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Longrun Relationship Between Energy Consumption And Economic Growth: Evidence From Nigeria.

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Abstract: *This article investigates the long run relationship between energy consumption and the economic growth in Nigeria from the period of 1985 to 2010. However, the study make use of secondary data analysis of ordinary least square method of Multiple regression analysis and the objectives of the study is to examine whether energy consumption brings economic growth in Nigeria and also to examine the long run effect of energy consumption on growth in Nigeria. Moreover, the results revealed that Petroleum, Electricity are positively related to Nigeria economic growth while coal and Gas shows that there is a negative relationship with Nigerian economic growth. However, the study conclude that that increased energy consumption is a strong determinant of economic growth having an implicit effect in lagged periods and both an implicit and explicit effect on the present period in Nigeria. Thus, the study recommends that the energy sector should be given more relevance even by exploiting the opportunities laden in the sector to increase economic growth.*
Key words*: Energy consumption, economic performance, economic growth, Long Run Relationship.*

I. INTRODUCTION

This research examines the long run relationship between energy consumption and economic growth in Nigeria between 1985 to 2010. The relationship between the two variables has received a significant attention in the recent time. The concern of this analysis has been gingered by the persistent increase in the awareness of global warming and climate change around the world. Government, professionals and academics alike are concerned about the impact of energy consumption on the economy (Adenikinju 2003). Similarly, it examine whether the high economic proceed benefited from energy consumption can change or bring solution to the positive externality inflicting on the society or not? This for some times has remained a controversial debate in the literature in the last two decades. If the marginal social welfare benefit of economic growth is greater than the marginal cost of environmental impact in the society, it is therefore necessary to increase energy consumption to improve economic growth. More so, if energy use cannot improve economic growth, a reduction in energy intensity is needed in order to avoid the negative impact on the economy. Furthermore, the causal relationship between energy use and economic growth is important given the threat of hydrocarbon and thus the need to reduce energy use so as to stem the CO2 emissions and help halt climate change (Okuku 2004). This research therefore evaluates the long run relationship between energy consumption and economic growth with the use of co-integration and Error Correction Mechanism and Multiple regression model using Nigeria data between 1985 to 2010.

The relationship between energy use and economic growth has been an intensive controversial issue in the literature of energy economics. Some energy economists argued that energy is a crucial input along with other factors of production such as capital and labour. Therefore, energy is an important requirement for economic growth to take place and is potentially a catalyst for economic and social development especially in Nigeria. However, in the literature some argued that the cost of energy consumption is a small percentage of Gross domestic products, therefore having a significant impact on economic growth is remote.

In conclusion, the increasing attention given to global energy issues and the international policies needed to reduce greenhouse gas (GHG) emissions have given a new area to research interest in the literature linkages between the energy sector and economic development at different country level. The empirical techniques and the different models adopted by various authors in the literature for vividly looking at these relationships depend on the economic development level and level of economic structure of the countries involved.

The significance that the country has placed on crude oil is relatively very high. The over reliance of crude oil in Nigeria is a major challenge because it has failed to diversify its energy consumption and ensure an appropriate energy mix. The consumption for oil is high practically because there is no alternative to it. Fossil fuels like coal are insignificantly mined in the country. The coal located in eastern Nigeria is sub-bituminous which means that it burns slowly and gives out a lot of heat. Subsequently, it is also low in sulphur and ash content. Coal is the oldest commercial fuel used in Nigeria in 1916. Since oil was discovered in Nigeria, coal was given less relevance and became highly dormant. With a reserve of over 2 billion metric tonnes, Nigeria produces about 200000 to 600000 tonnes yearly. Per capita power consumption in Nigeria is estimated at 82 KW where as other

African counterparts like South Africa has a per capita consumption of 3793 KW. Not withstanding, with vast potentials, energy can be adequately supplied in the country if well tapped. If consumption is positively related to economic growth, the benefits of increased consumption includes generating more income, boosting economic activities which will boost economic growth and increased development especially poverty reduction.

II. Petroleum Energy

The petroleum industry in Nigeria is the largest industry and main generator of GDP in the West African nation which is also the continent's most populous. Since the British discovered oil in the Niger Delta in Nigeria in the late 1950s, the oil industry has been marred by political and economic strife largely due to a long history of corrupt military regimes and complicity of multinational corporations, notably Royal Dutch Shell. Despite this, it was not until the early 1990s that the situation was given international attention, particularly following the execution by the Nigerian state of playwright and activist Ken Saro-Wiwa, provoking the immediate suspension of Nigeria from the Commonwealth of Nations. Nigeria is identified by the international community and the firms in operation there as a major concern with regard to human rights and environmental degradation (Brenton, P., (1997). The Nigerian government, oil corporations, and oil-dependent Western countries have been criticised as too slow to implement reforms aimed at aiding a desperately underdeveloped area and remediating the unsustainable environmental degradation that petroleum extraction has wrought.

