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Aggregate Energy Consumption and Sectoral Output in Nigeria

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Abstract

This study examined nexus between aggregate energy consumption and sectoral output in Nigeria for the period spanning 1980 to 2010. Utilizing a bi-variate Vector Auto-regressive (VAR) model, the study observed bi-directional causality between aggregate energy consumption and agricultural output while a unidirectional causality was found from service output to aggregate energy consumption. The concluded that the nexus between energy consumption and output of individual sectors of the economy are different and therefore recommended sector specific energy policies rather the one fit-for-all policy. Also, energy conservation policies would be

harmful to the productive activities of agricultural and service sectors of the Nigerian economy.

Introduction

Issues on energy consumption and economic growth nexus have figured prominently in the energy literature since the seminal study by Kraft and Kraft (1978). Subsequently, studies in both developed and developing countries have been conducted on aggregate energy consumption-economic growth nexus but their findings have been inconsistent. While some reported unidirectional causations: from aggregate energy consumption to economic growth (Akinlo, 2009; Narayan and Singh, 2007; Altinay and Karagoal, 2005); or from economic growth to aggregate energy consumption (Binh, 2011; Yoo and Kim, 2006; Kraft and Kraft, 1978), others have observed bidirectional causality between the variables (Kaplan et al, 2011; Chen et al, 2007). Yet, a few have equally reported the absence of causality between the variables (Ghaderi et al, 2006; Zou and Chau, 2006). Beyond focusing on the nexus between aggregate energy consumption and economic growth, studies have also examined the nexus between disaggregate energy consumption and economic growth (see Ogunleye and Ayeni, 2012; Aliero and Ibrahim, 2012; Omisakin, 2008). Apart from the above, a few studies (such as Liew et al, 2012; Chebbi and Boujelbere, 2008) have examined the nexus between aggregate energy consumption and sectoral output. Liew et al (2012) noted that there exist different directions of causality between aggregate energy consumption and the output of different sectors. According to Liew et al (2012), the worth of this research is that energy-dependent sectors of the economy can be recognized for appropriate energy policy implementation and to avoid energy conservation policies that may retard the growth of these sectors. However, with respect to the Nigerian economy, there exists a paucity of knowledge on the nexus between aggregate energy consumption and sectoral output. This issue has been utterly neglected by previous endogenous studies which have mainly focused on aggregate energy consumption-economic growth nexus (see Aliero and Ibrahim, 2012; Omisakin, 2008) and on disaggregate energy consumption-economic growth nexus (see Ogunleye and Ayeni, 2012; Akinlo, 2009). This neglect has strong policy implications for the Nigerian economy. For instance, the Nigerian economy has witnessed a sustained growth of about 6.5 percent since 2001, which in no doubt is a consequence of growth in some sectors of the economy. The increase in sustained growth over this period may also imply increased energy consumption in these sectors. Therefore, it is pertinent to explore the nexus between aggregate energy consumption and sectoral output in order identify sectors of the economy that are energy dependent and also to avoid energy conservation policy that might be injurious to the growth of these sectors in particular and economic growth. Apart from the above, an empirical analysis of this issue is equally appropriate now that the Federal Government is making concerted efforts to address the energy supply challenges in Nigeria, especially in an attempt at actualizing the 2011-2015 transformation agenda of the current administration and the desire to make the Nigerian economy one of the top 20 economies in the world by 2020. Without a doubt, the finding on the nexus between aggregate consumption and sectoral output is very central to addressing these challenges.

Given the above, there is the need for a sector specific analysis to ensure sectoral-purpose driven energy policies. Thus, this study follows studies by Liew et al, (2012) and Chebbi and Boujelbere, (2008) in examining the causal nexus between aggregate energy consumption and sectoral output in Nigeria over the period 1980 to 2010.

Literature review

While plethora of literature exists on energy consumption-economic growth nexus, a few of the studies that have focused on aggregate energy consumption and sectoral output are revealed herein. Liew et al (2012) analyzed the interdependence relationship between energy consumption and sectoral outputs in Pakistan for the period 1980 to 2007. The study utilized the Johansen-Juselisus co-integration approach and the Granger causality test. The co-integration estimate revealed that energy consumption exhibited long-run relationship with the agriculture as well as with services output. However, there is no evidence of long run relationship was observed between energy consumption and industrial output. Furthermore, the causality estimate revealed a bi-directional causal relationship between energy consumption and agriculture output while a unidirectional causation was observed from services and industrial output to energy consumption.

Chebbi and Boujelbene (2008) examined the co-integration and causal nexus between energy consumption and sectoral output in Tunisia for the period 1971 to 2003. The sectors covered included agricultural; manufacturing, and services sector as well as the overall gross domestic product. Utilizing the Johansen’s co-integration technique and the Vector Error Correction Model

(VECM), the study observed that the various sectors (agriculture, manufacturing and service) and overall gross domestic product are co-integrated with energy consumption. This implies that there exists a long run relationship between the various output and energy consumption. The VECM estimate observed that there exists unidirectional causality, running from the different sectors to energy consumption, as well as from overall GDP growth to energy consumption. The study concluded that causality estimate signified a less energy dependent economy and suggested that it is sectoral growth that drives the energy consumption in Tunisia and not vice versa.

