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Energy Sector Performance and Real Sector Activity in Nigeria: An Empirical Re-examination

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Abstract

In spite of the remarkable achievements in the Nigerian economy, the supply of electricity has remained the poor same and this has led to a shift in other alternative sources of power which require burning of fossil fuels and has consequently increased toxic emission. This paper examined the relationship between energy sector performance and real sector activity in Nigeria between 1986 to 2021 using the dynamic autoregressive distributed lag and Granger causality approaches. The model included variables are manufacturing value added (the dependent variable) and electricity consumption, the real gross domestic product, foreign direct investment, population growth and private sector credit as explanatory variables. The finding showed that electricity consumption (performance) has a positive but insignificant impact on manufacturing value added (productivity), while both foreign direct investment and real gross domestic product have positive and significant impacts on manufacturing value added. Furthermore, the Granger causality result showed bidirectional causality between electricity consumption and manufacturing value added and unidirectional causality between manufacturing value added and private sector credit. This paper recommended among others the need for monetary and fiscal policy interactions promote real sector- manufacturing productivity, thus, the Central Bank of Nigeria and Bank of Industry can provide credit incentives at lower cost for industrialist and manufacturers.

Keywords: Energy sector performance, electricity consumption, manufacturing productivity, manufacturing value added, econometric applications, Nigeria

JEL Codes: F14, Q54, L6, L16

Introduction

The real sector measured by manufacturing sub-sector has played an important role in national development especially that of developing economies (Naude, Szirimai & Haraguchi, 2016). The stories of emerging economies-Korea, Singapore and Malaysia have continued to show a positive connection between national economic growth and the growth of manufacturing sector (Banjoko, Iwuji& Bagshaw, 2012). Meanwhile, the sub-sector has not developed to its full capacity in utilization. This has resulted to a lot of challenges including capital flight, poverty, and unemployment among others. In this paper, manufacturing value added was used to measure manufacturing productivity.

In spite of the remarkable achievements in the Nigerian economy, the supply of electricity has remained the poor same. This has led to a shift in other alternative source of power which require burning of fossil fuels and has consequently increased toxic emission (Shuaibu & Oyinlola, 2014). Globally, carbon dioxide (Co_2) emissions account for more than 75 percent of greenhouse gas emissions with about 80 percent of it generated by energy sector (Akpan & Akpan, 2012) . This causes a lot concern given the enormous detrimental effects of pollutants emission on the environment. The energy consumption index of Nigeria over the years has being dipping even in the face of reforms.

Considerable efforts have been made by several studies to examine the relationship between manufacturing sector performance and electricity consumption for example (Binh, 2011; Omotor, 2008; Omisakin, 2008; Odulara & Okonkwo, 2009; Dantama et al., 2012; Olusanya, 2012; Shauibu & Onyiliola, 2014). Most of these studies focused on economic growth, neglecting the persistence of energy depletion on the manufacturing sector. Other studies include (Ezeh & Nnadi(2016); Aseleye *et al.,*(2021); Effiong & Inyang(2020); Ugwoke *et al.,*(2016); Quadiri & Bukola, 2022; Ismail & Hassan, 2016; Kassim & Isik, 2020; Ene *et al;* 2022, Ume *et al.,* 2019) . With the exception of Quadiri and Bukola (2022), these other studies never considered estimating the link in terms of causality between the energy sector and the manufacturing sector. This becomes imperative for energy and manufacturing policy issues. Therefore, the objective of this paper is to examine and estimate the relationship between both sectors in Nigeria as well as the long-run and short-run relationship between electricity consumption and manufacturing value added in Nigeria from 1986 to 2021.

The rest of this paper is adumbrated as follows: Preceding this section is section two, which presents the literature review; section three is the methodology, model specification and data sources. Section four presents the results and discussion, while section five presents the conclusion and policy implications.

Empirical Literature Review

This section presents the extant empirical studies on the related studies. For example, Abiola and Chisaa (2021) investigated the long-run impact of electricity consumption on manufacturing sector performance proxy by manufacturing value added to GDP using canonical co-integration regression for the period of 1981-2019. The result shows that electricity consumption and credit to manufacturing sector have a negative relationship with output. In the employment equation, consumption in electricity and interest rate has negative effects on employment. In conclusion, effects of electricity consumption as input on the manufacturing sector have not improved the performance in the sector. To improve the situation, the study recommended, among others, the need to create a framework to promote energy efficiency by maximizing output from the power sector to minimize wastage.