III. Natural Gas

Natural gas reserves are well over 187 trillion ft^3 (2,800 km^3), the gas reserves are three times as substantial as the crude oil reserves. The biggest natural gas initiative is the Nigerian Liquified Natural Gas Company, which is operated jointly by several companies and the state. It began exploration and production in 1999. Chevron is also attempting to create the Escravos Gas Utilization project which will be capable of producing 160 million standard ft^3 of gas per day.

There is also a gas pipeline, known as the West African Gas Pipeline, in the works but has encountered numerous setbacks. The pipeline would allow for transportation of natural gas to Benin, Ghana, Togo, and Cote d'Ivoire. The majority of Nigeria's natural gas is flared off and it is estimated that Nigeria loses 18.2 million US$ daily from the loss of the flared gas

IV. Coal Energy

The Energy Information Association (EIA) (2007) is of the view that Coal is not part of the country's energy consumption mix. Nigeria is heavily endowed with 22 mines of coal resources which have a total proven capacity of 2 billion tonnes. Coal was the first energy resource to be exploited in Nigeria. It then immediately became the power of the country but its relevance began to drop immediately after oil was discovered. The level of significance attributed to coal by the nation began to drop very quickly and today it is insignificantly used as an energy resource.

In many countries which use coal as an energy resource, increased coal consumption reflects the increasing output of industry, transportation, and even agriculture. Coal resources are mainly located in Anambra State and it is sub bituminous with low sulphur and ash content. This makes it attractive to African countries like Ghana; Egypt as well as European countries which have began to show interest in Nigerian Coal. Underground and surface coal production potential is reported to be 200,000 - 600,000 tonnes per year and 400,000 - 800,000 tonnes per year, respectively (World Bank, 1983). This potential still exists but the resource is not tapped.

V. Electricity

The Facts about Nigerian Electricity

Nigeria population is about 150 million and vast oil and gas reserves, can only boast of about 6000 Megawatts (MW) of installed power generation capacity, of which barely 3600MW is available at the best of times. The conservative estimate is that the country's current electricity demand is well above 15,000 MW which on a per capita basis is still two and half times less than Egypt's and one tenth that of South Africa the other two leading economies in Africa. In Nigeria, electricity generation and distribution currently rest with government and in the first half of the last three decades the sector suffered acute under investment, (Ayodele (2004)).

Recognizing that government alone cannot continue to fund the sector if the situation is to improve on the quick, government began to make way for private sector participation. The Independent Power Producers (IPPs) are intended to complement and eventually replace the federal government in providing electricity to the Nigerian populace. To date, this intent has failed to materialize. Apart from government owned or controlled IPPs, Geometric Power is the only IPP at advanced stages of completing its energy facilities. This begs the question: after so many years, why are private-sector driven IPPs not stepping up to the game?

The Main issues of Nigerian Electricity

First, the current tariffs are not attractive to investors. The wholesale price which is the price at which the IPPs are required to sell their power is currently at the equivalent of four US cents per kilowatt-hour. For most gas fired IPPs this number has to double for those to make investment sense. The case for coal, hydro and renewable energy sources would mean a much higher figure eight cents per kilowatt-hour. The good news is that in light of the consistent demand the industry regulator, Nigeria Electricity Regulatory Commission (NERC) has agreed to a major review of the tariff. It is hoped that this will lead to a better cost reflective tariff.
Second, for the IPPs, Power Holding Company of Nigeria (PHCN) the wholesale purchaser of power does not pay its bills and thus will not make a reliable purchaser of power from the perspective of an investor or banker. A solution to this problem, pending when the former PHCN distribution companies, DisCos (Distribution Companies) are transferred to private sector management with either deep pockets or a track record for efficient operation of a distribution company, is for the government to provide some credit enhancing instrument such as a sovereign guarantee for sales to the DisCos or in the alternative allow IPP to sell directly to a captive customer groups such as industrial parks, aggregated commercial locations and residential estates.

Third, is the issue of feedstock for power production particularly gas. While the country currently flares the approximate of 10,000 MW of gas equivalent IPPs find it difficult to contract for gas. The underlying reason is that current gas infrastructure is inadequate to deliver gas to both new and existing power plants. While the current gas-to-power price too low to incentivize the international oil companies (IOCs), who control gas production to invest in gas gathering and production facilities. Again following consistent agitation, NERC working with the National Nigerian Petroleum Company (NNPC) and the IOCs have just reached a decision on new gas-to-power price that makes the IOCs indifferent between selling gas to power plants or to other hitherto more profitable export clients. On May 27, 2010 the government announced a new price regime that increases gas price to $1/mmBtu from 40 cents starting from next year. This price still remains significantly cheaper than the average $6/mmBtu that is obtainable in the international markets.

