause economic growth
The Electricity Equation	0.271398×10^1		0.214793×10^1	
	(2)	>	(5)	Economic growth cause electric consumption
The GDP Equation	0.5719×10^2		0.3939549×10^2	
	(4)	>	(3)	Oil consumption cause economic growth
The Oil Equation	0.33959		0.310397	
	(2)	>	(1)	Economic growth cause oil consumption

The values in parenthesis are the optimum lags

Appendix 1: Survey of results

Article	Methodology	Countries and Results
Kraft and Kraft (1978)	Sims (1972) causality test	USA 1947-1974 unidirectional causality from GNP to energy use
Akarca and Long (1980)	Sims (1972) causality test	USA: Agnostic with respect to the causal relation between Gross Energy Consumption and GNP
Yu and Hwang (1984)	Sims (1972) causality test	USA: no causal relationship between GNP and energy consumption
Yu and Choi (1985)	Sims and Granger causality tests	USA, UK and Poland: no relationship South Korea: unidirectional from GNP to Energy use Philippines: unidirectional from Energy to GNP
Erol and Yu (1987a)	Sims and Granger causality tests	
Erol and Yu (1987b)	Sims and Granger causality tests	Japan and Italy: real income to energy consumption; West Germany: energy consumption to real income; Canada, France and the UK: neutrality of energy consumption with respect to real income
Abosedra and Baghestani (1989)	Direct Granger causality test	USA: unidirectional causality from GNP to EC (energy consumption) at the fourth year lag

Appendix 1: Continue

Article	Methodology	Countries and results
Hwang and Gum (1991)	Granger causality test with Hsiao sequential procedure	Taiwan: bidirectional causality
Yu and Yin (1992)	Cointegration analysis	USA: long-run relationship fails to exist in either energy consumption-income or energy consumption-employment
Stern (1993)	Granger causality in a multivariate setting using a vector autoregression (VAR) model	USA: no evidence that gross energy use Granger causes GDP; a measure of final energy use adjusted for changing fuel composition does Granger cause GDP
Cheng (1995)	Cointegration and Hsiao's version of Granger causality	Mexico, Venezuela and Brazil: no consistent causal patterns between energy and economic growth
Ebohon (1996)	Granger (1969) causality test	Tanzania and Nigeria: simultaneous causal relationship between energy and economic growth
Masih and Masih (1996)	Johansen multiple cointegration test and vector error correction models	India, Pakistan and Indonesia: long-run energy income relationship; Malaysia, Singapore and Philippines: no long-run relationship
Glasure and Lee (1997)	Two step Engle-Granger cointegration and error correction model	South Korea and Singapore: bidirectional causality between GDP and energy consumption
Masih and Masih (1997)	Johansen multiple cointegration test and vector error correction models	Korea and Taiwan: long-run equilibrium relationship
Cheng and Lai (1997)	Hsiao's version of the Granger causality method	Taiwan: no long-run equilibrium relationships
Masih and Masih (1998)	Johansen multiple cointegration test and vector error correction models	Thailand and Sri Lanka: found relationship; little evidence no directions
Asafu-Adjaye (2000)	Johansen multiple cointegration test and Granger causality	India and Indonesia: unidirectional Granger causality from energy to income Thailand and Philippines: bidirectional Granger causality from energy to income
Yang (2000a)	Two step Engle-Granger cointegration and Granger causality	Taiwan: bidirectional causality between total energy consumption and GDP. It was further found that different directions exist between GDP and various kinds of energy consumption.
Yang (2000b)	Two step Engle-Granger cointegration and Granger causality	Taiwan: unidirectional causality from economic growth to coal consumption
Stern (2000)	Single equation static cointegration and multivariate dynamic cointegration	USA: Energy is significant in explaining GDP.
Ferguson, Wilkinson Hill (2000)	Correlation analysis	More than 100 countries in the world: Wealthy countries have and a stronger correlation between electricity use and wealth creation than between total energy use and wealth.
Chang, Fang and Wen (2001)	Johansen multiple cointegration and vector error correction models	Taiwan: bidirectional Granger causality for employment-output and employment-energy consumption, but only unidirectional causality running from energy consumption to output
Glasure (2002)	Johansen multiple cointegration test	Korea: found no cointegration
Ageel and Butt (2001)†	Cointegration and Hsiao's version of Granger causality	Pakistan: Economic growth causes total energy consumption, but no causality between economic growth and gas consumption. In the power sector, electricity consumption leads economic growth without feedback. Energy consumption also directly cause employment.
Hondroyiannis, Lolos and Papapetrou (2002)	Johansen multiple cointegration and vector error correction models	Greece: long-run relationship between energy consumption, real GDP and price development, supporting the endogeneity of energy consumption and real output
Ghosh (2002) in Guttormsen (2004)	Johansen multiple cointegration test and traditional Granger causality tests	India: found no cointegration
Soytas and Sari (2003)	Johansen multiple cointegration and vector error correction models	Argentina: bidirectional causality Italy and Korea: causality running from GDP to energy consumption Turkey, France, Germany and Japan: causality from energy consumption to GDP
Yemane (2004)	A modified version of the Granger (1969) causality test	Shanghai: unidirectional Granger causality running from coal, coke, electricity and total energy consumption to real GDP but no Granger causality running in any direction between oil consumption and real GDP
Jumbe (2004)	Two step Engle-Granger: Cointegration and Granger causality	Malawi: bidirectional causality between kwh and GDP; one way causality running from nonagricultural GDP to kwh
Oh and Lee (2004)	Johansen multiple Cointegration test and traditional Granger causality tests	Korea: long-run bidirectional causal relationship between energy and GDP and short-run unidirectional causality running from energy to GDP
Morimoto and Hope (2004) in Guttormsen (2004)	Two step Engle-Granger: Cointegration and Granger causality	Sri Lanka: current as well as past changes in electricity supply in have a significant impact on real GDP.
Ghali and El-Sakka (2004)	Johansen multiple: Cointegration and Vector Error Correction models	Canada: short-run dynamics of the variable indicate that Granger causality is running in both directions between output growth and energy use.
Guttormsen (2004)†	Multivariate Johansen Cointegration using vector autoregression (VAR)	France, Germany, Greece, Italy, Japan, Argentina, India, Indonesia and Philippines: bidirectional causality
Fatai, Oxley and Scrimgeour (2004)†	Granger causality test. Cointegration using ARDL*	New Zealand and Australia: unidirectional link from real GDP to aggregate final energy consumption.