Research methodology

Data measurement and sources

This study examined a one-to one nexus between aggregate energy consumption and the output of the various sectors of the Nigerian economy. Data on aggregate energy consumption (AEC) and the outputs of the five sectors of the Nigerian economy namely; agriculture (AGR), manufacturing (MAN), building and construction (BOC), wholesale and retail (WOR) and the service (SER) are obtained from the Central Bank of Nigeria (CBN) statistical bulletin 2010 edition. All the variables are transformed into logarithms form.

Model specification

Since the focus of this study is to examine a one-to-one causal nexus between aggregate energy consumption and sectoral output, this study employed a bi-variate granger causality technique. The appropriate specification of the model (that is, whether in VAR or VECM) depends on the status of the unit roots of the variables and also on the existence of co-integration between the variables. If the variables are not co-integrated, then a VAR model specified of equations (1) and (2) is utilized.

$$Y_t = \sum_{i=1}^{n} \alpha_{11} Y_{t-i} + \sum_{i=1}^{n} \alpha_{12} X_{t-i} + u_{1t} \qquad (1)$$

$$X_t = \sum_{i=1}^{n} \alpha_{21} Y_{t-i} + \sum_{i=1}^{n} \alpha_{22} X_{t-i} + u_{2t} \qquad (2)$$

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Where Y_t refers to sectoral output (AGR; MAN; BOC; WOR and SER) and X_t refers to aggregate energy consumption (AEC). On the other hand, if the variables are co-integrated then, the VAR model must include an error correction term. Engel-Granger (1987) cautioned that the Granger causality test, which is conducted in the first differences of variables through a vector auto-regression (VAR) is misleading in the presence of co-integration. Therefore, an inclusion of an additional variable to the VAR system, such as the error correction term would help capture the long run relationship among the variables (Nwosa, 2012). To this end, an augmented form of causality test involving the error correction term is formulated in a bi-variate *pth* order vector error-correction model (VECM) as follows (Ferda, 2007).

$$\begin{bmatrix} \Delta Y_t \\ \Delta X_t \end{bmatrix} = \begin{bmatrix} \varphi_{10} \\ \varphi_{20} \end{bmatrix} + \sum_{i=1}^{p} \begin{bmatrix} \alpha_{11} & \alpha_{12} \\ \alpha_{21} & \alpha_{22} \end{bmatrix} \begin{bmatrix} \Delta Y_{t-i} \\ \Delta X_{t-i} \end{bmatrix} + \begin{bmatrix} \lambda_1 \\ \lambda_2 \end{bmatrix} \left[ECT_{h,t-1} \right] + \begin{bmatrix} u_{1t} \\ u_{2t} \end{bmatrix} \ldots\ldots\ldots\ldots\ldots (3)$$

where $ECT_{h,t-1}$ is the error correction term, the residual from the *h*th co-integration equation lagged one period.

Empirical result

Unit Root Test

This study commence it empirical analysis by first testing the properties of the time series, used for analysis. The stationarity tests on the variables were carried out using both the Augmented Dickey-Fuller (ADF) and the Phillip-Perron tests and the result are presented in table I (see appendix). From the table and using the ADF test estimate on the left hand of the table it was observed that Iboc, Iser, and Iaec were integrated of order one, that is, 1(1) while lagr and lwor were integrated of order zero, that is, I(0). With respect to variable lman, the ADF and PP tests give conflicting results on the order of integration. While the ADF test indicated that the variable is integrated of order two (that is I(2)), the PP test showed it to be integrated of order zero (that is, I(0)). However, for the purpose of this study, the variable lman, would be treated as an I(0) variable, in line with the Phillips-Perron estimate. With respect to other variables, the findings of the ADF test is confirmed with that of the Phillip-Perron result on the other column (right hand) of table I (see appendix).

Co-integration

Having confirmed the stationary status of the variables, the study proceeded to examine the existence of co-integration between the pair of variables via the Engel-Granger co-integration techniques. The Engel-granger technique is observed to be most suitable for testing co-integration between two variables as against the Johansen co-integration test which is adopted when the model is a multi-variate given the possibility of having more than one co-integrating vector. Since this study only considers two-variable scenarios (such as aggregate energy consumption and sectoral output) then the problem of multi co-integration does not exist (Nwosa, 2012). The co-integration estimate is presented on table II (see appendix).

From the table, it is observed that the Engel-Granger tua-statistics and z-statistics clearly showed that all pairs of variables were not co-integrated. This is because the z-statistics for all pairs of variables unanimously failed to reject the null of no co-integration at 5% level. However, the results for the tua-statistics were mixed, with the residuals from the lagr, lman and lwor equations rejecting the null of no co-integration at the 5% level. Given this mix, the test statistics suggest that we cannot reject the null hypothesis of no co-integration between aggregate energy consumption and output of the various sectors. The implication of the above is that there exist no co-integration (long run) relationship aggregate energy consumption and output of individual sectors of the Nigerian economy.

