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Energy consumption and economic growth nexus: Evidence from sectoral analysis in Nigeria (1981-2019)

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Abstract
Energy consumption and economic growth have been widely discussed at the aggregate level in literature. Notably, little emphasis has been placed on sectoral analysis. This study examines the energy-growth nexus at the sectoral level to avoid the aggregation problem associated with previous studies. It adopts time series data for the period 1981-2019, which were sourced from the Central Bank of Nigeria's Statistical Bulletin (2021) and the World Development Indicators (WDIs, 2020). Autoregressive distributed lag (ARDL) and fully modified ordinary least squares (FMOLS) techniques were adopted for short and longrun analyses. The results of the short-run analysis show that energy consumption is positively significant with agricultural sector output, while the reverse outcome was obtained for the construction sector. The long run results show that energy consumption is positively and significantly related to all sectors save for trade and services. This study identifies the agricultural, crude petroleum and mining, manufacturing, and construction sectors as growth catalysts for the Nigerian economy. Therefore, it is recommended that the government pursuean energy development agenda through the diversification of energy sources and ensuring that adequate energy is allocated to productive sectors.

Key words: Energy Consumption, Economic Growth, Sectoral Performance.

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I. Introduction

The omission of energy variable among growth enabling factors by the mainstream economists has been criticized by the resource and ecological economists, who view energy as the major driving force for economic growth (Stern, 2011; Ayres, 2016). Despite the neutral view of the mainstream economic theories on energy and growth nexus, evidence from empirical investigations shows the existence of cause and effect relationship between the variables (Kraft & Kraft, 1978; Abokyi, Apphiah-Konadu, Sikayena&Oteng-Abaiye, 2018; and Fatima, Ahmad, Jabeen& Li, 2019). Evidence has also shown that since the economic transition from agricultural to the industrial revolution and thereafter, energy has played critical role in driving economic growth (Stern &Kander, 2012). Furthermore, the growth of the developed countries and the newly industrialized economies (the NICs) have been found to covariate with increase in energy production and consumption (WDIs, 2020).

The relevance of energy to the growth rate of an economy is one of the most researched areas in energy economics. Many studies have attempted to verify the claim that energy has been unduly underplayed among the growth enabling factors. As a result, a wealth of empirical studies have been launched with various outcomes on the role of energy in economic growth. Although, the divergent results could be blamed on varying data quality across countries, data generating process, the variation in methodologies, among others, there is no study in the recent time that has refuted the claim on relevance of energy in spurring economic growth. As observed, more studies on energy-growth nexus have focused on the aggregate analysis on energy-growth relation [Asafu-Adjaiye (2000); Toman and Jemelkova (2003); Yoo (2005); Altinay and Karagol (2005); Ogundipe and Apata (2013); Dada (2019); Amir, Al Kabir and Khan (2020)]. However, the outcomes of these types of study have generated little or no relevance in local policy formulation. This is majorly because of aggregation problem and fallacy of decomposition (Chinedum&Nnadi, 2016). The duo opine that the growth of an economy is as a result of the activities of various sectors, which have different energy requirements. For instance, when energy variable is equally provided to all the sectors in an economy, economic activities will take place through production of goods and services. Distribution takes effect thereafter; all factors of production receive their rewards, which are aggregated in the national income. Thereafter, the national output is weighed in response to the previous year's output, and a seeming increase is recorded. This scenario has been the trend across countries and regions, where aggregate analysis on energy-growth nexus has been carried out.

Sadly, the energy consuming requirement of each sector, and their respective ability to spur growth is obviously erased by the aggregation problem. This could be identified as one of the reasons while recommendations provided by aggregate studies have generated the lowest impact in developing countries despite access to quality international data on local economy.

In the case of Nigeria, the literature has identified two critical problem areas. One, unavailability of energy. Two, equal allocation of energy to all sectors without considering sectoral energy requirements [Nwakwo and Njogo (2013), Chinedum and Nnadi (2016), Isaac, Nwedeh, Adenikinju and Abonyi (2021)]. The two identified problems, if added to aggregation problem by studies will only classify the research efforts and the resources that go into it as mere academic exercise with zero relevance for the local economy. In the face of erratic power supply, rising energy cost, and poor development of the energy sector in Nigeria, output of the sectors remains shamefully low in spite of growing population and the associated growing demands for consumables. A quick examination of Nigeria's sectoral contribution to GDP for 1981-2019 points to weak sectoral activities. Table 1.1 shows that the percentage contributions of each sector to national output, which depicts a turbulent rise and fall across the period, while energy consumption data has trended upwards for the whole period. The data evidence raise a concern on the amount of energy that goes to the productive sector, in spite of increasing energy production in Nigeria.

Table 1.1: Share of Key Sectors Contributions to Nigeria's GDP and Energy Consumption between 1981 and 2019

Sectors/Time Period	1981-1985	1986-1990	1991-1995	1996-2000	2001-2005	2006-2010	2011-2015	2016-2019
	%	%	%	%	%	%	%	%
Agriculture	15.20	20.60	23.20	27.00	30.40	25.60	21.20	21.25
Crude Petroleum & Mining	6.59	9.35	12.77	14.46	12.48	13.28	12.77	8.54
Manufacturing	20.56	19.74	18.39	13.31	10.28	7.50	9.30	10.54
Construction	5.40	3.40	2.60	2.00	2.00	2.40	3.40	4.75
Trade & Services	52.60	46.40	43.00	43.20	44.80	51.20	53.40	54.75
Energy Consumption (Kg of oil equivalent in billion)	54.40	61.70	72.10	80.97	97.69	112.06	134.03	151.67

Source: CBN Statistical Bulletin, 2021 and World Development Indicators (WDI, 2020)

In view of the foregoing, this study seeks to contribute to the literature by obtaining sectoral evidence on the effect of energy consumption on the output performance of the key sectors of the Nigerian economy. The study, unlike the previous studies will decompose aggregate energy consumption and other relevant variables into sectoral components using non-parametric Index Decomposition Analysis (IDA) by Ang and Zhang (2000). This is in a bid to ascertain the energy consumption by sectors to be able to effectively gauge the energy-sectoral output relation. The outcome of the study will assist policy makers in identifying the sector of the economy that is more responsive to energy consumption, which could be identified as the growth catalyst. The other parts of this paper are structured in the following manner: section 2 presents the literature review, section 3, the methodology; section 4, the presentation of empirical findings and discussion, while section 5 concludes the paper.

II. Literature Review

In this section, a quick consideration is given to theoretical and empirical review of the literature, in order to properly situate this study in the body of knowledge.

2.1.1 Review of Theoretical Literature

This works adopts Solow's (1957) neoclassical growth model, though, there are many theoretical postulations explaining the dynamics of economic growth. In particular, the theory sees the long run growth of an economy as a consequence of total saving, which enables capital accumulation; effective labour force; and technological progress. The choice of the neoclassical theory is based on its recognition of the role of capital alongside augmented labour in the production function. As such, energy variable can enter the production function directly or indirectly through enhancing the operational performance of plant and equipment (by aiding the functionality of capital stock for optimum performance, increased efficiency and enhanced output). Although, none of the earliest theories of economic growth explicitly considered the role of energy in production and growth, a wealth of empirical evidences have established the critical role that energy plays in production and by extension, in economic growth. Moreover, results obtained from empirical studies have further established correlation between wealth creation and electricity use [Ghosh (2002); Morimoto and Hope (2004); Narayan and Smyth (2005); Yoo (2005); Wolde-Rufael (2009); Makala and Zongmin (2020)].