Fourth is the consistency or lack thereof of government policy and direction. Towards the end of the Obasanjo administration, the government embarked on reform of the industry seeking to privatize the state owned PHCN. Only for the Yar'Adua administration to halt the process rationalizing that there was the need to review the process so far. If investors were hoping that there will be a quick resolution and a return to the reform initiative, their confidence was dealt a further blow by the sacking of NERC commissioners and the resultant undermining the authority of the regulator. For a nascent industry, such reversals convey a lack of stability in the investment environment and weaken the ability of the IPPs to raise capital.

Finally and maybe most important is the high cost of capital from the debt market and very short tenor compared to the project life. The life of a typical plant is about 20 years and long term finance for power project should be of 10-year tenor at the minimum. Unfortunately because of lack of capacity and experience for the nascent industry, local banks are unwilling to lend for longer than two years and at the interest as high as 25%.

VI. Brief Literature Review

Toman and Jenelkova (2003) argue that most of the literature on energy and economic development discusses how development affects energy use rather than its impact on the growth of the economy. This strand of literature considers economic growth as the main driver for energy demand and only advanced economies with a high degree of innovation capacity can decrease energy consumption without reducing economic growth.

Stern and Cleveland (2004) also stressed the importance of considering the effect of changes in energy supply on economic growth in both developed and developing countries. If energy supply is considered a homogenous input for the production function, this means that if policy constraints affect energy supply, economic development will not be achieved. When energy services are differentiated, emphasizing the existence of higher and lower-quality forms of energy, society should make a choice in terms of an optimal energy mix, considering that higher quality energy services could produce increasing returns to scale. This means that energy regulation policies supporting the shift from lower-quality (typically less efficient and more polluting) to higher-quality energy services could provide impulse to economic growth rather than be detrimental to the development process.

Therefore, it is necessary to know the long run relationship between energy consumption and economic growth or to know whether energy consumption is a significant determinant of economic growth or not? Using three econometrics analyses of co-integration, Error Correction Mechanism and multiple regression model to justify for the study and add more values to the existing literature. As indicated above, the solution to this question will go along way to assist the governments to formulate an appropriate policy on energy conservation in Nigeria. Specifically, if energy consumption causes economic growth then decreasing energy consumption could lead to high unemployment, budget deficit, low income, etc. However, if it is established that energy consumption does not have both short and long run effect on Gross Domestic Product, then energy conservation policy may be adopted with no adverse impact on the economy. Given the global issue on climate change and the need to reduce CO2 emissions by reducing energy consumption, it is important to establish whether energy use causes economic growth or not? Since any reduction in energy consumption to help stem CO2 Emissions will have an impact on the economy. Given the nature and importance of this research, various attempts have been made by academics and professionals alike to determine the long run relationship between the two variables for different countries; still no clear consensus has emerged. Different results for different countries are not unexpected given the institutional and structural differences among the countries. However, absence of similar results for similar countries is somewhat unexpected. According to Masih and Masih(1997), this might be due to differences in methodologies, analytical framework adopted and variably data disparity from country to country. However, the study will try to examine whether energy consumption has a long run effect on economic growth in Nigerian, and to examine whether there is conflicting results looking at the relationship and the long run relationship (that is using co-integration, Error correction mechanism and multiple regression model) and finally make policy recommendations based on the analysis from the study.

Although, the demand for energy leads to economic growth. It is true that consumption is derived from demand. That is whatever is consumed must have been demanded. Birol (2007) argues that demand for energy has surged and in that respect, the unrelenting increase has helped fuelled global economic growth. Yu and Choi (1985) carried out a research on the Philippines and found that there is a positive relationship between energy consumption and economic growth. They went further to define that relationship as a unidirectional one where economic growth served as the dependent variable and energy consumption was the independent variable. Asafu-Adjaye (2000) carried out the same research on Singapore and Indonesia respectively and found out the same unidirectional causality effect of Energy consumption and Economic growth. There are other economic findings which are contrary to the Energy – Gross Domestic Product causality relationship. Yu and Choi (1985) carried out a verification study on the causality relationship between energy consumption and economic growth and found out that the causality ran in an opposite direction, from economic growth to energy consumption.