Ubong and Nora (2020) investigated the relationship between electricity consumption and manufacturing sector performance in Nigeria over the period 1981 to 2018. Electricity consumption per capita was used to represent electricity consumption, while manufacturing sector performance was captured by manufacturing value added. The paper utilized the Augmented Dickey-Fuller unit toot technique, Granger causality test, and the vector autoregressive (VAR) approach. The Granger causality test indicated that a unidirectional causality flows between electricity consumption per capita and manufacturing value added. Meanwhile, the VAR result indicated that both electricity consumption and manufacturing value added were strongly endogenous. That is, they significantly predict themselves. However, electricity consumptions weakly exogenous in predicting manufacturing value added rather, manufacturing value added is strongly exogenous in predicting electricity consumption in Nigeria. This therefore points to the prevalence of the growth driven electricity consumption thesis in Nigeria. This thesis is in support of the conservation of electricity. The variance decomposition and impulse response indicated that variations in manufacturing value added responded more to shocks in itself than from shocks from electricity consumption.

Allcott (2019) conducted a study estimating the effect of electricity shortages on Indian manufacturing sector using Cobb-Douglas production function model, the variables used are electricity in kilo watt and manufacturing output in percentage of GDP. Annual time series data from 1992 to 2018 on weather, power sector and manufacturing production were used. The results obtained revealed that power shortages slowed down production in the manufacturing sector. This resulted in revenue reduction of 5.6 to 8.6 percent for the average plant in a short run. The results have also shown that producer’s surplus dropped 9.5 percent for the average plant, of which 3.9 percent was due to capital costs incurred for backup generators. It was also discovered that in the short run plants reduced their inputs in response to electricity shortages and that led to a decrease in total production.

Ezeh and Nnadi (2018) examined electricity supply and the output of the Nigerian manufacturing sector. The major objective is to critically determine the impact of electricity supply on the manufacturing output in Nigeria. Numerous literatures only revealed the relationship between economic growth and electricity supply, with little empirical attention on the effect of electricity on the various sectors of the economy. This could lead to fallacy of decomposition because economic growth is a function of the performance of different sectors which certainly differ in their need for electricity. In response to this perceived gap, this study explores the relationship between electricity supply and manufacturing sector’s output in Nigeria. Time series data spanning the period between 1981 and 2017 were analyzed using Johansen cointegration and vector autoregression tests. The results revealed that there exists a long run relationship between electricity and manufacturing output in Nigeria. It also identified that electricity supply has an insignificant relationship with the manufacturing sector in Nigeria.

Ganiyu and Odewale (2018) analyzed the performance of Nigerian power sector so as to suggest possible means of ensuring improvements of the sector. Specification and estimation techniques were used for a period of eleven years. Secondary data were sourced from Central Bank of Nigeria (CBN) Statistical Bulletin of 2018 and Nigerian Electricity Regulatory Commission (NERC). The performance of the power generated was evaluated using the overall efficiency and thermal efficiency. The results showed that the average value of the overall efficiency for the ten years period of study was 15.68% while the thermal efficiency had the average value of 15.37%. The result confirmed that deregulation of power sector has no effect on the efficiency of Nigerian power sector when the results were compared with the international best practice standards which are 30% and above for overall efficiency and 45% and above for thermal efficiency. The study therefore suggested possible strategies for efficient power sector improvement.

Ibrahim (2017) examined the relationship between electricity consumption, manufacturing output and financial development in Nigeria. Time series data for 1981 until 2005 was used to examine the symmetric relationship between the electric consumption, manufacturing output and financial development in Nigeria. The result indicates the co-movement in the variable over long time horizon, meaning that any inefficiency in electricity supply would impedes industrial output. Moreover, the Granger causality test based on vector error correction framework shows the presence of causality between power utilization of manufacturing firms and economic growth without feedback. In this sense it can be stress that stable electricity consumption is important factor for Nigeria's manufacturing sector. The result of variance decomposition further indicates that the variation in the industrial output responds more to shocks in the electricity supply than its own shock.

Adebusuyi and Obamuyi (2016) examined how electricity demand impacts the performance of the Nigerian manufacturing sector. The study was conducted over 1970 to 2014 period, and the autoregressive distributive lag (ARDL) bounds test for co integration along with the OLS approach were utilized in the study. The bound test for co integration presented an evidence of a long run relationship existing between electricity demand and manufacturing sector performance; while the OLS result of the translog function indicated that electricity is a weak substitute for both capital and labour.