2.1.2 Empirical Literature Review

From the body of the literature, the nexus between energy (supply and consumption) and economic growth has been observed to have featured in many research studies. From developed countries to developing and underdeveloped ones, energy-growth relationship has become important subject in explaining the dynamics of economic growth (Abosedra, Dah & Gosh, 2009; Narayan & Singh, 2007; Yuan, Zhao, Yu, Hu, 2007). In Nigeria, however, many studies on energy-economic output relationship have pointed out the role of energy, though, they all observe the erratic nature of power supply and how it impedes the growth of the Nigerian economy. Gbadebo and Okonkwo (2009) adopt error correction mechanism model and cointegration test on a data set of 1970 to 2005 for Nigeria and find that coal was positively related to economic growth, whereas, crude oil and electricity inversely relate to growth. In a similar study, Ogundipe and Apata (2013) adopt Vector Error Correction Mechanism (VECM) model and pairwise Granger Causality and establish long run cointegration between energy and growth variables. This outcome is contrary to the findings of Ogundipe, Akinyemi and Abalaba (2016), who adopt cointegration analysis in line with Johansen and Juselius Maximum Likelihood, and VECM. Their study could not find long run relationship between energy and growth variables. A similar study by Bernard and Adenuga (2016) adopts error correction mechanism on a data over the period of 1980 to 2013 and establish that energy positively relates with industrial performance in Nigeria.

While the energy-growth relationship at the aggregate level has been examined by many studies, little efforts have been made at the disaggregate level (Chinedum&Nnadi, 2016). As noted from the literature, the relationship of energy consumption with the performance of the various sectors of the economy have not only been neglected but the few studies on it have also yielded conflicting results. For example, Ibrahiem (2018) examined the linkage between energy and sectoral output in Egypt. The study adopts Johansen cointegration test, vector error correction mechanism model, and Toda-Yamamoto on time series data for the period of 1971-2013. The study considered energy-growth relationship at both aggregate and disaggregate levels. At the aggregate level, the study establish a co-movement between real output and energy consumption, where both energy and real output have positive relationship with each other. At the sectoral level, however, the study only establish the direction of causality, which was reported as bidirectional between energy and the services sector output. The results also establish unidirectional causality running from industrial real output to energy consumption, while also establishing neutral causality between agricultural real output and electricity consumption. Against the findings of Ibrahiem (2018) on agriculture-real output in terms of energy consumption, Dogan, Sebri, and Turkekul (2016) studied how energy consumption by agricultural sector relates with economic output for coastal and non-coastal regions of Turkey. Adopting Dumitrescu-Hurlin Granger causality test alongside OLS with regional fixed effects, the result reveal that increase in agricultural output is as a result of electricity consumption.

The issue of energy consumption and sectoral output performance has also been empirically investigated in Nigeria. One of the earliest studies in this regard is Nwosa and Akinbobola (2012). The duo adopt Bivariate Vector Autoregressive analysis on time series data for 1980-2010. The study dwells more on the direction of causality, establish conservative hypothesis with evidence of unidirectional causality running from services to total energy consumption, while feedback hypothesis is established between aggregate energy consumption and agriculture. Edame and Okoi (2015) also adopt ordinary least squares method on time series data for the period of 1999-2013. The results show that energy consumption does not have significant relationship with manufacturing output. In the same manner, Ugwoke, Dike and Elekwa (2016) adopt Double-Log Linear formulation on time series data set for the period of 1980-2014. The study shows that though electricity supply is positively related to industrial production, but such relationship is not significant. Similarly, the study by Alley, Egbetunde and Oligbi (2016), which investigates how electricity supply relates to industrialization and economic performance in Nigeria using 3-stage Least Squares, could not establish any direct negative effect of electricity on economic growth. Rather, the study affirms the positive influence of energy supply on increase in industrial sector output, which also enhances the growth of the economy. Contrary to the views is the study Chinedum and Nnadi (2016) who adopt vector autoregressive on energy and sectoral performance of the economy and find that electric power supply is not significantly related to the manufacturing sector.

III. Methodology

This section presents the methodology for analyzing the role of energy consumption on sectoral output performance in Nigeria. The section is further subdivided into four areas: decomposition of aggregate variable into sectoral components, model specification, estimation techniques, as well as data sources and measurements.

3.1 Model Specification

Following the neoclassical theory and the empirical works of Akinlo (2008); Gbadebo and Okonkwo (2009); Shabaz, Abosedra, and Sbia (2013); Ogundipe, Akinyemi, and Ogundipe (2016); Isaac, Nwedeh, Adenikinju, and Abonyi (2021), the empirical model for the study is specified as follows:

$Y_t = A_t F(K_t^{\propto}, L_t^{1-\propto})$ (1)

Where:

Y_t = Aggregate Economic Output at time (t).
K_t = Input of capital stock at time (t).
L_t = Input of labour at time (t),
A_t = Measure of technological productivity at time (t), and
α, and 1- α are respective measures of elasticities for capital and labour.

The intensive production function assumes that the inada conditions is satisfied, which imply that the elasticity of substitution is asymptotically equal to one, and further that marginal returns of input x_i are positive but decreasing, that is,

$$\frac{\partial f(X)}{\partial x_i} > 0, and \ \frac{\partial^2 f(X)}{\partial x^2{}_i} < 0$$

Energy variable is introduced into the Cobb-Douglas production function as an independent input and not as capital augmenting production factor. This has been carried out in line with observations from relevant literature. Albeit, by augmenting equation 5 with energy consumption variable, the equation becomes:

$Y_t = AF(K_t^{\propto}, L_t^{1-\propto}, E_t^{\beta})$ (2)

Where:

E_t = Input of energy variable consumed in time (t).
β = measure of elasticity for energy input

By expressing aggregate economic output equation 2 in terms of sectoral output, the equation becomes:

$Y_{it} = AF(K_{it}^{\propto}, L_{it}^{1-\propto}, E_{it}^{\beta})$ (3)

Equation (3) will enable the effect of energy consumption to be measured direct on sectoral economic output linearly. Meanwhile, Y_{it} represents the output of an economic sector (such as agriculture, crude petroleum and mining, manufacturing, construction, and trade and services, which are denoted by ‘i’ in equation 3). The linear relationship existing among capital stock, labour force, and economic output (sectorally decomposed as is the case in this study) can be expressed in a structural form as:

$lnY_{it} = \alpha_o + \alpha_1 lnK_{it} + 1 - \alpha lnL_{it} + \lambda lnE_{it} + \varepsilon_{it}$ (4)

Equation can be re-written as:

$lnY_{it} = \alpha_o + \alpha_1 lnK_{it} + \beta lnL_{it} + \lambda lnE_{it} + \varepsilon_{it}$ (5)

Where lnY_{it} is the log of economic sectors outputs, lnK_{it} is the log of capital stock, lnL_{it} is the log of labour force, lnE_{it} is the log of energy variable, ε_{it} is the idiosyncratic error term that is independently and identically distributed $\varepsilon_t \sim N(0,1)$, α_o is the intercept term, α_1, β, and λ are the unknown coefficients terms of the explanatory variables.