However, the positive relationship between energy consumption and economic growth has been justified by some authors as being consistent. Many economists agree that there is a strong correlation between energy use and economic development. Morimoto and Hope (2001) have discovered, using Pearson correlation coefficient that economic growth and energy consumption in Sri Lanka are highly correlated. Breshin (2004) said that energy is vital for driving growth in the energy, manufacturing and social sector. He went further to say that a parallel (positive) growth trend existed between energy demand and gross domestic product (GDP). According to Simpson (1969), "it is energy consumption rather than Steam engine, which is driving the developing industries in modern Africa". By implication, He re-emphasizes the fact that energy consumption drives economic growth. Ageel and Mohammad (2001) ran a co-integration on energy and its relationship with economic growth in Pakistan, a developing nation like Nigeria and found that increase in electricity consumption leads to economic growth. Sanchis (2007) stated that "electricity (source of energy consumption) as an industry is responsible for a great deal of output". She went on to say that electricity had effects not only on factors of production but also on the impact it had on capital accumulation. Alam (2006) agrees that there is a departure from neoclassical economics which include only capital, labour and technology as factors of production to one which now includes energy as a factor of production. He went further to say that energy drives the work that converts raw materials into finished products in the manufacturing process. Sanchis (2007) added that increase in the energy consumption (electricity) production will avoid the paralysation of the industrial production. Increased industrial production will eventually increase output. Thus, this implies that electricity production should become an economic policy high-priority objective which should be urgently responded to. Energy efficiency is also called 'efficient energy use'. It is not just about reducing utility bills of energy. It also involves boosting revenue through greater productivity. Energy efficiency is an indispensable component of any effort to improve energy consumption and productivity. Ultimately, energy efficiency contributes to wealth, Oviemuno (2006). Energy efficiency provides another option for meeting air quality goals in that combustion volumes are reduced proportionately with fossil fuel consumption. Energy Efficiency refers to the improvement of products and practices that result in a reduction in the amount of energy necessary to provide energy services such as lighting, cooking, heating, cooling, transportation and manufacturing (Amaewhule, 2000). Classical economists did not recognize energy as a factor of production in the production process and neither did the Neoclassicals. Today, economists like Alam (2006) found out in his work on 'Economic Growth with Energy' that not only does energy serve as a factor of production; it also acts as a booster to growth of a nation.

VII. Theoretical Framework

Before the growth theory proposed by Romar, there were other growth theories which thrived. Solow growth theory was one of such theories which was then in vogue. The Solow growth theory was also known as the exogenous theory because it professed technology as an exogenous factor which determines growth. One of the basic assumptions of the Solow model is the diminishing returns to labour and capital and constant returns to scale as well as competitive market equilibrium and constant savings rate. However, what is crucial about the Solow model is the fact that it explains the long run per capita growth by the rate of technological progress, which comes from outside he model.

The endogenous growth theory or new growth theory was developed as a reaction to the flaws of the neoclassical (exogenous) growth theory. Romar endogenous growth theory was first presented in 1986 in which he takes knowledge as an input in the production function. The theory aimed at explaining the long run growth by endogenizing productivity growth or technical progress. The major assumptions of the theory are:

1. Increasing returns to scale because of positive externalities,
2. Human capital (knowledge, skills and training of individuals) and the production of new technologies are essential for long run growth.
3. Private investment in Research and Development is the most important source of technological progress
4. Knowledge or technical advances are non-rival good.

In the New growth theory, the savings rate affects the long run economic growth because in this framework, a higher level of savings and capital formation allows for greater investment in human capital and Research and development. The model predicts that the economy can grow forever as long as it does not run out of new ideas or technological advancement. Just like the exogenous growth theory, the endogenous growth theory professes convergence of nations by diffusion of technology. That is, a situation where poor countries manage to catch up with the richer countries by gradual imitation of technology by poorer countries.

Romar states that production function of a firm in the following form:

Y = A(R) F (Ri, Ki, Li)

Where:

A - Public stock of knowledge from research and development (R),

Ri - Stock of results from the stock of expenditure on research and development.

Ki - Capital stock of firm i

Li - Labour stock of firm i

The Ri actually represents the technology prevalent at the time in firm i. Any new research technology spill over quickly across the entire nation. Technological progress (advancement) implies the development of new ideas which resemble public goods because they are non-rival.

When the new ideas are added as factors of production the returns to scale tend to be increasing.

In this model new technology is the ultimate determinant for long run growth and it is itself determined by investment in research technology. Therefore, Romar takes investment in research technology as endogenous factor in terms of the acquisition of new knowledge by rational profit maximization firms. From the forgoing, we can derive the aggregate production
function of the endogenous theory as follow:

Y=F (*A*, *K*, *L*)

Where;

Y = aggregate real output.

K = stock of capital.

L = stock of labour.

A = Technology (or technological advancement).

