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Energy Consumption and Economic Growth in Nigeria: A Causality Analysis

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ABSTRACT

This paper attempts to investigate the relationship between total energy consumption and economic growth in Nigeria using Granger Causality. The two variables of the study – energy consumption and real GDP were found to exhibit unit root property, i.e. non-stationary. The study finds no clear relationship between energy consumption and economic growth. Real GDP was found not to cause energy consumption while energy consumption was also found not to cause real GDP. As astounding as this result may be, it portends potential policy implications for the economy including the need to implement policies that link energy consumption with growth generating activities.

Keywords: Energy consumption, Economic growth, Causality analysis, Cointegration, Stationarity, Nigeria.

1. INTRODUCTION

The Nigerian energy sector has experienced remarkable transformation since the country's independence in 1960. From nearly zero oil production in the early 1960's, Nigeria has become a major player in the international oil market by the turn of the New Millennium. While the discovery of oil and its exploration in commercial quantities has brought about unprecedented transformation in the structure of the economy, a myriad of problems continued to plague other sources of energy in the country. The power sub-sector has remained erratic for almost a decade with promises of massive increase in generation capacity from successive regimes in the country. Attempts at economically utilizing the huge flared gas in the country have not been commendable.

Overall, annual growth rate of total energy consumption (measured in Tonnes of Coal Equivalent-TCE) has been fluctuating since the 1970s with 28 percent and 38 percent recorded in 1976 and 1977 respectively and only 1 percent and 5 percent in 1985 and 2010. Negative annual growth rate of total energy consumption of -29 percent and -1 percent were actually recorded in 1995 and year 2000 respectively (Central Bank of Nigeria, 2010).

In spite of the fluctuations in the total energy consumption, the country has continued to record some reasonable progress from the perspective of economic growth as measured by the

growth rate in the real GDP which has consistently been above 6 percent in the last ten years. The non-congruence between total energy consumption and economic growth in the country portends a number of issues among which are: what is the exact relationship between total energy consumption and economic growth within the Nigerian context? Does high energy consumption cause economic growth or *vice-versa*? What are the factors contributing to growth when there is weak energy consumption and global economic recession?

This paper attempts to address the above issues/research questions. Specifically, the key objective of the study is to investigate the relationship between total energy consumption and economic growth in Nigeria. To achieve this objective, the study uses the Granger Causality Tests to identify the causal relationship between total energy consumption and economic growth in Nigeria. The knowledge of the relationship between total energy consumption and economic growth is important for policy makers as it will ensure the direction of energy consumption to growth enhancing activities. In addition, as a developing economy, the understanding of the relationship between energy consumption and economic growth will allow government to be able to insulate the economy against fluctuations in international energy prices. The rest of the paper is organized as follows: Section two presents the outlook of the Nigerian macroeconomy and the energy sector to provide the basic information necessary for the understanding of the relevance of the energy sector in the growth process of the economy. Section three provides a brief review of empirical literature on the nexus between energy consumption and economic growth. While section four discusses the results from the empirical analysis and their economic policy implications, the last section concludes the study and proffers few recommendations to bring about efficient and sustainable energy sector that is expected to further ensure rapid growth and development of the economy.

2. NIGERIA'S MACROECONOMIC AND ENERGY SECTOR OUTLOOK

The Nigerian economy witnessed remarkable changes in the last ten years. The pace of economic liberalization and financial sector reforms accelerated with significant impact on macroeconomic performance and the outlook of business operating environment. The liberalization of the telecom sector transformed the country into one of the fastest growing cellular telecommunication sectors in the world; and financial sector reforms led to almost ten-fold increase in bank capitalization within a very short period. The country has witnessed steady growth, stable exchange rate, moderate inflation, sustainable external debt, favourable external accounts and a stable external reserves position.

2.1. Macroeconomic Performance and Structure of the Nigerian Economy

The growth rate of Nigeria's real GDP has been remarkable in the last ten years. From 5.4 percent in 2000, real GDP growth rate increases steadily to 6.5 percent in 2005 and 7.0 percent in 2009 (Table 1). The growth in real GDP has been dominated by the performance of the non-oil sector. The real non-oil GDP grew by astounding 9.4 percent and 9.5 percent in 2006 and 2007 respectively. Higher economic growth has benefited from the improved macroeconomic environment, higher oil export receipts, and policy initiatives to spur agricultural production.

