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The relationship between energy consumption and national income of Nigeria

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The purpose of this paper is to examine the causal relationship between energy consumption and National income of Nigeria. The importance of identifying the direction of causality emanates from its relevance in national policy-making issues regarding energy conservation. There are various evidences indicating some level of relation between national income and energy consumption of many countries: developed, developing, and third world alike. A relation that energy consumption enhances national income has been documented by Rakhshan for Canada, China, Japan (poor positive relation due to its efficient and successful energy conservation policy over the past decades), Iran, and Russia. More so, Amirat and Bouri found similar relation for Algerian Case. Also, Huang, Hwang, and Yang found no causal relationship between energy consumption and economic growth in the low income group whereas in the middle income groups, economic growth enhances energy consumption; and in the high income group countries, economic growth negatively affects energy consumption due to great environmental improvement impacts. On the other hand, a neutral relation between energy consumption and national income has also been verified to exist in Turkey according to Yalta's study. Therefore this paper evaluate the relationship between energy consumption and national income in Nigeria for the periods 1990 to 2010. Pearson correlation coefficient was used to determine the nature of the relationship that exist between energy consumption and national income while Granger causality test was employed to identify the direction of the relationship. The variables that were used include national income measured by GDP, energy consumption measured by its index, capital input and manufacturing capacity utilization. The energy combined includes coal, electricity (hydro-power), natural gas and petroleum products.

Key words: National income, energy consumption, economic growth.

INTRODUCTION

National income of any given country, in the words of Alfred Marshall, is the outcome of the activities undertaken by the factors of production using other natural resources in the production process measured in a given period of time. Therefore, the greater the activities efficiently undertaken the higher the national income that will result (Kuznets et al., 1941). The traditional Rostow's stages of growth theory emphasizes on the importance of the production technique (traditional or modern tools/equipment) as one of the major determinants of the developmental progress of the economy (Rostow, 1960). Thus, this is vividly demonstrated by the outcomes in the production sector since the industrial revolution of the 20th century.

However, energy has been the brain-box behind mass production since time immemorial. According to American Iron and Steel Institute (AISI) (2005), energy consumption in the steel industry entail both direct (iron- making)

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and indirect (mining, preparation, and transportation of raw materials). It found that the rate and quantum of steel production that take place in the industry makes the industry the largest energy consuming in the world.

As a result of its importance in production as well as in the domestic sector, world energy consumption has been on increase throughout the 20th century and is also projected to continue in the 21st century. According to European Union (2003), the picture of the world energy scene in 2030 mainly reflects an expanded vision of the current system; the world energy consumption is projected to increase by some 70% over the 2000 to 2030 period which implies an average increase of 1.8%/year as compared with 1.4%/year over the 1990 to 2000 period.

REVIEW OF RELATED EMPIRICAL LITERATURE

There are various evidences indicating some level of relation between national income and energy consumption of many countries around the world.

Fadavi et al. (2011) observed a ratio between net energy input and apple output to be 0.44 implying a positive relation between energy input and farm output. This means that one unit of energy yields about 2.5 units more of apple output compare to when no energy is used thereby improving income level of the farmers. While Koc and Kaplan (2007) evaluate the impact of energy consumption on yarn manufacturing systems and found a positive impact between energy consumption and yarn output.

A relation that energy consumption enhances national income has been documented by Rakhshan (2009) for Canada, China, Japan (poor positive relation due to its efficient and successful energy conservation policy over the past decades), Iran, and Russia. More so, Amirat and Bouri (2010) found similar relation for Algerien Case.

Huang et al. (2007) used a panel data and found in the low income group, there exists no causal relationship between energy consumption and economic growth; in the middle income groups, economic growth leads energy consumption positively; and in the high income group countries, economic growth leads energy consumption negatively due to great environmental improvement impacts.

Others contend that national income enhances energy consumption. Aqeel (2001) and Adnan and Riaz (2008) made the case for Pakistan both in the short and long run. Also, Noor and Siddiqi (2010) carried out study on five South Asian countries (Bangladesh, India, Nepal, Pakistan, and Sri Lanka) and found national income (economic growth – GDP) inducing energy consumption in the short-run while energy consumption negatively affect national income in the long-run partly due to energy crisis and partly due to inefficiency. On the other hand, a neutral relation between energy consumption and national income has also been verified to exist: Yalta (2011) used “maximum entropy bootstrap for Turkey” and found no causal direction between energy consumption and national income.