Hussain and Lean (2015) investigated the relationship between electricity consumption, output, and price in the manufacturing sector in Malaysia using regression analysis. The result revealed that electricity consumption, output, and price are co integrated in the long run. In addition, it has been found that the relationship between electricity consumption and output is positive. In the long run, they find a unidirectional causality from manufacturing output to electricity consumption. This result indicates that the development of manufacturing sector stimulates greater demand for electricity. Government needs to make sure that the planning of electric supply in the future is in line with the economic development planning to avoid shortage in electricity supply. In the short run, a unidirectional relationship runs from electricity consumption to output is found. A decrease of energy usage in production might reduce the output growth in short run.

Aslant (2014) carried out a study in Turkey from 1971 to 2007 using autoregressive distributed lag bound test and Granger causality test. The findings show that there is long-run correlation connecting electricity use and economic growth. Accordingly, the Granger causality test supported the neutrality hypothesis in the short run. However, there is bidirectional Granger causality between electricity use and economic growth in the long-run supporting the feedback hypothesis in Turkey.

Okoh and Ebi (2013) using the linear regression technique, invested the impact of the nexus between the investment in infrastructure and institutional quality-captured using corruption and the enforcement of contracts, and economic growth in Nigeria. The study found that corruption had a negative and significant growth effect, while investment in infrastructure had a positive and significant growth impact. On the other hand, the institutional quality – infrastructural investment nexus had an insignificant growth impact.

Onakoya (2013) found that the consumption of gas has a positive but insignificant impact on economic growth in Nigeria, while the consumption of electricity, petroleum and aggregate energy consumption have a positive and significant effect on economic growth. The consumption of coal was found to have a negative and significant growth impact. The results of similar study by Olusanya (2012) which covered the period 1985 – 2010 indicated that the consumption of petroleum and electricity have positive growth effects. On the other hand, the consumption of coal and gas were found to have negative growth effects. Akpan and Akpan (2012) utilized a multivariate vector error correction model (VECM) in their investigation of the relation between electricity consumption, carbon emissions and economic growth in Nigeria between 1970 and 2008. The study found no causality between economic growth and electricity utilization in Nigeria.

Abu (2012) investigated the link between power supply and business industrial development by examining the influence of government policies on power supply and industrial development in Nigeria. The Johansen co-integration technique was adopted to determine the long run relationship among some macroeconomic variables that includes the industrial component of real gross domestic product (RGDP), explicitly chosen using explanatory variables. The independent variables includes electricity consumption, electricity production (Kwh), growth rate of labour force, real gross fixed capital formation and telephone lines per hundred population and their impact on industrial component of real GDP. Annual time series data on these variables from 1981 to 2010 were collected from the Central Bank of Nigeria Statistical Bulletin, the World Bank and United Nations Statistics. Augumented Dickey Fuller (ADF) and Phillips-Perron (PP) tests are employed to test the order of integration of the variables. The study also performed a Vector Error Correction Model – VECM to correct possible disequilibrium caused in the short-run relationships. The study concluded that electricity condition which is a result of existing government policies exerts a negative impact on industrial output in the long run affects the business viability.

Theoretical Framework, Model Specification and Data Sources

Theoretical Framework/Model Specification

The theoretical framework of this study is the Kaldor growth model. Kaldor's growth theory suggests a vital significance to the manufacturing industry for economic growth. The Kaldor's theory is of the assumption that a close association exists between increasing manufacturing output and increasing gross domestic product made possible by the application/usage of the electricity consumption per kilowatt, as such based on the above literature and following the framework of the adopted growth models, the relationship we want to estimate can be written as:

$$MVA = \alpha 0 + \beta_1 LnDCRE + \beta_2 DINVEST + \beta_3 LnELCON + \beta_4 LnFDI + \beta_5 LnPGR + \beta_6 LnOILPRICE + \beta_7 RGDP + \mu t \qquad 3.1$$