It is worthy to note that *A* (technological advancement) is based on the investment on research technology. Technology is seen as an endogenous factor which could be related to energy. Most technology as given per time is dependent on the availability of useful energy to power it. The technology referred to here is that such as plants, machinery and the likes. Without adequate energy supply (in this case electricity or petroleum) then these technology are practically useless. The law of thermodynamics helps to justify this by stating that "no production process can be driven without energy conversion". Energy is not the sole determinant of technology but is a necessary factor to ensure that technology (at what ever level) is being utilized. Conversion of energy in its raw state into useful state is highly technology oriented. Taking cue from the technology oriented nature of energy production; it is also known that energy production is capital intensive. Huge machineries are required to produce useable energy. This will mean that huge amount of capital will be required to produce energy. Huge investments must then be made on energy not only to produce but to attain energy efficiency. For the sake of
justifying the endogenous growth model, capital and labour will be used along side with various energy sources in the specification of the model.

VIII. Model Specification

Taking inference from the empirical findings and theories, which has been derived from the theoretical exposition of the exogenous growth theories and then making energy central to the equation, a model will be drawn up to determine economic growth in Nigeria context.

If energy is taken as an independent variable then the model can be stated as:
Y = f (K. L, E) …………………………………………….. (1)
Where;
Y = Output.
K = Capital
L = Labour
E = Energy.
However, we considered 4 main energy types in Nigeria and they include petroleum, electricity, coal and Gas. Therefore, splitting Energy into 3 then the model could be restated as follows:
RGDP = f (PT, Ec, Cc, GS, E)……………………………...(2)
We can decompose equation 2 into simple regression analysis to become;
RGDP = f(PT)……………………………………………..(4)
RGDP = f(EC)………………………………………………(5)
RGDP = f(Cc)……………………………………………….(6)
RGDP = f(GS) ……………………………………………..(7)
However, equation 4 to 7 can be further be written in form of a simple regression as;
RGDP = ao + a1PT + e ...………………………………(8)
RGDP = ao + a1EC + e …………………………………(9)
RGDP = ao + a1Cc + e ………………………………..(10)
RGDP = ao + a1GS + e……………………………….(11)
However, equation 8 to 11 can be added together to becomes a multiple regression model as;
RGDP = ao + a1PT + a2EC + a4Cc + a5GS + e ………………(3)
Where;
RGDP = Real gross domestic product
PT = Petroleum Consumption
EC = Electricity Consumption
Cc = Coal Consumption
GS = Gas Consumption
E = Error term
Moreover, the apriori expectations are stated as follows;
a1>0, a2>0, a3>0, a4>0, that is we expect all the explanatory variables to has a direct relationship with the Real Gross domestic Product.

IX. Unit Root Test

In time series models in econometrics (the application of statistical methods to economics), a unit root is a feature of processes that evolve through time that can cause problems in statistical inference if it is not adequately dealt with.
A linear stochastic process has a unit root if 1 is a root of the process's characteristic equation. Such a process is non-stationary. If the other roots of the characteristic equation lie inside the unit circle — that is, have a modulus (absolute value) less than one — then the first difference of the process will be stationary.
Consider a discrete time stochastic process $\{y_t, t = 1, ..., \infty\}$, and suppose that it can be written as an autoregressive process of order p:

$$y_t = a_1 y_{t-1} + a_2 y_{t-2} + \cdots + a_p y_{t-p} + \varepsilon_t \quad \text{……………………..(13)}$$

Here, $\{\varepsilon_t, t = 0, \infty\}$ is a serially uncorrelated, mean zero stochastic process with constant variance σ^2. For convenience, assume $y_0 = 0$. If $m = 1$ is a root of the characteristic equation:

$$m^p - m^{p-1} a_1 - m^{p-2} a_2 - \cdots - a_p = 0 \quad \text{………………………(14)}$$

then the stochastic process has a unit root or, alternatively, is integrated of order one, denoted $I(1)$. If $m = 1$ is a root of multiplicity r, then the stochastic process is integrated of order r, denoted $I(r)$.
The Augmented Dickey-Fuller (ADF) test is adopted in this research to determine the order of integration and is stated as follows:

$$\Delta Xt = \beta_1 + \beta_{2t} + \delta X_{t-1} + \alpha_i \Sigma \Delta X_{t-1} + \varepsilon_t \quad \text{…………………… (15)}$$

Where ε_t is a white noise error term and where $\Delta X_{t-1} = (\Delta X_{t-1} + \Delta X_{t-2})$, $\Delta X_{t-2} = (\Delta X_{t-2} + \Delta X_{t-3})$, etc. the number of lagged difference terms to include is often determined empirically, the idea being to include enough terms so that the error term is serially uncorrelated.