Furthermore, the ARDL short run model for each sector is specified as:

$$\Delta lnAGR_t = \theta_o + \sum_{i=0}^{q} \theta_1 \Delta lnKAGR_{t-i} + \sum_{i=0}^{q} \theta_2 \Delta lnLAGR_{t-i} + \sum_{i=0}^{q} \theta_3 \Delta lnENAG_{t-i} + \sum_{i=0}^{q} \theta_4 \Delta lnEXCH_{t-i} + ECT_{t-1} + \mu_{1t} \quad (6)$$

$$\Delta lnCPM_t = \gamma_o + \sum_{i=0}^{q} \gamma_1 \Delta lnKCPM_{t-i} + \sum_{i=0}^{q} \gamma_2 \Delta lnLCPM_{t-i} + \sum_{i=0}^{q} \gamma_3 \Delta lnENCPM_{t-i} + \sum_{i=0}^{q} \gamma_4 \Delta lnEXCH_{t-i} + ECT_{t-1} + \mu_{2t} \quad (7)$$

$$\Delta lnMAN_t = \eta_o + \sum_{i=0}^{q} \eta_1 \Delta lnKMAN_{t-i} + \sum_{i=0}^{q} \eta_2 \Delta lnLMAN_{t-i} + \sum_{i=0}^{q} \eta_3 \Delta lnENMAN_{t-i} + \sum_{i=0}^{q} \eta_4 \Delta lnEXCH_{t-i} + ECT_{t-1} + \mu_{3t} \quad (8)$$

$$\Delta lnCONX_t = \sigma_o + \sum_{i=0}^{q} \sigma_1 \Delta lnKCONX_{t-i} + \sum_{i=0}^{q} \sigma_2 \, \Delta lnLCONX_{t-i} + \sum_{i=0}^{q} \sigma_3 \Delta lnENCONX_{t-i} + \sum_{i=0}^{q} \sigma_4 \Delta lnEXCH_{t-i} + ECT_{t-1} + \mu_{4t} \quad (9)$$

$$\Delta lnTSV_t = \omega_o + \sum_{i=0}^{q} \omega_1 \Delta lnKTSV_{t-i} + \sum_{i=0}^{q} \omega_2 \, \Delta lnLTSV_{t-i} + \sum_{i=0}^{q} \omega_3 \Delta lnENTSV_{t-i} + \sum_{i=0}^{q} \omega_4 \Delta lnEXCH_{t-i} + ECT_{t-1} + \mu_{5t} \quad (10)$$

However, the FMOLS long run model for each sector is also specified as:

$$lnAGR_t = \alpha_o + \alpha_1 lnKAGR_t + \alpha_2 lnLAGR_t + \alpha_3 lnENAG_t + \sum_{i=0}^{q} \tau_i \Delta lnKAGR_{t-i} + \sum_{i=0}^{q} \tau_i \, \Delta lnLAGR_{t-i} + \sum_{i=0}^{q} \tau_i \Delta lnENAG_{t-i} + \emptyset' \boldsymbol{D_i} + v_{1t} \quad (11)$$

$$lnCPM_t = \gamma_o + \gamma_1 lnKCPM_t + \gamma_2 lnLCPM_t + \gamma_3 lnENCPM_t + \sum_{i=0}^{q} \partial_i \Delta lnKCPM_{t-i} + \sum_{i=0}^{q} \partial_i \, \Delta lnLCPM_{t-i} + \sum_{i=0}^{q} \partial_i \Delta lnENCPM_{t-i} + \varphi^{'\boldsymbol{D_i}} + v_{2t} \quad (12)$$

$$lnMAN_t = \eta_o + \eta_1 lnKMAN_t + \eta_2 lnLMAN_t + \alpha\eta_3 lnENMAN_t + \sum_{i=0}^{q} \rho_i \Delta lnKMAN_{t-i} + \sum_{i=0}^{q} \rho_i \, \Delta lnLMAN_{t-i} + \sum_{i=0}^{q} \rho_i \Delta lnENMAN_{t-i} + \Phi^{'\boldsymbol{D_i}} + v_{3t} \quad (13)$$

$$lnCONX_t = \eta_o + \eta_1 lnKCONX_t + \eta_2 lnLCONX_t + \alpha\eta_3 lnENCONX_t + \sum_{i=0}^{q} \rho_i \Delta lnKCONX_{t-i} + \sum_{i=0}^{q} \rho_i \, \Delta lnLCONX_{t-i} + \sum_{i=0}^{q} \rho_i \Delta lnENCONX_{t-i} + \Phi^{'\boldsymbol{D_i}} + v_{4t} \quad (14)$$

$$lnTSV_t = \eta_o + \eta_1 lnKTSV_t + \eta_2 lnLTSV_t + \alpha\eta_3 lnENTSV_t + \sum_{i=0}^{q} \rho_i \Delta lnKTSV_{t-i} + \sum_{i=0}^{q} \rho_i \, \Delta lnLTSV_{t-i} + \sum_{i=0}^{q} \rho_i \Delta lnENTSV_{t-i} + \Phi^{'\boldsymbol{D_i}} + v_{5t} \quad (15)$$

3.2 Estimation Techniques

The study adopted Autoregressive Distributed Lag (ARDL) for the short run analysis while Fully Modified Ordinary Least Squares (FMOLS) was adopted for the long run analysis. The ARDL was chosen among other techniques in that it is able to accommodate variables that are of the same or different integration orders whether I(0) or I(1) or a combination of both. The ARDL was also chosen because it is appropriate for small sample size. Meanwhile, the FMOLS was adopted because it is computational simple and that it solves the major problems that are associated with Ordinary Least Squares (OLS) regressions; hence, it is suitable in capturing the long run effect of energy consumption on the key sectors performance in Nigeria. All the variables in this study except exchange rate were log-linearized for uniformity and ease of interpretation.

3.3 Data Sources and Measurement

In achieving the objective of this study, time series data on key sectors of the Nigerian economy such as: Agriculture, Crude Petroleum & Mining, Manufacturing, Construction, and Trade & Services for the period of 1981-2019 were adopted. The sectors have been classified as key by Central Bank of Nigeria (2021 based on their contributions to GDP. Similarly, data on economic growth variables, such as capital stock, labour force, and energy consumption were also obtained for the study. Exchange rate was chosen among other control variables like inflation, real interest rate because of its relation to all the sectors in terms of input and output, and more so because Nigeria runs an open economy. The study therefore considered the influence that exchange rate would have on both the model and in relation to the key sectors' output.

Variable	Measurement	Sources
Sectoral Outputs: Agriculture Output, Crude Petroleum & Mining Output, Manufacturing Output, Construction Output, Trade & Services Output	Annual data on output of each sector, measured in ₦'Billion.	Statistical Bulletin of the Central Bank of Nigeria, 2020
Capital (decomposed into sectors)	Gross Capital Formation (Constant 2010 US$)	World Development Indicators, 2019.
Labour Force (decomposed into sectors)	Population Ages 15 – 64 (total)	World Development Indicators, 2019.
Energy Consumption (decomposed into sectors)	Energy Use (kilogram of oil equivalent per capita multiplied by total population for the period of the study	World Development Indicators, 2019.
Exchange Rate	Real exchange rate	World Development Indicators, 2019.

3.4 Decomposition of Aggregate Variables into Sectoral Components

One of the common phenomena observed in the previous studies on energy consumption and sectoral output performance in Nigeria is the regression of aggregate energy variable on sectoral outputs. This has been observed across countries (developed and undeveloped alike). This, according to Ang& Zhang (2000), Ang& Wang (2015), could have negative influence on the predictive power of energy variable on economic performance, sectoral or aggregate. Non-parametric Index Decomposition Analysis (IDA) was adopted for decomposition of aggregate variables into sectoral component as follows: Assuming:

E_T = Total energy consumed in the economy
$E_{i,T}$ = Energy consumed in each sector
Y_T = Total economic output
$Y_{i,T}$ = Production by economic sector

Based on the foregoing definitions, the share of sectoral output as a proportion of national output can be obtained as:

$$S.Y_{i,T} = \frac{Y_{i,T}}{Y_T} \quad (16)$$

Similarly, the proportion of energy consumed by sectors as a proportion of aggregate energy consumed in the economy can be obtained as:

$$S.E_{i,T} = \frac{E_{i,T}}{E_T} \quad (17)$$

Equating equations 4 and 5

$$S.Y_{i,T} = S.E_{i,T} = \frac{Y_{i,T}}{Y_T} = \frac{E_{i,T}}{E_T} \quad (18)$$

By making $E_{i,T}$ the subject of the formula, equation 18 becomes,

$$E_{i,T} = \frac{Y_{i,T}}{Y_T} \text{ x } E_{,T} (19)$$

This means that by taking a proportion of the sectoral output as ratio of national output, and multiplying the resulting figure by total energy consumption, a proportion of energy component available to and consumed by the sector in productive activities can be estimated. This approach was adopted to disaggregate total energy consumption into sectoral components, thereby enabling a sectoral analysis of economic output and sectoral economic growth enabling variables (energy component by sectors, capital stock by sectors, and labour force by sectors).