Where MVA is manufacturing value added as percentage of gross domestic product (GDP), DCRE is domestic credit, DINVEST is domestic investment, ELCON is electricity consumption per kilowatt; FDI is foreign direct investment, PGR is population growth, proxy for labour force; OILPRICE is oil price; and RGDP is real gross domestic product; α_0 is the intercept, which is a constant term. Ln is the natural logarithm of the variables that are not in rates or percentages, for proportional effects. These variables are described and justified according to theoretical and empirical reasoning. Following Pesaran *et al* (2001), the Error Correction Model (ECM) of the unrestricted Autoregressive Distributed Lag (ARDL) equation based on the model specified in (3.2) is specified as follows:

$$\Delta MVA_t = \alpha_0 + \alpha_1 MVA_{t-1} + \alpha_2 DCRE_{t-1} + \alpha_3 DINVEST_{t-1} + \alpha_4 ELCON_{t-1} + \alpha_5 FDI_{t-1} + \alpha_6 PGR_{t-1} + \alpha_7 OILPRICEt_{-1} + \alpha_8 RGDPt_{-1} + \sum_{i=1}^{R} B_1 \Delta MVA_{t-i} + \sum_{i=0}^{R} \phi_i \Delta DCRE_{t-i} + \sum_{i=0}^{K} Z_I \Delta DINVEST_{t-i} + \sum_{i=0}^{K} d_i \Delta ELCON_{t-i} + \sum_{i=0}^{K} u_i \Delta FDI_{t-I} + \sum_{i=0}^{K} N_i \Delta PGR_{t-i} + + \sum_{i=0}^{K} \phi_i \Delta OILPRICE_{t-I} + \sum_{i=0}^{K} \partial i_i \Delta RGDP_{t-I} + \sum_{i=0}^{K} u_i \Delta MVA_{t-I} + Ut \quad 3.2$$

Where: U_t is the white noise error term. To establish the short-run relationship among the variables, the following ARDL-ECM- error correction model was estimated.

$$\Delta MVA_t = \alpha_0 + \sum_{i=1}^{K} B_1 \Delta MVA_{t-i} + \sum_{i=0}^{K} \phi_i \Delta DCRE_{t-i} + \sum_{i=0}^{K} Z_I \Delta DINVEST_{t-i} + \sum_{i=0}^{K} d_i \Delta ELCON_{t-i} + \sum_{i=0}^{K} A_i \Delta FDI_{t-i} + \sum_{i=0}^{K} \partial i \Delta PGR_{t-i} + \sum_{i=0}^{K} u_i \Delta OILPRICE_{t-I} + \sum_{i=0}^{R} \phi_i \Delta RGDP + \sum_{i=0}^{K} S_i \Delta ECM_{t-i} + Ut \quad 3.3$$

Procedurally, the descriptive statistic properties of the variables were examined. The unit root, co-integration and diagnostic test were also examined. Table 3.1 presented the data set sources

Table 3.1: Summary of Relevant Data

Variables	Description/Measurement	Source (s)
MVA	Manufacturing value added – proxy for industrial productivity	Central Bank of Nigeria Statistical Bulletin (CBN, 2020)
DCRE	Domestic credit	CBN (2020), NBS (2021)
DINVEST	Domestic investment	CBN (2020), NBS (2021)
ELCONS	Electricity consumption measured in kilo watt	CBN (2020), NBS (2021)
PGR	Population growth proxy for labour force.	NBS (2020)
OILPRICE	oilprice	CBN (2020)
FDI	Foreign direct investment, proxy for investment	CBN (2020)
RGDP	Real gross domestic product	CBN (2020)

Where: NBS = National Bureau of Statistics (2020); WDI = World Bank Development Indicator (2021).
Source: Authors' Compilation (2022)

Result Presentation and Analysis

Descriptive Statistics

This study commences its empirical analysis by examining the characteristics of the variables of estimate. The results are presented in Table 4.1

Table 4.1: Summary of Descriptive Statistics

Variables	MVA	DCRE	DINVEST	ELCON	FDI	PGR	RGDP
Mean	13.52	9.73	30.68	106.16	1.66	1.41	40.361
Std. Dev.	4.83	3.56	12.89	25.19	1.25	38.670	19.660
Skewness	0.19	0.99	0.31	0.55	1.66	0.33	0.41
Kurtosis	1.49	3.64	1.86	1.97	5.73	1.88	1.59
Jarque-Bera	3.61	6.31	2.53	2.74	27.11	2.52	4.03
Prob	0.16	0.04	0.28	0.25	0.00	0.28	0.3
Observation	36	35	36	29	35	36	36

Note: MVA = Manufacturing value added; DCRE = Domestic credit; DINVEST = Domestic credit; ELCON = Electricity consumption; FDI = Foreign direct investment; PGR = Population growth; RGDP = Real gross domestic product.