X. Co-integration Test

Co- integration is a statistical property of time series variables. Two or more time series are co-integrated if they share a common stochastic drift.

If two or more series are individually integrated (in the time series sense) but some linear combination of them has a lower order of integration, then the series are said to be co-integrated. A common example is where the individual series are first-order integrated (I(1)) but some (co-integrating) vector of coefficients exists to form a stationary linear combination of them. For instance, a stock market index and the price of its associated futures contract move through time, each roughly following a random walk. Testing the hypothesis that there is a statistically significant connection between the futures price and the spot price could now be done by testing for the existence of a co-integrated combination of the two series. (If such a combination has a low order of integration - in particular if it is I(0), this can signify an equilibrium relationship between the original series, which are said to be co-integrated).

Before the 1980s many economists used linear regressions on (de-trended non-stationary time series data, which Nobel laureate Clive Granger and others showed to be a dangerous approach that could produce spurious correlation. His 1987 paper with Nobel laureate Robert Engle formalized the co-integrating vector approach, and coined the term.

The possible presence of co-integration must be taken into account when choosing a technique to test hypotheses concerning the relationship between two variables having unit roots (i.e. integrated of at least order one).

The usual procedure for testing hypotheses concerning the relationship between non-stationary variables was to run ordinary least squares (OLS) regressions on data which had initially been differenced. Although this method is correct in large samples, co-integration provides more powerful tools when the data sets are of limited length, as most economic time-series are.

XI. Test

The three main methods for testing for co-integration are:

1. The Engle-Granger two-step method

If two time series x_t and y_t are co-integrated, a linear combination of them must be stationary. In other words:

$y_t - \beta x_t = u_t$ ……………………………………….(16)

Where u_t is stationary.

If we knew u_t, we could just test it for stationarity with something like a Dickey-Fuller test, and be done. But because we do not know β, we must estimate this first, generally by OLS, and then run our stationarity test on the estimated u_t series, often denoted $\hat{u}_t$. This is the Engle-Granger two-step method.

2. The Johansen test

The Johansen test is a test for co-integration that allows for more than one co-integrating relationship, unlike the Engle-Granger method.

3. Phillips-Ouliaris co-integration test

In practice, co-integration is often used for two I(1) series, but it is more generally applicable and can be used for variables integrated of higher order (to detect correlated accelerations or other second-difference effects). Multico-integration extends the co-integration technique beyond two variables, and occasionally to variables integrated at different orders.

However, these tests for co-integration assume that the co-integrating vector is constant during the period of study. In reality, it is possible that the long-run relationship between the underlying variables change (shifts in the co-integrating vector can occur). The reason for this might be technological progress, economic crises, changes in the people's preferences and behaviour accordingly, policy or regime alteration, and organizational or institutional developments. This is especially likely to be the case if the sample period is long. To take this issue into account, tests have been introduced for co-integration with one unknown structural break, and tests for co-integration with two unknown breaks are also available.

In this research study we adopt the Johansen procedure, which is stated as follows:

$\Delta M_t = \beta_0 + \delta M_{t-1} + \alpha \Sigma \Delta M_{t-1} + \varepsilon_t$ ……………………………………(17)

The method that is adopted for testing co-integration is the co-integrating regression Durbin-Waston (CRDE) test, whose values where first provided by Sargan and Bhargava (1983).

Error Correlation Mechanism (ECM)

The error correlation mechanism is employed to tie the short-run dynamic behaviours of a variable to its long-run value. The error correlation mechanism (ECM) first used by Sargan and later popularized by Engle and Granger (1987) corrects for disequilibrium.

Given these dynamics, Engle and Grander suggested that adjustments should be involved through the (iterative) process to obtain a more parsimonious model. The ECM is stated as;

$\Delta Pt = \alpha_0 + \alpha_1 \Delta Q_t + \alpha_2 U_{t-1} + \varepsilon_t$ ……………………………………..(18)

Where Δ as usual denotes the first differences operator, ε_t is the random error term, and $M_{t-1} = (P_{t-1} - \beta_1 - \beta_2 Q_{t-1})$, this is the one period lagged value of the error from the co-integrating regression.

XIII. RESULT AND ANALYSIS

Unit Root Test Result

Table 1: Unit Root Test Result

Variables	ADF T-Statistic	Order
LNRGDP	**-7.342702**	**I(1)**
LNPT	**-2.441281**	**I(1)**
LNEC	**-5.765291**	**I(1)**
LNCOc	**-2.554187**	**I(0)**
LNGS	**-1.454367**	**I(1)**

Note: The 5% critical value for the ADF statistic is -2.95

The result above in table 1 shows that Real Gross Domestic Product (GDP), Petroleum Consumption (PT), Electricity consumption (Ec), and Gas Consumption are stationary at first difference that is the variables are I(1) series, while only Coal Consumption is stationary at levels meaning is an I(0) series. This is deducted from the fact that for the levels of variables, the absolute values of the ADF statistics are greater than the critical values of the ADF at 5% level of significance.