Year-on-year single digit inflation was recorded in 2006 and 2007 with threat from inflation posing challenges to monetary regulating authorities in the last three years. Nigeria's external reserves stood at US$51.3 billion and US$42.4 billion as at end 2007 and 2009 respectively. Another remarkable macroeconomic issue is in relation to the debt profile of Nigeria, especially as it relates to external debt. The debt cancellation agreement with the Paris Club crashed the ratio of Nigeria's total external debt to GDP from about 66 percent in 2000 to mere 2 percent in 2008 (Table 1). The Naira exchange rate has been relatively stable since 2005 except in 2008 when the currency experienced little appreciation against major World currencies.

Table-1. Nigeria Macroeconomic Indicators

	1990	2000	2005	2006	2007	2008	2009	2010
GDP (US$'billion)	32.0	46.0	98.6	144.5	176.8	191.8	170.3	196.2
Real GDP growth rate (%)	10.8	5.4	6.5	6.0	6.5	6.0	7.0	7.9
Growth of money supply M2 (%)	32.7	48.1	16.2	43.1	44.2	57.8	17.5	6.7
Inflation (%)	7.5	6.9	17.9	8.4	5.4	11.5	12.6	13.8
Total government expenditure (% of GDP)	15.9	25.7	18.9	18.7	35.4	34.88	29.98	32.77
Debt service (% of GDP)	4.3	6.9	16.8	4.5	9.3	7.6	8.9	6.9
Current account (% of GDP)	7.7	11.6	9.3	25.3	16.8	13.7	7.9	1.5
Total external debt (% of GDP)	106.5	66.1	20.8	3.0	2.1	2.0	2.4	2.4
Average exchange rate (N/US $)	8.04	101.7	131.3	128.7	125.8	118.5	148.9	149.7
Reserves including gold (US$ billion)	3.87	9.91	28.28	42.30	51.33	53.00	42.40	32.34

Source:CBN Annual Report and Statement of Account 2010 and Statistical Bulletin 2010

The structure of the Nigerian economy and its dichotomy has been significantly influenced by the emergence of oil and gas receipts as dominant source of revenue to the government. In the past two to three decades, the oil sector has been contributing an average of about 80 percent of total government revenue, 97 percent of total exports, and about 15 percent of real GDP. Agriculture remains the mainstay of the economy within the non-oil sector, contributing the largest share of non-oil GDP and occupying a pivotal role in poverty alleviation efforts. The agricultural sector contributed 34.7 percent and 40.4 percent to real GDP in 1981 and 1985 respectively. Its' average contribution to real GDP between 2006 and 2010 was about 42 percent. The share of non-oil sector in real GDP has remained significant with 86 percent and 84 percent recorded in 1981 and 2009 respectively.

Table-2. Share of Nigeria's Real GDP by Sectors (%)

Activity/ Sector	1981	1985	1990	1995	2000	2005	2006	2007	2008	2009	2010
Agriculture	34.7	40.4	39.0	38.8	37.88	41.21	41.7	42.0	42.1	41.7	40.9
Crude Petroleum	14.0	15.1	12.9	12.6	25.91	24.33	21.7	19.6	17.3	16.3	15.8
Mining & Quarrying	1.3	0.5	0.3	0.3	0.25	0.27	0.3	0.3	0.3	0.3	0.3
Manufacturing	9.9	8.6	8.5	6.6	3.44	3.79	3.9	4.0	4.1	4.2	4.2
Building & Construction	4.6	1.9	1.9	2.0	1.32	1.52	1.6	1.7	1.8	1.9	2.0
Wholesale & Retail Trade	13.0	13.0	12.7	12.2	13.04	13.64	14.9	16.2	17.4	18.1	18.7
Services	22.5	20.5	24.7	27.5	18.16	15.24	15.7	16.2	16.8	17.4	18.1
Total (%)	100	100	100	100	100	100	100	100	100	100	100
Share of NON-OIL	86.0	84.9	87.1	87.4	74.09	75.67	78.1	80.4	82.7	83.7	84.2

Source: Author's computations from CBN 2010 Statistical Bulletin

The weak state of the Nigeria's manufacturing sector is encapsulated in its share in real GDP that decreased from 8.5 percent in 1990 to 4.2 percent 2009 (Table 1). While the weak performance of the manufacturing sector could be attributed to the poor state of the power sector, a number of other challenges, ranging from intense competition posed by mass importation of goods from Asian countries and frequent trade and industrial policies changes continued to confront the sector in the last few years.