Source: Authors' computation using EVIEW-10 Software version

From the estimates reported in Table 4.1, it was shown that the mean value for manufacturing value added was 13.52; that of domestic credit were 9.73; that of domestic investment was 30.68 while that of electricity consumption was 106. The foreign direct investment was 1.66; 1.41 for population growth. The mean value of the real gross domestic product was stood at 40.361. The kurtosis coefficient of the variables ranges from 1.49 to 5.73 which reflect a leptokurtic distribution for only FDI. This implies that the data was characterized by the presence of outlier. The probability values for Jaque-Bera suggested that the included variables were normally distributed except for DCRE and FDI. Table 4.2 presents the correlation matrix which detects the presence of multicollinearity in the data series.

Table 4.2: Correlation Matrix Result

Variables	MVA	DCRE	DINVEST	ELCON	FDI	PGR	RGDP
MVA	1.000						
DCRE	0.75	1.00					
DINVEST	0.92	0.74	1.00				
ELCON	0.82	0.62	0.83	1.00			
FDI	0.02	0.09	0.40	0.80	1.00		
OILPRICE	0.87	0.72	0.84	0.91	0.03		
PGR	0.93	0.74	0.97	0.83	0.02	1.00	
RGDP	0.89	0.73	0.94	0.91	0.05	0.97	1.00

Sources: Authors' computation using EView 10 Software version

The results presented in Table 4.2 show that the variables are positively correlated with one another. However, the correlation coefficient of RGDP shows high degree of correlation with domestic investment. This followed by the unit root test to examine the stochastic properties of the variables. The results are presented in Table 4.3

Table 4.3: Unit Root Test Results

Variables	ADF Test Statistic			Philips-Perron Test Statistics		
	Level [I(0)]	**1st Diff.**	**O**rder of Integration I(1)	**Level [I(0)]**	**1st Diff.**	**Order of Integration I(2)**
MVA	-1.367	-9.171***	I(1)	-1.372	-21.861***	I(1)
DCRE	-1.630	-5.136***	I(1)	0.42	-2.955***	I(1)
DINVEST	-0.646	-5.345***	I(1)	-1.004	-5.157***	I(1)
ELCON	-1.180	-5.454***	I(1)	-1.180	-5.971***	I(1)
FDI	-1.661	-3.679***	I(1)	1.960	-3.543***	I(1)
OILPRICE	-1.653	-8.060***	I(1)	1.646	-8.085***	I(1)
PGR	-0.643	-5.859***	I(1)	-1.466	-5.859***	I(1)
RGDP	-2.653	-7.122***	I(1)	-1.954	-7.333***	I(1)

Note: *** and * indicate significant at 1% and 10% levels, respectively or a rejection of the null hypothesis of no unit root. Note: Variables previously defined.

Source: Authors' computation using EView 10 Software Version.

The result of the unit root tests as presented in Table 4.3 showed that ADF test result was a mixture of order zero and order one at the 1% significant level. Again, the PP test showed that the variables were integrated at order 1, which is the highest order of integration. The Johansen co-integration test was used to complement the examination of the long-run relationship between the co-integrated variables. The co-integration test is presented in Table 4.4

Table 4.4: Summary of the Co-integration Estimate

Trace Test				Maximum Eigen Value Test			
Null	**Alternative**	**Statistic**	**0.05 Critical Values**	**Null**	**Alternative**	**Statistics**	**0.05 Critical Values**
$r = 0$	$r = 0$	446.91	159.53	$r = 0$	$r = 0$	172.68	52.36
$r \leq 1$	$r \geq 1$	274.23	125.62	$r \leq 1$	$r \geq 1$	121.30	46.23
$r \leq 2$	$r \geq 2$	152.94	95.75	$r \leq 2$	$r \geq 2$	57.06	40.08
$r \leq 3$	$r \geq 3$	96.87	69.82	$r \leq 3$	$r \geq 3$	37.24	33.88
$r \leq 4$	$r \geq 4$	58.63	47.86	$r \leq 4$	$r \geq 4$	20.87	27.58
$r \leq 5$	$r \geq 5$	37.76	29.80	$r \leq 5$	$r \geq 5$	17.70	21.13
$r \leq 6$	$r \geq 6$	20.06	15.50	$r \leq 6$	$r \geq 6$	15.40	14.26
$r \leq 7$	$r \geq 7$	4.67	3.84	$r \leq 7$	$r \geq 7$	4.67	3.84

Source: Authors' computation using EVEW-10 Software

From the Table 4.4, it was observed that there 8 co-integrating equations at the 0.05 level of significance using the Trace Statistics. Again, from the Maximum Eigen value, there are 4 co-integrating relationship between the dependent variable (MVA) and the covariates. of DCRE, electricity consumption, foreign direct investment, population growth and real gross domestic product. Thus, the trace and maxi-eigen statistic assert the existence of a long-run relationship among the variables. The bound test to co-integration is the major test of this study since we are using the ARDL approach. The results are presented in Table 4.5.