Johansen's Co-integration Test Result

The co-integration analysis helps to test for the existence of long run stable relationship that exists between the dependent variable and its regression. A vector of variables integrated of order one is co-integrated if there exist linear combination of variables that are stationary. Following the approach of Johansen and Juselius (1990) two likelihood ratio test statistic, the maximal eigen value and the trace statistic were utilized to determine the number of co-integration vectors.

Table 2: Test of Johansen's Co-integration

Series	Eigenvalue	Trace Value	Percent Critical value	1 percent critical Value	Hypothesized No. of CE(S)
LNRGDP	**0.332160**	**46.21232**	**57.32**	**84.22**	**None****
LNPT	**0.651231**	**64.42317**	**59.28**	**24.45**	**At most 1**
LNEC	**0.545412**	**27.06548**	**31.76**	**22.75**	**At most 2**
LNCoc	**4.32E-05**	**0.005543**	**11.65**	**36.29**	**At most 4**
LNGS	**3.66E-04**	**6.439801**	**10.47**	**33.21**	**At most 4**

***(**) denotes rejection of the null hypothesis at the 5% (1%) level respectively**

Trace test indicates 1 co-integrating equation at both 5% and 1% level

The table above reveals that the null hypothesis of no co-integration is rejected and this implies that the long run test reveals co-integration relationship among variables that were included.

However, the result also reveals that there is one Co-integration equation(s) at both 1% and 5% levels, and this indicates a long run equilibrium relationship between Real Gross Domestic Product and its explanatory variables (Petroleum Consumption (PT), Electricity consumption (Ec), Gas Consumption, and Coal Consumption), and the implication of this is that energy consumption has a long run relationship with economic growth in Nigeria and vice versa.

Error Correlation Model (ECM) Result

The next step is to proceed to estimate the short run error correlation model after having reached a conclusion regarding the inherent long run relationships. Hendry's 'general to specific' approach was used to reduce the over-parameterized equation to its parsimonious form.

However, the results presented in the table below shows that the model has a good fit indicated by the R squared of 0.85. That is the explanatory variables explain 85% of the variation in Real Gross Domestic Product (GDP) while the remaining 15% are not included in the model or are outside the model. There is no serial autocorrelation given that the Durbin Watson statistic (2) is within the acceptable bound.

Table 3: Error Correlation Model

Variable: D (LNRGDP)
Included Observation: 25
Excluded Observation: 2 after adjusting and points

Variable	Co-efficient	Std. Error	T-Statistic	Prob.
Constant	0.554213	0.033228	3.239971	0.0441
D (LNPT (-1)	1.434528	0.039980	1.443210	0.0110
D(LNEC (-1)	6.887140	7.022319	1.776310	0.0443
D(LNCoc (-1)	-3.442167	0.055432	1.974569	0.0213
D(LNGS (-1)	-2.344168	0.044318	1.985428	0.0546
ECM (-1)	1.763452	3.848653	2.747651	0.0453

R squared	0.850021	Mean Dependent Var.	0.054561
Adjusted R squared	0.780560	S.D. Dependent Var.	0.023185
S.E of regression	0.044311	Akaike info Criterion	-3.873342
Sum squared resid.	44.55430	Schwarz Criterion	-5.334197
Log likelihood	0.077862	F statistic	11.208388
Durbin Watson stat	2.055410	Prob (F-statistic)	0.002221

The table below shows that Real Gross Domestic Product Gross has a direct or positive relationship with Petroleum and Electricity Consumption while it has a negative or an inverse relationship with Coal and Gas Consumption. However, parameter Petroleum and Electricity consumption are statistically significant at 5% level of significance and they are good explanatory variables for Gross domestic product while parameter Coal and Gas Consumption are not statistically significant at 5% level of significance and is not a powerful explanatory variable for Gross domestic Product. The lagged value of error correction model also has a positive impact but it's statistically insignificant to Gross Domestic Product (GDP). More so, the F statistics shows that the overall parameters in the model are all statistically significant at 5% level of significance and the coefficient of multiple determination R squared is 0.850021 which is 85% and this mean that about 85% variation in the dependent variable has been explained by the independent variables while the remaining 15% are not present or are not included in the model. In conclusion, some previous studied have reported similar result, Adenikinju (2005) notes that there is a positive relationship between energy consumption in Nigeria and growth.