Causality Estimate

Consequent to the absence of co-integration between aggregate energy consumption and the output of each sectors, the bi-variate VAR causality model of equations (1) and (2) is used to examine the causal nexus between aggregate energy consumption and sectoral output. The result is presented on table III (see appendix). From table III, it is revealed that the null hypothesis that aggregate energy consumption (laec) does not granger-cause manufacturing output (lman), building and construction output (lboc) and wholesale and retail output (lwor) could not be rejected at 5% significance level. This simply indicates that there exist no evidence of causality from aggregate energy consumption to the outputs of the aforementioned sectors of the economy and no feedback was observed. Using the F-statistics and the probability values, the causality estimate revealed a unidirectional causality from service output (lser) to aggregate energy consumption (laec) and no evidence of feedback was observed. This simply implies that increased service output lead to increased aggregate energy consumption. Furthermore, the causality estimate revealed a bi-directional causation between aggregate energy consumption and agricultural output. This implies that increased agricultural output leads to increased energy consumption while increased energy consumption also leads to increase in agricultural output.

Conclusions and policy recommendations

This study examined a one-to-one causal nexus between aggregate energy consumption and sectoral output in Nigeria for the period covering 1980 to 2010. Given the result of the unit root test and the Engel and Granger co-integration estimate, it was revealed that the variables were not co-integrated. Consequently, the causality nexus between the pair of variables were analyzed using the bi-variate VAR granger causality approach. Base on the analysis, it was revealed that bi-directional causation exists between aggregate energy consumption and agricultural output while a unidirectional causation was found from service output to aggregate energy consumption. The findings of the study therefore confirmed our argument at the introductory section that the nature of causality between aggregate energy consumption and individual output of the sectors of the economy may be different. Base on these findings this study recommends that energy policy should be sector specific rather than a one fit-for-all energy policy. Also, energy conservative policies would be harmful to the productive activities of agricultural and service sectors of the Nigerian economy.

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Appendix

Table I: Unit Root Test

Augmented Dickey-Fuller (ADF) Test				**Phillip-Perron (PP) Test**		
Variables	Level	1st / 2nd Diff	Status	Level	1st /2nd Diff	Status
lagr	-4.7868*	-	I(0)	-4.2074	-	I(0)
lboc	-1.0251	-9.8655*	I(1)	-1.1104	-7.7208*	I(1)
lman	-1.10898	-13.1683*	I(2)	-4.0492*	-	I(0)
lser	-2.3983	-19.4817*	I(1)	-2.3577	-15.0173*	I(1)
lwor	-3.0794**	-	I(0)	-2.9843**	-	I(0)
laec	-1.6742	-5.8893*	1(1)	-1.6742	-5.8764	I(1)

Note: *=1% and **=5% significance level.

Table II: Engel-Granger Co-integration Estimate Total Energy Vs Sectoral Output

Dependent Variables	tua-statistics	z-statistics
Laec	-2.2429 (0.4171)	-7.7984 (0.4600)
Lagr	**-5.3562 (0.0008)***	-12.7123 (0.1600)
Laec	-2.3710 (0.3578)	-8.1207 (0.4337)
Lman	**-5.0953 (0.0014)***	-15.2476 (0.0826)
Laec	-2.4752 (0.3127)	-10.5569 (0.2644)
Lboc	-2.0940 (0.4895)	-8.7063 (0.3880)
Laec	-2.2225 (0.4268)	-7.8540 (0.4554)
Lwor	**-3.6286 (0.0423)***	-9.6796 (0.3190)
Laec	-2.1927 (0.4411)	-7.8245 (0.4579)
Lser	-2.9681 (0.1633)	-7.0431 (0.5249)

Note: values in () are probability values while
*/** implies 1/5 percent significance value respectively.

Table III: Causality Estimates between Total Energy Consumption and Sectoral Output

H_0	F-Stat(Prob Value)	Conclusion
lser→ laec	**3.6074 (0.0427)***	Unidirectional causality from lser → ltec
laec→ lser	2.0757 (0.1474)	No causality from ltec→ lser
lagr→ laec	**4.0825 (0.0298)****	Bidirectional causality between lagr and ltec
laec→ lagr	**7.7821 (0.0025)***	
lman→ laec	1.4313 (0.2587)	No causality from lman → ltec
laec→ lman	0.1604 (0.8527)	No causality from ltec→ lamn
lboc→ laec	2.4182 (0.1105)	No causality from lboc → ltec
laec→ lboc	0.0918 (0.9127)	No causality from ltec→ lboc
lwor→ laec	2.4474 (0.1078)	No causality from lwor→ ltec
laec→ lwor	1.2537 (0.3035)	No causality from ltec→ lwor

Note: * implies significant at 1 percent level