Table 4.5: Results of the ARDL Bounds Test

Unrestricted Intercept	**Critical Values**
F-Statistics	4.26
5% Critical Bound Value	
Lower	2.79
Upper	3.67
10% Critical Bound Value	
Lower	2.37
Upper	3.2
1% Critical Bound Value	
Lower	3.65
Upper	4.66

Source: Authors' computation using EVIEW-10 (Software)

From the results as presented in Table 4.5, and using the standard 5% level of critical value, the E-statistics lies ahead of the lower and upper bounds. Therefore, we accept the alternate hypothesis and reject the null hypothesis and concluded that there is a long-run relationship between MVA and the covariates in line with the Johansen co-integration test of long-run relationship. Having established the long-run relationship among the variables, we proceed to estimate the long-run coefficients based on the ARDL approach is reported in Table 4.6.

Table 4.6: Estimated Long-run Coefficients using the ARDL Approach
Dependent Variable: LNMVA

Variables	**Coefficient**	**t-Statistic**	**Prob.**
C	-42.80	-4.02	0.0069
$LNELCON_{t-1}$	0.08	1.809	0.12
$LNFDI_{t-1}$	1.54	2.51	0.05
$LNRGDP_{t-1}$	0.00	3.32	0.01
LN MVA	1.25	3.51	0.01

Source: Authors' computation using EVIEW-10 (Software).

The long-run estimates as shown in Table 4.6 indicates that electricity consumption, foreign direct investment and real gross domestic product all have positive long run relationship with manufacturing value added in Nigeria within the reviewing period. This implies that a 1 percent increase in electricity consumption, foreign direct investment and real gross domestic product will lead to 0.08, 1.54 and 0.00 percent increase in manufacturing value added.

The results of the short-run dynamics show that the error correction factor is correctly signed and also statistically significant as expected. This showed a rapid rate of adjustment from the short-run disequilibrium to the long-run equilibrium. As can be seen from the result, about 25 percent of the deviation from equilibrium was corrected within one year. The coefficient of determinations shows that the estimated variables with the exception of domestic credit, domestic investment, oil price and population growth removed from the final estimation due to their collinear nature accounted for 0.91 percentage, implying that these variable explained that 91 percent of the variations in the dependent variable (MVA). The adjusted R-Square (0.79) shows that the explanatory variables have explained about 80 percent of the total variations in manufacturing value added in Nigeria. This indicates a high explanatory power of the short-run dynamic model. The Durbin Watson statistic value of 2.62 showed that there's no first order autocorrelation in the model.

The analysis of the short-run estimates show that changes in the previous (one-lagged) period of foreign direct investment and real GDP have positive impact on manufacturing value added while foreign direct investment has a negative impact on manufacturing value added. From the results, foreign direct investment and real GDP were statistically significant at the 1 percent significant. Electricity consumption was not statistically significant in influencing manufacturing value added in the long-run; however, it may be significant impact in the short-run. The short-run dynamic estimates are reported in Table 4.7 using the parsimonious error correction model based in the short-run ARDL version of the estimating equation.

Table 4.7: Estimated Coefficients of the Short-run Dynamic Error Correction Model
Dependent Variable: D(LNMVA)

Variables	**Coefficient**	**t-Statistic**	**Prob.**
C.	0.176	3.19	0.0040
D(LN MVA (-1))	-1.81	-5.02	0.002
D(LN ELCON)	0.03	2.19	0.07
D(LN ELCON)-1))	0.002	0.187641	0.8573
D(LNFDI)	0.750	5.33	0.00
D(LNFDI(-1))	-0.56	-3.36	0.01
D(LN RGDP)	-3.26E-05	-0.22	0.83
D(LN RGDP(-1))	0.000	-3.21	0.01
Cointeq(-1)	-0.25	5.95	0.00

R-Square = 0.91
Adjusted R-square = 0.79
Durbin Watson = 2.62

Source: Authors' computation using EVIEW-10 (Software)

This means that a1percentage increase in the previous period of electricity consumption and real GDP leads to 0.002 and 0.00 percent increase in manufacturing value added respectively, in the short-run. While a 1 decrease in foreign direct investment decrease manufacturing value added by 0.56 percent. Further examination of the short-run model shows that changes in electricity consumption and foreign direct investment are positively but insignificantly related to changes in manufacturing value added in the short-run. The implication of this is that a 1 percent increase in electricity consumption and foreign direct investment bring about 0.03 and 0.75 increase in manufacturing value respectively.