*ARDL Autoregressive Distributed Lag ,†Order than these studies, others were abridged from Guttormsen (2004)

CONCLUSION

Primary energy consumption in Nigeria is mainly derived from oil, natural gas and hydroelectricity. Of these three, crude oil is the dominant source. Since, the last two decades however, the collapse of the power sub-sector has created energy supply deficits which has been augmented by large quantities of imported generators. While over 50% of natural gas produced which could have been converted into power generation is flared, the implication of the recent available data is that any policy initiation should take into cognisance the causal relationship between energy consumption and economic activities. This constitutes the basic focus of this study. Issues of empirical analyses of causality and relationships have been an integral part of time series econometrics. There is also an enormous and bourgeoning literature on the relationships between energy use and economic growth. This study among others abridged the extensive literature. The summary of the studies establishes the existence of a relationship between energy use and economic growth. The causality test results are however mixed.

This study modestly attempted to determine the direction of the causal relationship between energy use and economic growth by disaggregating energy use into coal, electricity and domestic oil consumption. The method of analysis is based on the Hsiao's Granger causality test. The Hsiao's Granger causality version uses differential data to obtain a mean square prediction error from a systematic autoregressive method for choosing an optimum lag length for variable in an equation.

The estimates indicate that generally, energy consumption and economic growth are bidirectionally related in Nigeria despite the existence of no cointegrating relationship of variables that are not cointegrated.

The policy implication of the findings suggest with a caution that energy conservation policy will inhibit economic growth in Nigeria and as such, energy growth policies particularly electricity, coal and oil should be adopted and enhanced to amplify the economic growth of Nigeria. Finally, for energy supply and consumption to be competitive and efficient in Nigeria, efforts must be put in place to reduce gas flaring. The flared gas can be processed to augment power generation, given that the present stage of Nigeria's production structure and activities are energy intensive.

One limitation of this study is its inability to incorporate gas flaring in the causality test. Future research should not only look at this direction, concerns about the impact of increased energy consumption on the environment via a decomposition methodology could be studied.

Note:

- Since these eras, oil price has further quadrupled.
- Appendix 1 reports an overview of the empirical studies in chronological order-summarising both results and methodology employed. It is to be emphasised that most of the survey chronological are abridged from Guttormsen (2004).

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