IV. Presentation of Empirical Result and Discussions

This section of the study is also divided into four components: the descriptive results, correlation analysis, unit root and cointegration, and empirical results.

4.1 Descriptive Statistics of the Data

In order to ascertain the nature and quality of the data adopted for the econometric analysis, the descriptive statistics was generated and presented in tables 4.1 to 4.5.

Table 4.1 Descriptive Statistics for Agricultural Sector

	AGR ('000,000)	ENAG ('000,000)	KAGR ('000,000)	LAGR ('000,000)	EXCH
Mean	6,940,000.00	22,100.00	13,200.00	15.97	94.14
Median	1,510,000.00	23,400.00	13,700.00	17.74	101.70
Maximum	31,900,000.00	35,000.00	21,300.00	25.83	306.92
Minimum	17,100.00	6,010.00	7,060.00	4.69	0.62
Std. Dev.	8,910,000.00	8,680.00	3,320.00	5.83	92.82
Skewness	1.21	0.32	0.06	- 0.40	0.81
Kurtosis	3.39	1.80	2.80	1.97	2.85
Jarque-Bera	9.79	2.97	0.09	2.77	4.30
Probability	0.01	0.23	0.96	0.25	0.12
Sum	2.71E+14	8.64E+11	5.15E+11	6.23E+08	3,671.60
Sum Sq. Dev.	3.02E+27	2.86E+21	4.20E+20	1.29E+15	327,405.30
Observations	39.00	39.00	39.00	39.00	39.00

Table 4.2 Descriptive Statistics for Crude Petroleum & Mining Sector

	CPM ('000,000)	ENCPM '000,000)	KCPM ('000,000)	LCPM ('000,000)	EXCH ('000,000)
Mean	3,380,000.00	10,900.00	6,510.00	7.83	94.14
Median	976,000.00	10,900.00	6,300.00	8.06	101.70
Maximum	13,600,000.00	22,300.00	11,000.00	15.24	306.92
Minimum	8,000.00	2,700.00	2,460.00	2.04	0.62
Std. Dev.	4,340,000.00	5,160.00	2,350.00	3.48	92.82
Skewness	1.09	0.18	-0.02	0.04	0.81
Kurtosis	2.74	2.27	2.10	2.13	2.85
Jarque-Bera	7.82	1.08	1.32	1.23	4.30
Probability	0.02	0.58	0.52	0.54	0.12
Sum	1.32E+14	4.24E+11	2.54E+11	3.06E+08	3.67E+03
Sum Sq. Dev.	7.15E+26	1.01E+21	2.10E+20	4.61E+14	3.27E+05
Observations	39.00	39.00	39.00	39.00	39.00

Table 4.3 Descriptive Statistics for Manufacturing Sector

	MAN ('000,000)	ENMAN ('000,000)	KMAN ('000,000)	LMAN (0'000,000)	EXCH
Mean	2,990,000.00	11,700.00	7,830.00	8.52	94.14
Median	843,000.00	11,300.00	7,300.00	8.62	101.70
Maximum	18,100,000.00	19,900.00	21,600.00	13.52	306.92
Minimum	30,000.00	8,210.00	4,170.00	5.87	0.62
Std. Dev.	4,380,000.00	2,430.00	3,530.00	1.67	92.82
Skewness	1.79	0.98	2.21	0.46	0.81
Kurtosis	5.54	4.61	8.63	3.61	2.85

Jarque-Bera	31.21	10.38	83.23	1.95	4.30
Probability	0.0000	0.01	0.0000	0.38	0.12
Sum	1.17E+14	4.55E+11	3.06E+11	3.32E+08	3.67E+03
Sum Sq. Dev.	7.30E+26	2.25E+20	4.73E+20	1.06E+14	3.27E+05
Observations	39.00	39.00	39.00	39.00	39.00

Table 4.4 Descriptive Statistics for Construction Sector

	CONX ('000,000)	ENCONX ('000,000)	KCONX ('000,000)	LCONX	EXCH
Mean	1,120,000.00	2,960.00	1,950.00	2.12	94.14
Median	122,000.00	2,280.00	1,400.00	1.68	101.70
Maximum	9,000,000.00	9,860.00	7,960.00	6.72	306.92
Minimum	6,100.00	1,300.00	852.00	0.99	0.62
Std. Dev.	1,950,000.00	1,800.00	1,450.00	1.19	92.82
Skewness	2.36	1.95	2.50	1.94	0.81
Kurtosis	8.75	7.21	9.64	7.28	2.85
Jarque-Bera	89.78	53.63	112.25	54.17	4.30
Probability	0.0000	0.0000	0.0000	0.0000	0.12
Sum	4.35E+13	1.15E+11	7.61E+10	82818782	3671.595
Sum Sq. Dev.	1.44E+26	1.23E+20	7.95E+19	5.37E+13	327405.3
Observations	39	39	39	39	39

Table 4.5 Descriptive Statistics for Trade & Services Sector

	TSV ('000,000)	ENTSV ('000,000)	KTSV ('000,000)	LTSV ('000,000)	EXCH
Mean	16,100,000.00	46,500.00	28,500.00	33.39	94.14
Median	3,150,000.00	38,200.00	25,600.00	29.22	101.70
Maximum	72,400,000.00	87,800.00	53,100.00	59.72	306.92
Minimum	73,600.00	25,900.00	18,200.00	20.26	0.62
Std. Dev.	22,600,000.00	19,600.00	8,920.00	12.49	92.82
Skewness	1.29	0.77	0.86	0.74	0.81
Kurtosis	3.26	2.19	2.86	2.17	2.85
Jarque-Bera	10.94	4.93	4.80	4.65	4.30
Probability	0.00	0.09	0.09	0.10	0.12
Sum	6.29E+14	1.81E+12	1.11E+12	1.30E+09	3671.595
Sum Sq. Dev.	1.95E+28	1.47E+22	3.03E+21	5.93E+15	327405.3
Observations	39	39	39	39	39

From table 4.1 to 4.5, all the data maintained good statistical characteristics and qualities. The data shows that the trade & services sector had the maximum output during the period of the study with an average production output of ₦16,100,000 million output, which was followed by agricultural (₦6,940,000 million), crude petroleum & mining (₦3,380,000 million), manufacturing (₦2,990,000 million), and N1,120,000 million for the construction sector. The same trend was observed for energy consumption by sectors. The data showed that trade & services sector consumed the highest energy in the period of the review. Similarly, high rate of volatility was observed for all the variables. The crude petroleum & mining sector had the highest volatility effect, which is followed by the trade & services sector. Fluctuations in global oil and exchange rate volatility could be responsible for the volatilities experienced by the sectors.

4.2 Correlation Matrix

Correlation analysis was carried out for the data with a view to observing their interaction and the extent of their co-movement over time. The outcome shows that all the economic variables have positive relationship with one another. However, all the key sectors of the Nigerian economy, in relation to sectoral energy consumption, show high level of correlation. This is part of the choice of the choice for the long run relationship, especially in terms of correcting the effect of serial correlation. The details are provided in the appendices.