These results are, however, in conformity with theoretical expectations. It is noteworthy that the positive impact of electricity consumption and foreign direct investment reflects the reforms embarked upon in the energy sector in the most recent times. However, the negative impact of the lagged real GDP could be as a result of the shocks on the Nigerian economy including 2008 financial sector crisis, the 2016 recession, the 2020 induced COVID-19 pandemic and recession which affected the global economy including the Nigeria economy. The implication of this finding especially with reference to real GDP is that in the short-run, shocks on the economy may have adverse effect on manufacturing value added.

From empirical analysis, the results of Asaleye (2021) are on the contrary. This study reported a negative relationship with manufacturing value added. In summary, the study concluded that effects of electricity consumption as input in the manufacturing sector have not improved the performance in the sector. This is in line with our insignificant relationship between electricity consumption and manufacturing value added. In the case of foreign direct investment and manufacturing value added, Ido and Taiga (2016) reported a positive but minimal effect of FDI on manufacturing value added, using the vector autoregressive approach. The authors went ahead to recommend infrastructure/power development to improve on the gains of FDI on the manufacturing sector. The positive relationship between FDI and manufacturing value added as revealed by Idoko and Taiga (2016) is in line with our findings.

In the case of real GDP and manufacturing value added, Karami, Naser and Karami (2019) found a significant positive relationship between the variables. The authors suggested for economic policies that promotes growth of the manufacturing sector by increases of manufacturing productivity and increases in the manufacturing employment share to create job opportunities. The Granger causality test results are presented in Table 4.8

Table 4.8: Granger Causality Test Results

Null Hypothesis	Obs	F-Statistic	Prob.	Remark
DCRE does not Granger cause MVA	33	1.10646	0.34	Reject
MVA does not Granger cause DCRE		7.77866	0.00*	Accept
DINVEST does not Granger cause MVA	34	1.00582	0.3781	Reject
MVA does not Granger cause DINVEST		3.69952	0.0371	Accept
ELCON does not Granger cause MVA	37	4.11	0.0304**	Accept
MVA does not Granger cause ELCON		6.92	0.046**	Accept
FDI does not Granger cause MVA	33	0.0160	0.9841	Reject
MVA does not Granger cause FDI		0.336	0.7171	Reject
OILPRICE does not Granger cause MVA	34	0.747	0.482	Reject
MVA does not Granger cause OILPRICE		5.312	0.01	Accept
PGR does not Granger cause MVA	34	1.714	0.1978	Reject
MVA does not Granger cause PGR		8.680	0.0011	Accept
RGDP does not Granger cause MVA	34	3.244	0.05	Accept
MVA does not Granger cause RGDP		1.678	0.20	Reject

Note: Accept at 5% significance. * = Unidirectional causality, ** = Bidirectional causality.

Source: EView-10. (Software) Version

The Granger causality result as presented above showe4d that there is a unidirectional causality between MVA and domestic credit. In order words, manufacturing value added has the capacity for promoting private sector credit. Ekundayo, Ndubuisi and Ismaila (2018) suggested that credit to the private sector exerts positive impact on manufactured output in the long-run. Furthermore, manufacturing value added showed unidirectional causality with investment at a P-value of 0.04. It is expected that investment whether domestic is expected to improve investment, technological capacities and acceleration of industrial performance in domestic firms (Adeboye, Ojo & Ifeoluwa, 2016).

Bidirectional causality was shown between electricity consumption and manufacturing value added and a feedback effect from manufacturing value added to electricity consumption. The result is in contrast to earlier studies (Kassim & Isik, 2020) who showed a unidirectional causality between electricity consumption and manufacturing value added. In addition, manufacturing value added showed causality with population growth and as expected, population growth had no causality with manufacturing value added. Finally, real gross domestic product Granger causes manufacturing value added and not the other way round. This implies a unidirectional causality between real gross domestic product and manufacturing value added. Industrial development has had an important role in the economic growth of countries like China, the Republic of Korea, Taiwan Province of China (Taiwan) and Indonesia.

To ensure the reliability of the estimates, model diagnostic tests were carried out to determine the robustness and stability of the model. The model was tested for normality, serial correlation, auto regressive conditional heteroskedasticity and stability using the cumulative sum residual.