Jaruwan et al. (2006) used Granger causality test to evaluate the relationship between energy consumption and GDP using a consistent data set for 30 OECD and 78 non - OECD countries and found a prevalent bi-directional relationship between energy consumption and GDP in developed OECD countries. The paper concluded that any policy to reduce energy consumption aimed at reducing emissions is likely to have greater impact on the GDP of the developed countries rather than the developing OECD countries (Jaruwan et al., 2006).

Kamal (2008) carried out a study on the causal relationship between energy consumption and economic growth in Nepal and used a time series data on total commercial energy consumption and real GDP over the period 1980 to 2004. He applied co-integration and vector error model and found that there is a unidirectional causality running from coal, oil and commercial energy consumption to per capita real GDP whereas a unidirectional causality running from per capita real GDP to per capita electricity consumption is found. He suggested that the input of per capita energy consumption stimulates enhanced economic growth in Nepal (Kamal, 2008).

Qiang (2009) considered China's economy and examined the relationship between energy consumption growths and economic growth using updated data of GDP and energy consumption from 1953 to 2006. He applied the techniques of ADF, co-integration, Hsiao's granger causality test and found that economic growth granger causes energy consumption and energy consumption granger causes economic growth respectively. He recommended that since China is a big energy consumer agent, which has a huge gap between energy supply and demand. Rates of taxes and price of energy should be enhanced and sensitize the general public on saving energy, improve the exploitation efficiency (Qiang, 2009).

Given that the nature of relation between energy consumption and national income differ among countries, and few existed for the Nigerian case; this paper aim to investigate the kind of energy consumption and national income relationship in Nigeria.

MATERIALS AND METHODS

This paper used Pearson correlation coefficient to determine the nature of relation between energy consumption and national income and Granger causality test to identify the direction of such relationship. The correlation coefficient used in this study is the common statistics and since the aim is to determine the linear relation; it best fit the study. Hence, it is useful to know the extent of the relationship from its nature which called for the Granger causality test in this paper. Given this statistical analytical tool background, time series data is used between 1991 and 2010. Variables included are national income measured by GDP, energy

Table 1. Correlation matrix.

	ECI	NI	MCU	CI
ECI	1			
NI	0.7973	1		
MCU	-0.0006	0.0268	1	
CI	0.7118	0.9680	-0.0013	1

Table 2. Pairwise Granger causality tests.

Sample: 1991- 2010
Lags: 3

Null hypothesis	Obs	F-statistic	Probability
NI does not Granger Cause ECI	17	2.40263	0.12847
ECI does not Granger Cause NI		3.90837	0.04386
MCU does not Granger Cause ECI	17	3.31952	0.06512
ECI does not Granger Cause MCU		3.60936	0.05341
CI does not Granger Cause ECI	17	0.49125	0.69619
ECI does not Granger Cause CI		0.28146	0.83765
MCU does not Granger Cause NI	17	9.28854	0.00307
NI does not Granger Cause MCU		1.38019	0.30478
CI does not Granger Cause NI	17	0.07876	0.97006
NI does not Granger Cause CI		1.57740	0.25565
CI does not Granger Cause MCU	17	2.21153	0.14964
MCU does not Granger Cause CI		0.60495	0.62661

consumption measured by its index, capital import, and manufacturing capacity utilization. The energy combined includes coal, electricity (hydro – power), natural gas, and petroleum products. Hence, energy consumption index, manufacturing capacity utilization and national income measured by GDP were measured in 1990 base year. Rule of Thumb was used for the interpretation of causality test performed, when the value of F-statistics ≥ 3.6 and/or Probability value ≤ 0.05.

The rationale for the inclusion of these variables is to identify the implication of whatever relation that may exist between energy consumption and national income. Both manufacturing capacity utilization as well as capital import will enable us determine whether the Nigerian economy is a productive or consuming economy.

RESULTS AND DISCUSSION

Five variables were examined for the nature and extent of relationship that may exist between energy consumption and economic growth in Nigeria. The result from the application of E – views software is thus presented in Table 1.