2.2 Nigeria's Demographic Trend and its Energy Demand Implication

Nigeria's 2006 National Census gave a population of 140.3 million with males and females sharing the same proportion of 50 percent just as revealed by the 1991 National Census..With this klevel of population, Nigeria remains the most populous country in Africa. The population is distributed between 46.1 percent Urban and 53.9 percent rural, with a density of 160.3 people per square kilometer. The current population of Nigeria, which is estimated at 157 million as at 2011, with an annual growth rate of 2.3 percent, portends significant implication for her energy demand. Nigeria's population currently ranks among the first ten largest in the world. As Nigeria's population is relatively young and the fastest growing among its peers, it is projected to reach 382 million by 2050, placing the country as the fourth largest in the world behind the United States, India, and China respectively. With the projected shrinking of South Africa's population from 44.3 million to 33 million between 2005 and 2050, Nigeria's population would be more than ten times that of South Africa and would be more than the combined population of Algeria, Egypt, Mexico, and South Africa by 2050 (Oshikoya, 2007). The Nigeria's demographic trends are expected to impact long-term economic development and the energy demand of the country.

2.3 Outlook of the Nigeria's Energy Sector

Numerous energy resources in the form of oil, natural gas, coal and hydroelectric potential abound in Nigeria. The country ranks the six highest producer of crude oil and has an unlimited supply of natural gas. The hydroelectric potential is largely supported by the Rivers Niger and Benue while numerous smaller rivers have remained untapped with attempts being made to ascertain the coal reserve, which is estimated at over 2 billion tonnes. In spite of this endowment, the country ranks among lowest in energy performance in terms of energy consumption, efficiency, accessibility and quality.

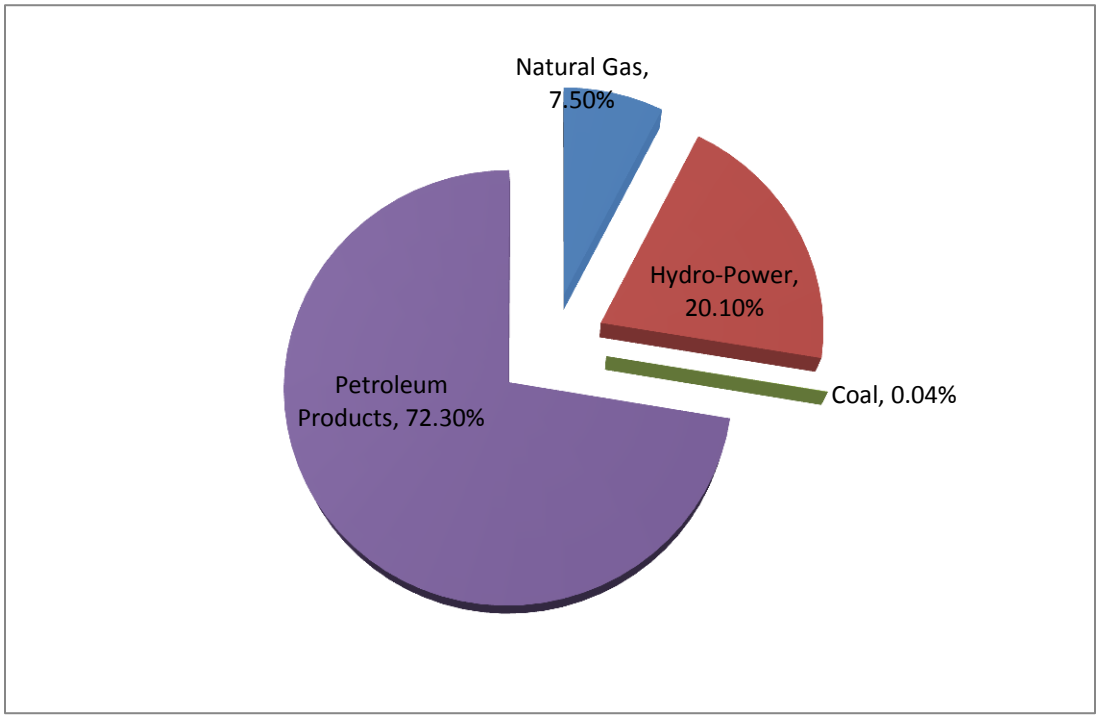
A key feature of the Nigerian energy situation is the wide gap between production and consumption. While Nigeria's primary total production of petroleum (crude oil and natural gas plant liquids), dry natural gas, and coal, and net generation of hydroelectric, nuclear, and geothermal, solar, wind, and wood and waste electric power increased from 4.1 Quadrillion Btu in 1990 to 6.5 Quadrillion Btu in 2005, its total primary energy consumption stood at 1.1 Quadrillion Btu in 2005 from a level of 0.7 Quadrillion Btu in 1990.According to the International Energy Agency (IEA), in 2008, Nigeria's total energy consumption was 4.4 Quadrillion Btu (111,000 kilotons of oil equivalent) (Energy Information Administration, 2011). Primary energy consumption comprises of consumption of petroleum, dry natural gas, and coal, and net