4.3. Unit Root Result &Cointegration

4.3.1 Variables Stationarity Test (Unit Root Test)

For the avoidance of regressing one non-stationary data on the other, which could bring up spurious regression results, the study conducted unit root test using Augmented-Dickey Fuller (ADF), Phillips Perron (PP). All the variables except are stationary at first difference, except log of Construction Output, which is stationary at level.

Table 4.6 Unit Root Test

Unit Root Test Without Structural Break

	Augmented Dickey-Fuller			Philips –Peron		
Variables	**t-stat**	**Prob.**		**Adj. t-stat**	**Prob.**	
AGRICULTURE	**At Level**	**At First Diff**	**Remark**	**At Level**	**At First Diff**	**Remark**
LNAGR	2.803415 (0.9983)	-2.199626 (0.0286)	I(1)	5.467124 (1.0000)	-2.135235 (0.0331)	I(1)
LNENAGR	2.592677 (0.9970)	-4.920131 (0.0000)	I(1)	2.680376 (0.9976)	-4.304087 (0.0001)	I(1)
LNKAGR	0.754722 (0.8727)	-7.037992 (0.0000)	I(1)	0.459101 (0.8090)	-6.3974 (0.0000)	I(1)
LNLAGR	2.350324 (0.9945)	-5.012079 (0.0000)	I(1)	2.402788 (0.9952)	-4.330251 (0.0001)	I(1)
CRD PET & MINING	At Level	At First Diff	Remark	At Level	At First Diff	Remark
LNCPM	2.926705 (0.9988)	-4.939016 (0.0000)	I(1)	3.280712 (0.995)	-4.919991 (0.0000)	I(1)
LNENCPM	1.209567 (0.9391)	-6.456617 (0.0000)	I(1)	1.823799 (0.9818)	-6.934408 (0.0000)	I(1)
LNKCPM	0.324535 (0.7739)	-6.42037 (0.0000)	I(1)	0.230839 (0.5965)	-9.072376 (0.0000)	I(1)
LNLCPM	1.137255 (0.9309)	-6.568385 (0.0000)	I(1)	1.554342 (0.9682)	-7.017721 (0.0000)	I(1)
MANUFACTURING	At Level	At First Diff	Remark	At Level	At First Diff	Remark
LNMAN	3.809401 (0.9999)	-3.663064 (0.0386)	I(1)	7.633204 (1.0000)	-4.374835 (0.0013)	I(1)
LNENMAN	-0.529767 (0.9776)	-6.422274 (0.0000)	I(1)	-0.517127 (0.9783)	-6.426299 (0.0000)	I(1)
LNKMAN	-1.990064 (0.5879)	-5.183844 (0.0009)	I(1)	-1.976474 (0.5951)	-6.056156 (0.0001)	I(1)
LNLMAN	-0.557709 (0.9759)	-6.32314 (0.0000)	I(1)	-0.504914 (0.9790)	-6.32896 (0.0000)	I(1)
CONSTRUCTION	At Level	At First Diff	Remark	At Level	At First Diff	Remark
LNCONX	-4.335052 (0.0076)	-3.643696 (0.0395)	I(0)	-4.776669 (0.0023)	-3.552812 (0.0483)	I(0)
LNENCONX	-0.916637 (0.9435)	-5.760019 (0.0002)	I(1)	-0.886284 (0.9472)	-5.747628 (0.0002)	I(1)
LNKCONX	-2.81991 (0.1993)	-4.57851 (0.0042)	I(1)	-2.83093 (0.1957)	-4.71566 (0.0029)	I(1)
LNLCONX	-0.951946 (0.9389)	-5.906319 (0.0001)	I(1)	-0.87201 (0.9489)	-5.918923 (0.0001)	I(1)
TRADE & SERVICES	At Level	At First Diff	Remark	At Level	At First Diff	Remark
LNTSV	-0.086697 (0.9933)	-2.654309 (0.0917)	I(1)	-0.64111 (0.8493)	-2.654309 (0.0917)	I(1)
LNENTSV	0.065603 (0.9587)	-5.124796 (0.0002)	I(1)	0.008016 (0.9535)	-5.124796 (0.0002)	I(1)
LNKTSV	-2.199274 (0.2098)	-4.398655 (0.0013)	I(1)	-2.428283 (0.1410)	-4.889738 (0.0003)	I(1)
LNLTSV	-0.020898 (0.9507)	-5.173796 (0.0001)	I(1)	-0.032081 (0.9495)	-5.150174 (0.0001)	I(1)

P-values are in the parenthesis

Test Critical Values		
Significance	Level	First Diff
1%	-2.628961	-2.628961
5%	-1.950117	-1.950117
10%	-1.611339	-1.611339

Mackinnon (1996) one-sided p-values.

Note: ADF, PP, and *, **, and *** represent 1%, 5%, and 10% level of significance
All variables are integrated of order 1, that is, they are I(1) variables at 1%, 5%, and 10% level of significance, except construction output, which is I(0) at 1% level of significance.
Source: Author's Computation using EViews 10, 2022

4.3.2 Cointegration Test
As a prerequisite in econometric analysis, the need to investigate the existence or otherwise of long run relationship between variables of interest cannot be overemphasized. There is a confirmation of the existence of long run equilibrium between the variables as provided in Table 4.7.

Table 4.7 Bounds Test for Cointegration

F-Bounds Test — Null Hypothesis: No levels relationship

Test Statistic	Value	Signif.	I(0)	I(1)
Sector: **Agriculture**				
F-statistic	9.669535*	10%	3.03	4.06
k	4	5%	3.47	4.57
		2.5%	3.89	5.07
		1%	4.4	5.72
Sector: **Crude Petroleum & Mining**				
F-statistic	9.157558*	10%	3.03	4.06
k	4	5%	3.47	4.57
		2.5%	3.89	5.07
		1%	4.4	5.72
Sector: **Manufacturing**				
F-statistic	25.28788*	10%	2.2	3.09
k	4	5%	2.56	3.49
		2.5%	2.88	3.87
		1%	3.29	4.37
Sector: **Construction**				
F-statistic	9.072940*	10%	2.2	3.09
k	4	5%	2.56	3.49
		2.5%	2.88	3.87
		1%	3.29	4.37
Sector: **Trade & Services**				
F-statistic	11.74215*	10%	3.03	4.06
k	4	5%	3.47	4.57
		2.5%	3.89	5.07
		1%	4.4	5.72

*, **, and *** represent 1%, 5%, and 10% level of significance respectively
Source: Authors' Computation using EViews, 2010

4.4 Effect of Energy Consumption on Sectoral Output
4.4.1 Short Run Results

The short run results on the effect of energy consumption on sectoral output is presented as:

Table 4.8 Dependent Variable: Agriculture

Variable	Coefficient	Std Error	t-Stat	Prob.	R-Sqd	Adj. R-Sqd	DW
D(LNENAG)	1.822958***	0.538152	3.387439	0.0044	0.9567	0.9182	2.5450
D(EXCH)	-0.002678***	0.000549	-4.874384	0.0002			
CointEq(-1)*	-0.595654***	0.07555	-7.884244	0.0000			

Dependent Variable: Crude Petroleum & Mining

Variable	Coefficient	Std Error	t-Stat	Prob.	R-Sqd	Adj. R-Sqd	DW
D(LNENCPM)	-0.445155	0.497788	-0.894267	0.3830	0.98899	0.9825	2.2810
D(LNENCPM(-1))	-1.576892***	0.534818	-2.948464	0.0086			
D(EXCH)	0.001208*	0.000662	1.825885	0.0845			
CointEq(-1)*	-0.17676***	0.023628	-7.480833	0.0000			

Dependent Variable: Manufacturing

Variable	Coefficient	Std Error	t-Stat	Prob.	R-Sqd	Adj. R-Sqd	DW
D(LNENMAN)	-0.503525	0.63064	-0.798435	0.4432	0.8547	0.6804	1.9856
D(LNENMAN(-1))	-4.32569***	0.693757	-6.235161	0.0001			
D(EXCH(-1))	0.006202***	0.000736	8.425996	0.0000			
CointEq(-1)*	-0.061995***	0.004109	-15.08612	0.0000			