From Table 1, there exists weak negative relationship (-0.0006) between energy consumption and manufacturing capacity utilization on one hand and a weak positive (0.0268) relationship between national income and manufacturing capacity utilization on the other hand. More so, a weak negative relationship (-0.0013) also exists between manufacturing capacity utilization and capital import. Table 1 also indicates a strong positive relation (0.7973) between energy consumption and national income as well as between energy consumption and capital import (0.7118) and between national income and capital import (very strong, that is 0.968).

However, the direction of relation and the extent of impact will be determined by Granger causality test in the next section.

Test for Granger causality

Given that Pearson's correlation coefficient revealed both positive (energy consumption and national income; energy consumption and capital import; national income and capital import; and national income and manufacturing capacity utilization) and negative (energy consumption and manufacturing capacity utilization; and capital import and manufacturing capacity utilization) relations, the kind of relation is important for every policy making process in Nigeria.

Table 2 showed the result for Granger causality test based on three lags. Using 17 degree of freedom and 0.05 for probability values, the hypothesis that national income does not Granger causes energy consumption is

Table 3. Data set for the study.

Year	Energy consumption index	GDP by Income	Manufacturing capacity utilization	Capital import
1991	91.5	328.6	109.3	17.9
1992	91.5	337.3	112.2	62.2
1993	127.1	342.5	89.3	74.6
1994	107.4	345.2	89.5	46.2
1995	76.2	352.6	83.7	206.9
1996	74.3	367.2	85.1	129.4
1997	78.7	377.8	85	203.0
1998	97.7	388.5	81.7	196.0
1999	89.7	393.1	84.5	204.4
2000	89.2	412.3	84.8	234.1
2001	169.2	431.8	84.5	327.2
2002	170.7	451.8	89.8	378.8
2003	171.2	495.0	90.3	498.8
2004	175.7	527.6	89.4	458.9
2005	176.7	561.9	89.4	613.4
2006	170	595.8	89.4	680.8
2007	169.2	634.3	89.2	856.7
2008	177.5	672.2	91.2	1,141.8
2009	174.2	719.0	92.4	1,137.8
2010	179.1	775.4	93.7	1,777.2

Sources: CBN, 2007, 2010a,b.

accepted as the probability value is greater than 0.05 (that is 0.13) while the second hypothesis that energy consumption does not Granger Causes national income is rejected based on the fact that the probability value is less than 0.05 (that is 0.04). This implies a unidirectional relationship running from energy consumption to national income.

Also, the hypothesis that manufacturing capacity utilization does not Granger causes energy consumption is rejected as the probability values were greater than 0.05 (that is 0.07) while the other hypothesis that energy consumption does not Granger causes manufacturing capacity utilization is accepted given that the probability value is not greater than 0.05 but equal to it. The implication being that even if energy is available for the manufacturing activities, its cost should not be too high to erode the underlying principle of business operations (profit maximization) and efficiency issues.

With regard to null hypothesis that capital import does not Granger causes energy consumption as well as the hypothesis that capital import does not Granger causes energy consumption were both rejected on the basis that both probability values were greater than 0.05 (that is 0.70 and 0.84 respectively).

While the hypothesis that manufacturing capacity utilization does not Granger causes national income is rejected as the probability value is less than 0.05 (that is 0.003) the other hypothesis that national income does not Granger causes manufacturing capacity utilization is accepted as the probability value is greater than 0.05 (that is 0.30).

The null hypotheses that capital import does not Granger causes national income as well as national income does not Granger causes capital import; capital import does not Granger causes manufacturing capacity utilization and manufacturing capacity utilization does not Granger causes capital import were rejected as their probability levels were greater than 0.05 (that is 0.97, 0.26, 0.15, and 0.63 respectively).

Conclusion

From the empirical evidences, the paper found a strong positive relation between energy consumption and national income and it is energy consumption that Granger causes national income for the period (1991 to 2010) under study (Table 3). The paper also found energy consumption to Granger causes manufacturing capacity utilization as well as manufacturing capacity utilization Granger causing national income. In addition, the Nigerian economy is also found to be a consuming nation rather than producing economy as negative relationship was found to exist between energy consumption and manufacturing capacity utilization as well as between energy consumption and capital import. Hence, there exist strong positive relation between energy consumption and national income and a

unidirectional causation running from energy consumption to national income.

The paper concluded therefore that for greater national income attainment in Nigeria, policies should be directed at enhancing efficient manufacturing capacity utilization which has tremendous impact on national income.

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