hydroelectric, nuclear, and geothermal, solar, wind, and wood and waste electricity as well as net electricity imports.

By 2009, Nigeria's energy consumption mix continued to be dominated by petroleum products (72.3 percent), followed by hydro-power (20.1 percent) and natural gas (7.5 percent). Though, the share of coal in total energy consumption has remained insignificant (0.04 percent), the recent increase in petroleum products prices that emanated from some proportional removal of subsidy has led to some observed increase in usage of coal for domestic energy consumption. It is important to note that nuclear and other renewable sources of energy have not been part of the country's energy consumption mix. Between 1984 and 2009, the share of petroleum products in Nigeria's energy mix decreased slightly from 77 percent to 72.3 percent. Natural gas consumption decreased from 18 percent to 7.5 percent during the same period while hydro-power experienced a significant increase in its share of total energy consumption from 5 percent in 1984 to 25.1 percent in 2009.

According to the *Oil and Gas Journal*, Nigeria had an estimated 37.2 billion barrels of proven oil reserves as of January 2011.

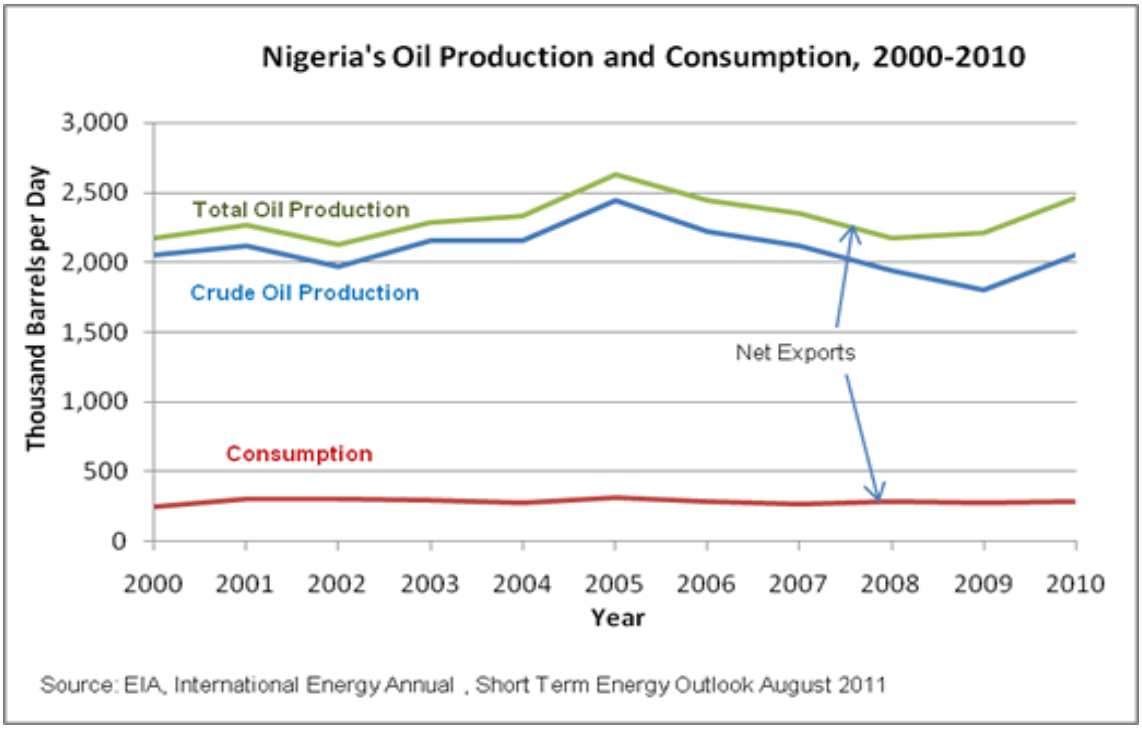
Figure-1. Total Energy Consumption in Nigeria, by type (2009)