Dependent Variable: Construction

Variable	Coefficient	Std Error	t-Stat	Prob.	R-Sqd	Adj. R-Sqd	DW
D(LNENCONX)	-0.82062**	0.384726	-2.132998	0.0511	0.9375	0.8882	2.0938
D(LNENCONX(-1))	-2.774522***	0.457668	-6.062310	0.0000			
D(EXCH(-1))	0.000994**	0.000433	2.292152	0.0379			
CointEq(-1)*	-0.106415***	0.012381	-8.595327	0.0000			

Dependent Variable: Trade & Services

Variable	Coefficient	Std Error	t-Stat	Prob.	R-Sqd	Adj. R-Sqd	DW
D(LNENTSV)	0.411938	0.498889	0.825709	0.4187	0.8065	0.7260	2.2245
D(LNENTSV(-1))	-2.07679***	0.538549	-3.856270	0.0010			
CointEq(-1)*	-0.174438***	0.020782	-8.393621	0.0000			

*, **, and *** represent 10%, 5%, and 1% level of significance; Note: DW is Durbin Watson; R-Sqd is R-Squared
Source: Author's Computation using EViews, 2010

The short run relationship between energy consumption and agricultural output reveals that in its natural log, energy consumption has positive and significant impact on agricultural output. Specifically, a percentage increase in energy consumption will bring about 1.88 percent (t = 3.3874, p < 0.01) increase in agricultural output. This result supports the findings of Ishioro (2018). Exchange rate has a significantly negative relationship with agricultural output in a manner that 1 percent increase in the rate will bring about 0.003 percent (t = 4.8744, p < 0.01) decline in the output of the sector. The Error Correction Term (ECT) *(-0.5957; t = -7.8842, p < 0.01)*, which measures the speedy of long run convergence between the variables is negative and statistically significant. Precisely, it shows that the error between agricultural output and its regressors in the short run can be corrected at the rate of 60 percent annually. The test of goodness of fit by the model, which is measured as R-Squared and Adjusted R-Squared implies that 95.67 and 91.82 percent of the variations in agricultural output is explained by energy consumption, gross capital formation, labour force, and exchange rate. Furthermore, the Durbin Watson statistic value of 2.55 shows the likelihood of the presence of serial correlation in the residuals of the model.

The results for Crude Petroleum & Mining (CPM) output reveal positive but insignificant self-shocks in both one and two lag periods. Meanwhile, in relation to the effect of energy consumption on crude petroleum and mining output, the results, in the current period, show that energy consumption has a negative and insignificant effect on the sector's output. However, unlike the outcome in the current period, energy consumption is found to negatively and significantly related to crude petroleum & mining output in both one and two lag periods. In lag period one, for instance, a percentage increase in energy consumption will cause about 1.5 percent ($t = 2.9485$, $p = 0.01$) decline in crude petroleum & mining output. This result is considered novel in that little or no study among the reviewed ones and in the body of literature on Nigeria has considered the nexus between energy - crude petroleum & mining relationship. Moreover, exchange rate has been found to be positively related to crude petroleum & mining; only that such positive effect is significant at 10 percent significance level. The Error Correction Term (ECT) has a value of -0.177 ($t = -7.4808$, $p < 0.01$), which is also significant at 1percent, showing the speed of adjustment to long run equilibrium. In the instance of this study, the ECT term of -0.177 implies that the disequilibrium in the short run will be corrected at a speed of 17.7 percent annually. Besides, the model also enjoys appreciable goodness of fit measure with R-squared coefficient of 98 percent, which implies that the variations in the explained variable is caused by the explanatory variables. More so, the absence of serial correlation is also confirmed by the Durbin Watson statistic value of 2.28.

In the manufacturing sector, as it was the case under crude petroleum & mining, energy consumption has a negative effect on manufacturing output in the current period, which is only significant at 10 percent significance level. This result corresponds with the findings of Kassim&Isik (2020), and Isaac, Chukwuemeka, Adenikinju& Donald (2021), where energy consumption has small, insignificant effect on manufacturing output. However, a negative and significant relation is found in the one lag period. Meanwhile, in relation to the Error Correction Term, the ECT value of -0.06 ($t = -15.09$, $p < 0.01$) shows that the disequilibrium in the short run can be corrected at the speed of 0.06 percent annually. The R-squared of 0.855 also shows a good measure of goodness fit between the explained and the explanatory variables; while Durbin Watson statistic value of 1.99 reveals the absence of serial correlation in the residuals of the model.

In the construction sector and unlike the results of the previous sectors, energy consumption shows negative and significant effects on construction output, both in the current and the lagged periods one and two. In the current period, a percentage increase in energy consumption reduces the output of construction sector by 0.82 percent ($t = -2.13$, $p = 0.05$). Meanwhile, the effect of exchange rate on construction output, as revealed by the results, is small and of no significance. Besides, the Error Correction Term (ECT) value of -0.11 is not only significant with t-value and p-value of -8.60, and 0.0000, respectively, but also implies that the short run disequilibrium will autocorrect at the speed of 11 percent annually. Likewise the test of goodness of fit and serial correlation are also remarkably good with Adjusted R-squared value of 0.88 percent and Durbin Watson statistic value of 2.09, respectively. As it was the case in the crude petroleum & mining sector, the results on the effect of energy consumption on construction output is equally a novel outcome. This is because very few studies exist in the literature on the effect of energy consumption on construction sector output.

Lastly for the short run analysis, the effect of energy consumption on trade & services output is in the current period is not significant, though, it is positive. This result corroborates the findings of Isaac, Nwedeh, Adenikinju, and Abonyi (2021). In the one lag period, however, the effect of energy consumption is found to have a negative and significant effect on trade & services sector output. As found in the results, a percentage increase in energy consumption will bring about 2.08 percent ($t = -3.86$, $p < 0.05$) reduction in trade & services output. Regardless, the Error Correction Term of the model of -0.17 ($t = -8.39$, $p < 0.01$) is significant, and reveals that the disequilibrium in the short run will adjust automatically in the long run at the rate of 17 percent annually. The results further reveal that the R-squared value is 0.81, which implies that 81 percent of the variation in trade & services output can be explained by energy consumption, gross capital formation, and labour force, while Durbin Watson statistic of 2.23 shows the absence of serial correlations among the variables.

4.4.2 Long Run Results

The results of the long run effect of energy on sectoral output in Nigeria has been examined using the Fully Modified Ordinary Least Squares (FMOLS) method is thus presented as:

Table 4.9 Fully Modified OLS Results

Dependent Variable: Agriculture

Ind. Variable	Coefficient	Standard Error	t-Statistic	Prob.	R-Squared	Adj. R-Squared
LNENAG	19.41558	2.733815	7.102008	0.0000***	0.953799	0.949722
C	-203.5950	21.00223	-9.693972	0.0000***		

Dependent Variable: Crude Petroleum & Mining

Ind. Variable	Coefficient	Standard Error	t-Statistic	Prob.	R-Squared	Adj. R-Squared
LNENCPM	21.24316	5.287804	4.017389	0.0003***	0.873644	0.862495
C	31.03938	9.212333	3.369328	0.0022*		

Dependent Variable: Manufacturing

Ind. Variable	Coefficient	Standard Error	t-Statistic	Prob.	R-Squared	Adj. R-Squared
LNENMAN	29.55895	6.252183	4.727781	0.0000***	0.763363	0.742483
C	-157.1050	53.73350	-2.923782	0.0061***		