XII. Conclusion And Recommendation

This study aimed to assert that there exist a positive relationship between energy consumption and economic growth. While reviewing the relevant literatures on the relationship between energy consumption and economic growth, it adopts the endogenous growth theory as its theoretical framework. Taking cue from the basics of this theory, a model was specified using real Gross Domestic Product as a function of Petroleum consumption, electricity consumption and coal consumption and Gas consumption. The study uses the Johansen's co-integration technique to test for the long run relationship between the variables in the specified model and subsequently come up with some findings.

In light of the test being carried out covering a period of 25 years (1985 - 2010), the following are the key findings to the study:

1. There is a positive relationship between real gross domestic product and Petroleum.
2. There is a positive relationship between real gross domestic product and Electricity.

However, the test of Error correction mechanism reveals the following findings;

5. There is a positive relationship between real gross domestic product and lagged value of Petroleum consumption.
6. There is a positive relationship between the real gross domestic and lagged value of Electricity consumption.
7. There is a negative relationship between the real gross domestic and lagged value of coal consumption
8. There is a negative relationship between the real gross domestic and lagged value of Gas consumption.

The analysis reveals that Petroleum and Electricity consumption conform with apprior expectation which state that they are positively related to economic growth except Coal and Gas consumption. The reason for this could be because Petroleum and Electricity Consumption as energy sources have a high direct influence on the economy both in the present period and in lagged periods. That is to say that energy consumption acts mainly as an intermediate good in past periods and then acts both as an intermediate and a final product in the present period. In other words, the effect of Petroleum and Electricity consumption in the past can only be seen in other factors or products which influences Gross Domestic Product today but the effects of Petroleum and Electricity consumption has a great impact on the growth of the Nigerian economy because about 95% of the total population in Nigeria consume both Petroleum and Electricity and less of Gas and Coal. Therefore this study has shown that all the explanatory variables (except Coal and Gas) have a positive or direct effect on the growth of Nigerian economy but Petroleum and Electricity consumption has a higher or greater impact on the growth of Nigerian economy and it serves has source of revenue for the country since independence.

From the result and analysis of this study, we can recommend that the Nigerian Government should increase energy supply around the country, since it has been found that energy is related to growth, increasing energy supply in an energy hungry nation like Nigeria will have a positive influence on economic growth. Increasing energy supply should also involve optimal production and utilization. However, the Government should still sustain and enhance energy infrastructures because this does not only involve good maintenance practices of existing energy infrastructure but it also deals with ensuring that there is increase in such infrastructure through the issuance of licenses to the private sector for operation of such facilities and by reducing regulatory barriers even to long term capacity contracting. Also, natural gas infrastructures are required in the country to reduce natural gas flare. Availability of such facilities will increase the gas production and consumption and possibly growth.

Further more, the Government and the stake holder in the energy sector in Nigeria should increased research and development in the energy sector because there is need to increase research and development in the energy sector so that innovation can be fostered. Research and development into renewable sources of energy could be fostered and this could enhance economic growth. More over, diversification of energy sources should be the priority of the Government because Petroleum product has single handedly accounted for the majority share in energy production and consumption. Due to this, it has the ability to cause microeconomic volatility by halting major economic activities. Natural gas, coal and even ethanol could be used to serve as additions and backups in times of oil shortages.

Promotion of energy efficiency and conservation is also another area Nigerian Government should focus which will include education of the public on energy conservation and efficiency. It also involves a review and upgrade of energy efficient standards. By this we mean that buildings and appliances used in the country should have been of high standards such that it consumes the lowest quantity of energy possible. However, when energy prices are too high, then there is abuse of resource by the masses who cannot afford it and this might reduce consumption especially that of the low income class of people. More so, when prices are a bit too low there tends to be inefficient use of energy and Government should increased funding in the sector because it is certain that the energy sector is capital intensive and would require huge amount of investments. Towards this end, the public and private sector could form a partner partnership to tackle this investment problem. Also, government needs to increase the budgetary allocation to the sector and make the release of funds as fast as possible without delays.

Finally, from the study carried out, it would be wrong to conclude that there is no relationship between energy consumption and economic growth. The place of energy as a contributor to economic growth cannot be overemphasized. It is therefore paramount that such a sector is not neglected in the country. The government should ensure that energy supply is beefed up in diversity so that more economic activity can thrive. Energy is the vital backbone of an economy. Research and development backed up by energy efficiency will be beneficial to the nation. Also, increased investment will be needed to foster increased energy production. The private, public or a partnership project could be carried out to see to the increase in provision of energy. Government should still do more in the power sector because improvement has been seen in the recent time all over the country.

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