Source: CBN Annual Report and Statement of Account 2010

In 2010, total oil production in Nigeria was about 2.46 million bbl/d, making it the largest oil producer in Africa with crude oil production averaging about 2.15 million bbl/d during the year (Energy Information Administration, 2011).

Figure-2. Nigeria's Oil Production and Consumption (2000-2010)



Nigeria had an estimated 187 trillion cubic feet (Tcf) of proven natural gas reserves as of December 2010, which makes the country the ninth largest natural gas reserve holder in the world and the largest in Africa.. In 2009, Nigeria produced about 820 Bcf of marketed natural gas and consumed about 255, mostly for electricity generation of which natural gas accounts for about 60 percent (Energy Information Administration, 2011). Due to lack of required infrastructure in the oil fields, Nigeria's gas is flared with 536 Bcf natural gas flared in 2010 – or about a third of gross natural gas produced in 2010 according to NNPC. In 2011, the NNPC claimed that flaring cost Nigeria US$2.5 billion per year in lost revenue (Energy Information Administration, 2011).

The Power sector is a critical infrastructure needed for the economic, industrial, technological and social development of any country. One of the indices for measuring the standard of living of a country is electricity consumption. In Nigeria, power sector was initially managed by the Power Holding Company of Nigeria (PHCN), formerly National Electric Power Authority (NEPA), as an integrated utility with generation, transmission and distribution all in the same organization. The national electricity grid presently consists of nine generating stations (3 hydro and 6 thermal) with a total installed generating capacity of 5906MW. The Transmission network is made up of 5000km of 330KV lines, 6000km of 132KV lines, 23 of 330/132KV sub–stations and 91 of 132/33KV substations.

Although the installed capacity of the existing power stations is 5906MW the maximum load ever recorded was 4,000MW. Presently, most of the generating units have broken down due to limited available resources to carry out the needed level of maintenance. The transmission lines

are radial and are overloaded. The distribution sub-sector requires upgrading as many of its distribution transformers are overloaded. The electricity network has been characterized by constant system collapses as a result of low generating capacity by the few stations in service.

As shown in Table 3, 46 percent of Nigeria's population had access to electricity in 2005, though better than Africa's 38 percent access, it is a far cry from 68 percent average for developing countries and 76 percent global access. North Africa's electrification access of about 96 percent represents the highest in the developing countries regional averages.

Table-3. Electricity Access in 2005: Regional Aggregates

	Population million	**Electrification Rate (%)**	**Urban Electrification Rate (%)**	**Rural Electrification Rate (%)**
Africa	891	37.8	67.9	19.0
North Africa	153	95.5	98.7	91.8
Sub-Saharan Africa	738	25.9	58.3	8.0
Nigeria	131.6	46.0		
Developing Asia	3418	72.8	86.4	65.1
China and East Asia	1951	88.5	94.9	84.0
South Asia	1467	51.8	69.7	44.7
Latin America	449	90.0	98.0	65.6
Middle East	186	78.1	86.7	61.8
Developing countries	4943	68.3	85.2	56.4
Transition economies and OECD	1510	99.5	100.0	98.1
World	6452	75.6	90.4	61.7