Dependent Variable: Construction

Ind. Variable	Coefficient	Standard Error	t-Statistic	Prob.	R-Squared	Adj. R-Squared
LNENCONX	32.15589	10.03300	3.205004	0.0029***	0.800258	0.782634
C	-42.56026	16.28902	-2.612819	0.0141***		

Dependent Variable: Trade & Services

Ind. Variable	Coefficient	Standard Error	t-Statistic	Prob.	R-Squared	Adj. R-Squared
LNENTSV	-3.804745	6.926985	-0.549264	0.5864	0.918821	0.911659
C	-33.46916	38.82566	-0.862037	0.3947		

*, **, and *** represent 10%, 5%, and 1% level of significance
Source: Author's Computation using EViews, 2010

The empirical results for the agriculture sector shows the existence of positive and significant long run effect of energy consumption on the sector's output. According to the results, a percentage increase in energy consumption will cause 19.4 percent ($t = 7.10$, $p < 0.01$) increase in agricultural output. In the other sectors considered in the study, especially the crude petroleum & mining sector, the manufacturing sector, and the construction sector, a significantly positive long run effect of energy consumption is expected on the sectors' performance. However, a reverse case was observed for the trade & services sector, where an insignificant and negative long run relation is observed for the sector. This, perhaps, corroborates the global shift from fossil fuel to modern energy sources for trade and services across the globe.

V. Conclusion and Recommendation

Energy component is an important factor in modern day production function. All sectors of the economy in their respective areas require sufficient energy input to produce output. Notably, the energy requirements of the sectors vary; this is an important area where policy makers need proper research guidance in formulating policy for allocation of energy resources to sectors. At the level of this study, the long run equilibrium has been affirmed between energy component and sectoral output performance as energy consumption has positive and significant relation to all the sectors in the long run, save for trade & services, in which an insignificant and negative long run effect of energy consumption is recorded for the sector. From the study, Agriculture, Crude Petroleum & Mining, Manufacturing, and Construction sectors have been identified as the growth catalysts due to the higher positive output demonstrated in the long run results. This shows that with good policy in place, the actualization of economic growth objective of the Nigerian government is not only feasible but also plausible in the future. Meanwhile, since energy consumption is both significant and positive in the long run, it is, therefore, recommended that government pursues energy development agenda through the diversification of energy sources, formulation of realistic energy policies, and ensuring that adequate energy is allocated to the productive sectors, especially those identified by the study as growth catalysts.

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Appendices

Correlation Matrix Results

	AGR	ENAG	KAGR	LNAGR	EXCH
AGR	1.0000				
ENAG	0.7328	1.0000			
KAGR	0.4830	0.8316	1.0000		
LNAGR	0.7991	0.9634	0.7590	1.0000	
EXCH	0.9392	0.8410	0.6102	0.8759	1.0000
	CPM	**ENCPM**	**KCPM**	**LNCPM**	**EXCH**
CPM	1.0000				
ENCPM	0.7270	1.0000			
KCPM	0.4430	0.8269	1.0000		
LNCPM	0.8004	0.8616	0.5960	1.0000	
EXCH	0.8626	0.6141	0.3225	0.8561	1.0000
	MAN	**ENMAN**	**KMAN**	**LMAN**	**EXCH**
MAN	1.0000				
ENMAN	0.6002	1.0000			
KMAN	-0.1790	0.2924	1.0000		
LMAN	0.4002	0.9673	0.4088	1.0000	
EXCH	0.8959	0.3074	-0.4091	0.0871	1.0000
	CONX	**ENCONX**	**KCONX**	**LCONX**	**EXCH**
CONX	1.0000				
ENCONX	0.9553	1.0000			
KCONX	0.3884	0.6148	1.0000		
LCONX	0.9379	0.9977	0.6578	1.0000	
EXCH	0.8544	0.7542	0.1440	0.7199	1.0000
	TSV	**ENTSV**	**KTSV**	**LTSV**	**EXCH**
TSV	1.0000				
ENTSV	0.9620	1.0000			
KTSV	0.6150	0.5837	1.0000		
LTSV	0.9557	0.9983	0.5848	1.0000	
EXCH	0.9159	0.9407	0.5116	0.9416	1.0000

Model Residual Diagnostic Tests

The tests conducted are: Breusch-Godfrey serial correlation Lagrange Multiplier (LM) test; ARCH LM heteroskedasticity test, and Jarque-Bera normality test.

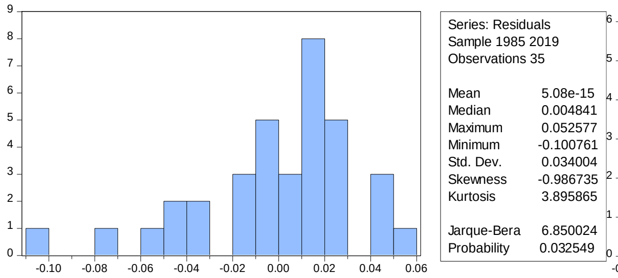
Table 4.10 Diagnostic Tests Result

Diagnostic Tests

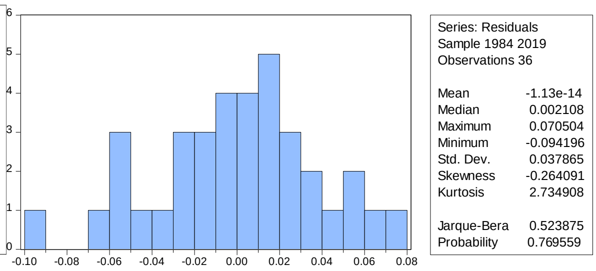
Variable/Diagnostic Test	Serial Correlation LM Test	Jarque-Bera Normality Test	ARCH Heteroskedasticity Test
Agriculture	3.3138 (0.0715)	6.8500 (0.0326)	0.7843 (0.3825)
Crude Petroleum & Mining	0.6913 (0.4173)	0.5239 (0.7696)	0.8241 (0.3706)
Manufacturing	0.3791 (0.6962)	0.9176 (0.6321)	1.1361 (0.2974)
Construction	0.1597 (0.8542)	0.3091 (0.8568)	0.0229 (0.8808)

Trade & Services	0. 4566 (0.6406)	1.5068(0.4708)	0.8630 (0.3599)

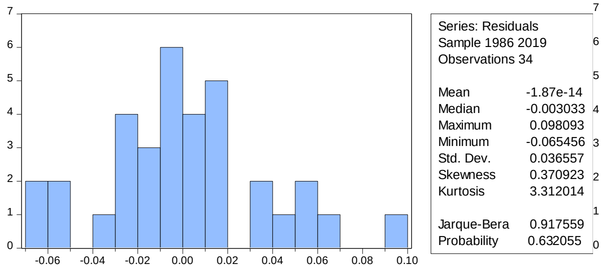
Notes:
i. The first set of values in each row and column, outside the parenthesis are the F-Statistic values
ii. The set of values within the parenthesis are the probability value
Source: Author's Computation using EViews 10, 2021