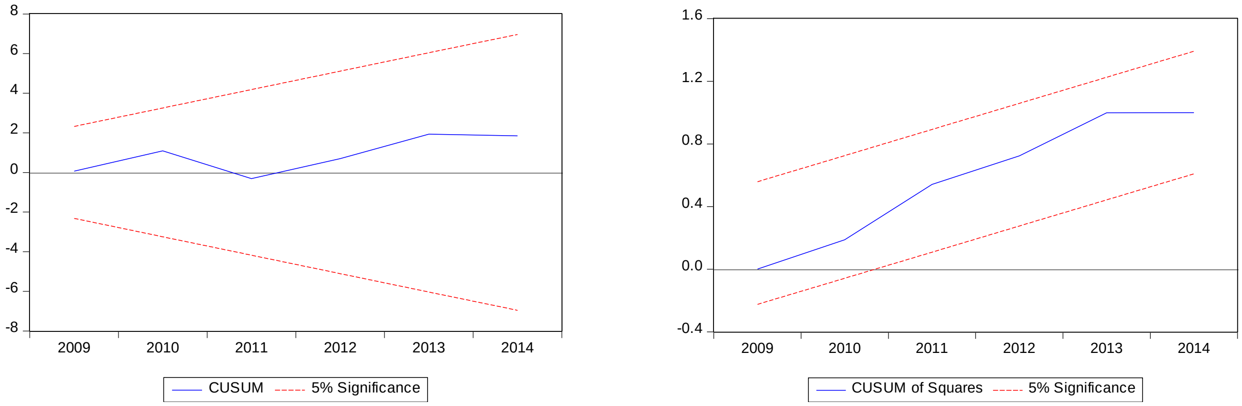
Table 4.9: Model Diagnostic Tests

	Test	**F-Statistic**	**Probability**
1.	Normality: Jarque-Bera Statistics	0.635086	0.727935
2.	Serial Correlation: Breusch-Godfrey Serial Correlation	3.33	0.2131
3.	Heteroskedasticity	0.851003	0.6376
4.	Stability: CUSUM CUSUM Sq	---	0.05

Source: Authors' computation using EVEW-10 (Software) version

This battery of tests showed that the null hypothesis of no serial correlation is not rejected; the coefficient of the variables are unbiased and could be used for forecasting and that the variables are normally distributed. The graph of the CUSUM tests within the 0.05 percent showed that the variables are stable and that the model exhibits stability over time and can be used for forecasting. Figure 4.1 shows the stability of the model using the CUSUM and the CUSUM SQ.

Figure 4.1: The stability diagnostics using the CUSUM and the CUSUM SQ.



Policy Implication of Findings

The policy implication of the findings can be espoused as follows:

(i) Energy sector performance has positive but insignificant impact on manufacturing productivity in Nigeria. This requires some policy actions for improvement.

(ii) External influence through the flow of foreign direct investment has positive and significant impact on manufacturing productivity in Nigeria. Hence, attracted FDI should be sustained since it impacts positively on manufacturing productivity in Nigeria in the immediate to the long term.

(iii) Real gross domestic product has positive and significant relationship with manufacturing value added. This implies that manufacturing productivity has the capacity of promoting national income.

(iv) Since there's a bidirectional causality between energy sector performance and manufacturing sector productivity any policy to promote the energy sector will have ripple effect on the manufacturing productivity and vice versa.

Conclusion and Policy Recommendations

Conclusion

This paper examined the relationship and the causality between energy sector performance and manufacturing productivity in Nigeria between the period 1986-2021, using the autoregressive distributed lag and the Granger causality approaches in line with the overarching objectives of this paper. This paper concluded that the Nigerian energy sector performance has significant impact on manufacturing productivity in Nigeria. Furthermore, it was concluded that there is a long-run relationship between energy sector performance and manufacturing productivity. However, bidirectional causality was suggested between energy sector performance and manufacturing productivity.

Policy Recommendations

This paper suggested the following policies aimed at promoting the energy sector performance and manufacturing productivity in Nigeria.

i) The electricity power sector reform needs to be appraised or evaluated for policy action. This will enable the identification of policy bottlenecks. The improvement of the energy sector will also impact positively on manufacturing productivity.

ii) Monetary and fiscal policy measures can be used to promote manufacturing productivity. The Central Bank of Nigeria and Bank of Industry can provide credit incentives to industrialist and manufacturers.

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