Source: World Energy Outlook, 2006

3. BRIEF LITERATURE SURVEY

The relationship between energy consumption and economic growth has been debated extensively in the literature, yet the direction of causality remains unresolved. The debate has focused mainly on whether energy consumption leads economic growth or lags it. Some studies confirm unidirectional causality running from GDP to energy consumption (Ghosh, 2002; Narayan and Narayan, 2005). Others find unidirectional causality running from energy consumption to economic growth (Altinay and Karagol, 2005). This shows that causal relationship between energy consumption and growth remains uncertain. A number of empirical studies have been carried out on the relationship between energy consumption and economic growth in developing countries, especially in Asian countries. Yu and Choi (1985) for Morimoto and Hope (2004) for Sri-Lanka among others. Most of these studies reported conflicting results of no causality, unidirectional and bi-directional causalities. .It is important to note that the conflicting evidences from the studies have been attributed to the methods and the data-generation process adopted by the researchers (Yu and Choi, 1985). According to the empirical literature analyzing causality between energy consumption and economic growth, when causality flows from energy to income, it implies that the economy is energy dependent and energy growth can be adversely affected by redistribution in energy consumption. When causality flows from income to energy, then an economy is relatively less dependent on energy and environmental

policies for energy conservation would have little or no impact on economic growth. Finding a bi-directional causality between energy consumption and economic growth suggests that energy and economic growth complement each other (Lee, 2005). There is paucity of research on energy consumption and growth in Nigeria despite the importance of this study in energy policy design. Majority of the study are conducted in Asia (Kraft and A., 1978; Yu and Choi, 1985).

4. EMPIRICAL ANALYSIS

The data used for this study are the real GDP and the total energy consumption for the period 1970 to 2010 sourced mainly from the CBN 2010 Annual Report and 2010 Statistical Bulletin. While real GDP requires no explanation except that 1990 was used as the base year for the entire data, energy consumption requires some explanation. Total energy consumption for Nigeria (measured in Tonnes of Coal Equivalent-TCE) for the period 2004 to 2010 was used in combination with the Index of Energy Consumption for the energy consumption used for the study. As is the case with similar studies, the Augmented Dickey-Fuller (ADF) and the Phillips-Perron tests were used to ascertain whether the two variables of the study exhibit unit root property. As shown in Table 4, the real GDP and energy consumption exhibited unit root process at various critical levels but mostly at the 0.01 levels, that is, they were found to be non-stationary.

Table-4. The Integration Tests Results

Variables	ADF	Phillips Perron	Decision
Lrgdp	1.037	0.307	I(1)
ΔLrgdp	-3.281*	-5.584**	I(0)
Lengcons	-1.961	-2.173	I(1)
ΔLengcons	-5.140**	-5.669**	I(0)

Note: (i) Lrgdp = Log of real GDP, Lengcons= Log of energy consumption

(iii) Critical values (1% and 5%); ADF and Phillips Perron (-3.61 and -2.89).

(iv) **(*) means significant at 1%(5)% level.

The results of the Granger Causality tests are contained in Table 5. It is astonishing to find that the two main causality null hypotheses of the study were accepted. Specifically, no clear relationship was found between energy consumption and economic growth. Real GDP was found not to cause energy consumption while energy consumption was also found not to cause real GDP. As astounding as this result may be, it portends potential policy implications for the country.

Table-5. Pairwise Granger Causality Tests Result

Null Hypothesis	F-Statistic	Probability	Decision
LRGDP does not Granger Cause LENGCONS	0.938	0.94	Accepted
LENGCONS does not Granger Cause LRGDP	0.084	0.92	Accepted

Note: (i) A probability value less than 0.05 implies the rejection of the null hypothesis at 5%.

(ii) Variables are as defined in Table 4

5. CONCLUSION AND RECOMMENDATIONS

This paper investigates the relationship between total energy consumption and economic growth in Nigeria using Granger Causality. An in-depth review of Nigeria's macroeconomic performance as well as the energy sector outlook was presented. The rapidly increasing population was identified as a major source of increasing energy demand. The study finds no clear relationship between energy consumption and economic growth. Real GDP was found not to cause energy consumption while energy consumption was also found not to cause real GDP. As astonishing as this result may be, it portends potential policy implications for the economy including the need to implement policies that link energy consumption with growth generating activities. In addition, there is a need to revamp the value-added components of energy consumption.

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