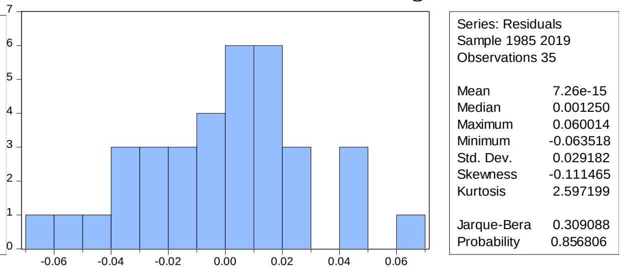
Agricultural Sector



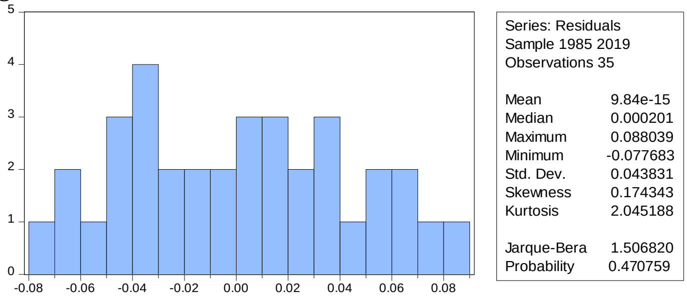
Crude Petroleum & Mining Sector



Manufacturing Sector



Construction Sector



Trade & Services Sector

Model Stability Test

Figure 4.9 CUSUM

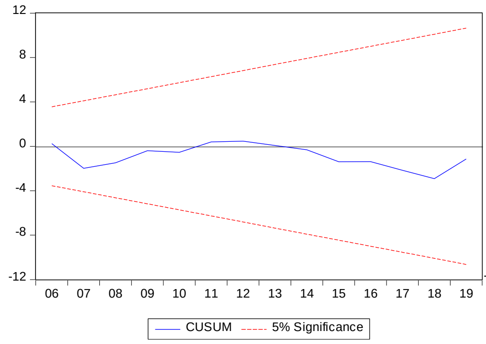
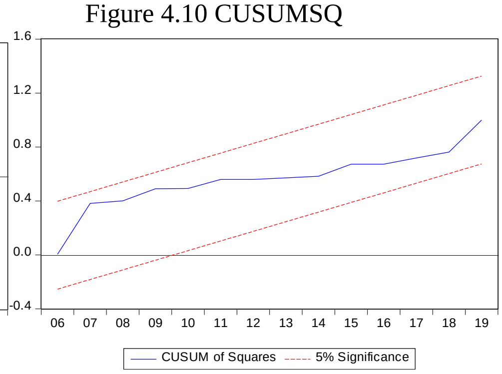


Figure 4.10 CUSUMSQ



Agricultural Sector

Figure 4.11 CUSUM

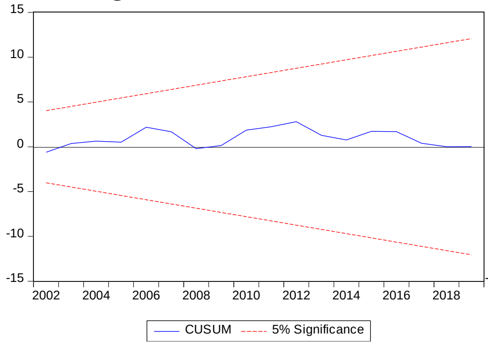
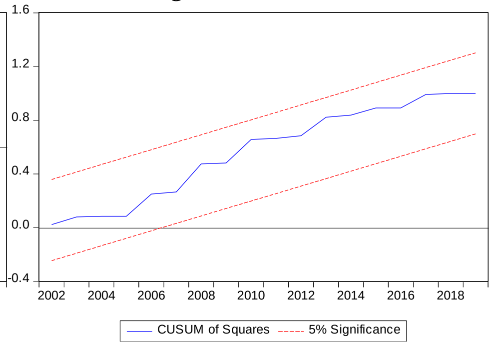


Figure 4.12 CUSUMSQ



Crude Petroleum & Mining

Figure 4.13 CUSUM

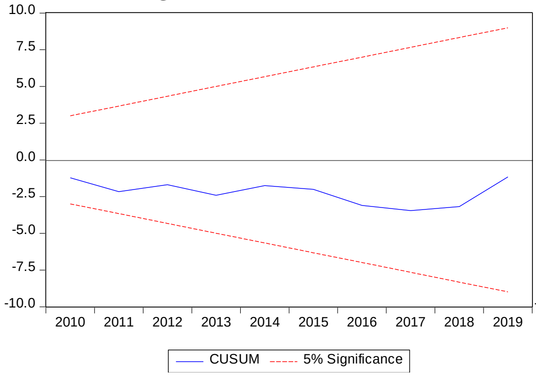
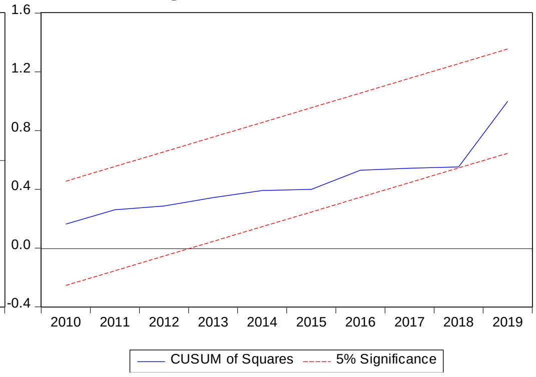


Figure 4.14 CUSUMSQ



Manufacturing

Figure 4.15 CUSUM

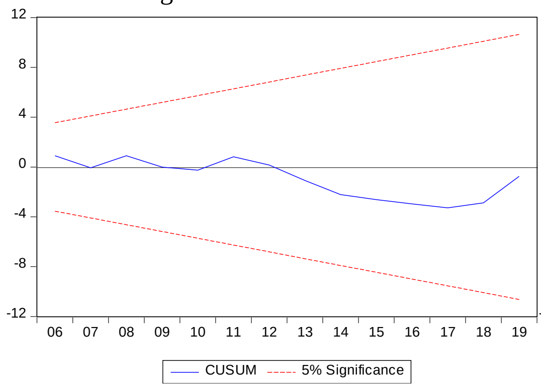
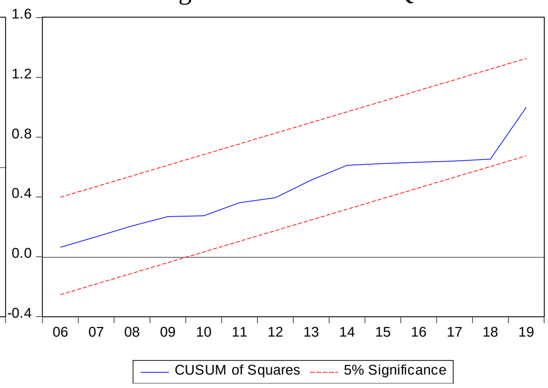


Figure 4.16 CUSUMSQ



Construction

Figure 4.17 CUSUM

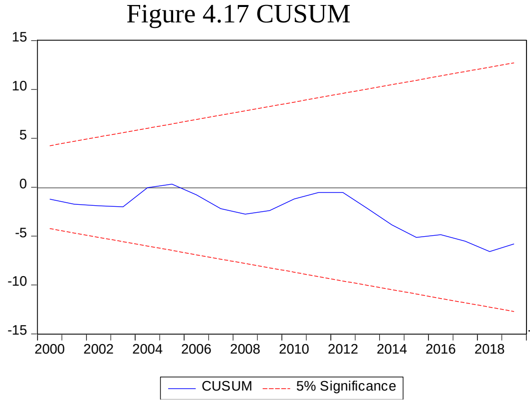
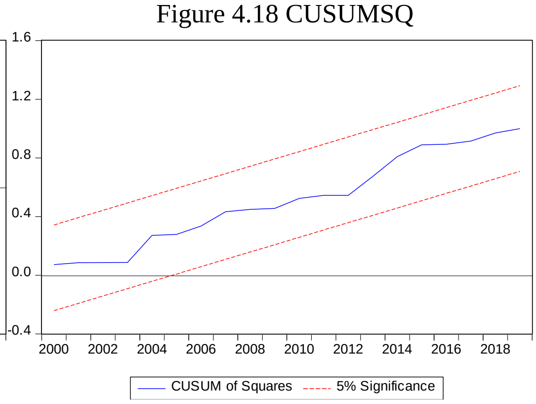


Figure 4.18 CUSUMSQ



Trade & Services