Afropolitan Journals

ISSN: 3027-2971 www.afropolitanjournals.com

Long-run Relationship between Power Consumption and Manufacturing Sector Output in Nigeria

Nwosu Chinedu A.; Emeh Kenneth O.; Ndukwe Obinna P.; Akobundu Precious C.; and Ikechukwu Precious C.

Department of Economics, Alvan Ikoku Federal University of Education, Owerri.

Corresponding author: chinedunwosu2002@gmail.com

DOI: *https://doi.org/10.62154/ajmbr.2024.016.010440*

Abstract

Power remains the engine of growth of every economy while the manufacturing sector remains the key driver of a transformed modern economy. Despite several power sector reforms, Nigeria's manufacturing sector continued to under-perform. This study focused on examining the long-run relationship between power consumption and manufacturing sector output in Nigeria. We estimated an ARDL model based on the bounds testing approach to cointegration. Our result indicate that manufacturing sector output and electricity consumption are cointegrated and that short-run deviations from equilibrium are corrected up to 83 percent annually. The result showed that power consumption is positively related with manufacturing sector output. This implies that improved power sector will stimulate manufacturing sector growth. Our result also showed that capital formation, labour force and private sector credit are positively related to manufacturing sector while monetary policy rate is negatively related to manufacturing sector. Given our findings, we recommend that government should implement a sustainable power sector reform that prioritizes the manufacturing sector. This will stimulate growth and reduce cost of energy and indirectly reduce price of manufactured products. We equally recommend creating a conducive environment for investment in the manufacturing sector through favourable monetary policy rates to allow manufacturers access to credit.

JEL Code: C22, L60

Keywords: Power Consumption, Electricity Supply, Industrial Output, Manufacturing Output, ARDL.

Introduction

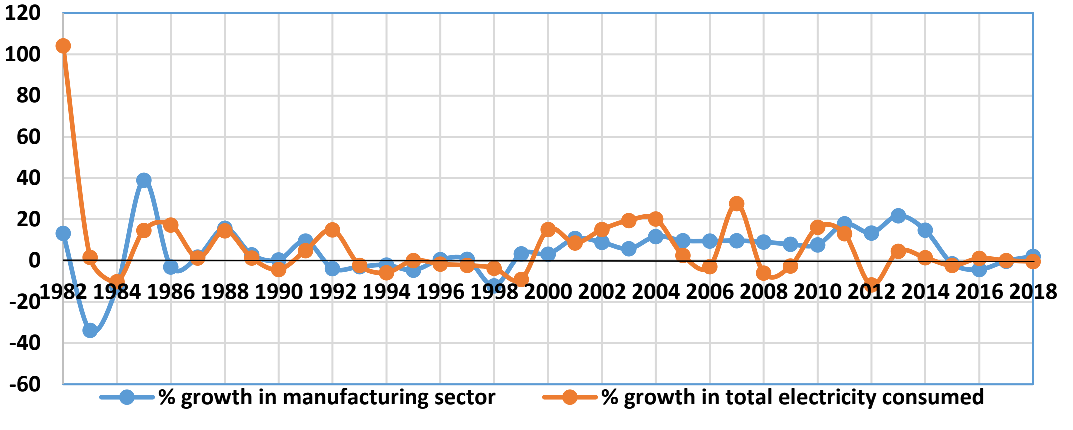
The linkage between energy and economic development is not in doubt as industrial and manufacturing sector productivity depend on energy resources to thrive. Apart from household energy usage for cooking, heating and fueling the automobiles, factories and other forms of business activities require energy for their productions. This linkage created a whole body of research known today as energy economics. However, the issue of energy and economic growth nexus thickened following the energy crisis of the 1970's and since then it has attracted a lot of research attention (Jiang et al, 2011). Most under-developed economies with low rate of industrial output growth are found to be suffering unstable energy production and utilization, particularly electricity utilization (Ugwoke et al,2016;

Asaleye et al.,2021)). According to Velasquez and Pichler (2010), electricity contributes more than 40 percent to manufacturing sector energy need which is why the sector is vulnerable to shortages in electricity supply. As a result, manufacturing firms in developing economies like Nigeria where there is unstable electricity supply incur huge costs to procure alternative sources of electricity. Despite the abundance of energy sources, Nigeria has been greatly challenged in the production, supply and pricing of various types of energy. Specifically, electricity production and distribution remained a huge drag towards the growth of the Nigerian economy. Asaleye et al. (2021) had argued that access to electric power has perennially been inefficient thus adversely affecting the industrialization of the Nigerian economy which has exacerbated poverty and unemployment rates. Furthermore, the quest for structural transformation and diversification of Nigeria's economy has remained elusive due largely to inadequate power supply. According to Ezeh and Nnadi (2016), the total electricity need for the Nigerian economy is 40,000 megawatts whereas the average generated electricity is 4,600 megawatts with its attendant transmission losses. Some of the espoused reasons for electricity supply shortages in Nigeria include: inefficient and inadequate facilities, poor investment and lack of preventive/routine maintenance, outdated and heavily overloaded equipment, insufficient power generation due to operational/technical hitches, disruption of gas supply pipelines, unstable gas pressure and water levels for hydro plants, unsustainable billing system and vandalism and theft of power generation equipment.

Empirically, the manufacturing sector is the hub of growth and development in any economy as it quickens diversification while creating relatively high paying jobs. Ezeh and Nnadi (2016) opine that manufacturing sector performance is the life force for sustainable economic growth and a catalyst for transformation from raw material base into a more active and productive economy. According to Ebomuche et al. (2023), manufacturing sector performance is a key determinant of the pace of growth of Nigerian economy. However, given the poor production and distribution of electricity, the growth rate of manufacturing sector output in Nigeria has continued to be unstable. Yahaya et al (2015) avows that in 2015 alone, the demand for electricity by the manufacturing sector was 2500 megawatts while only 267 megawatts were supplied. This leaves a gap of 2,233 megawatts. Despite huge government investment towards improving electricity production and distribution in Nigeria, electric power has at best remained insufficient. Previously, Adenikinju (2005) had argued that cost of power outages in Nigerian economy imposes significant costs on the business sector. Most companies operating in Nigeria depend on generators with attendant huge petrol cost to survive. Consequently, many Small and Medium Scale Enterprises (SMEs) struggle to survive while some major multinational companies had relocated to neighboring countries where power supply is relatively stable. This scenario has exacerbated the cost of doing business in Nigeria with high price of manufactured products. This had also worsened the issues of unemployment.

Previous empirical studies found a strong correlation between electricity consumption and economic growth as measured by gross domestic product (GDP). This establishes the empirical linkage between total electricity consumed and economic activity. This can easily be confirmed using Nigerian data on the percentage growth rate of manufacturing sector output and percentage growth rate of total electricity consumed. Figure 1 shows the percentage growth rate of manufacturing sector output and total electricity consumed.

Figure 1: Percentage Growth Rate in Manufacturing Output and Total Electricity Consumed



A cursory look shows that the percentage growth rate of manufacturing sector output trails percentage growth rate of total electricity consumed. Most of the period between 1982 and 2018, manufacturing sector output recorded positive growth rates whenever there is positive growth rate in total electricity consumed and in turn recorded a negative growth rate whenever there is negative growth rate in total electricity consumed. For instance, total electricity consumed grew by about 104 percent in 1982 while manufacturing sector output grew by about 13.2 percent. By 1983, the percentage growth rate of total electricity consumed declined to about 1.6 percent while percentage growth rate of manufacturing sector output recorded a negative growth of about 34 percent. Similarly, total electricity consumed grew by about 15 percent in 2000 while manufacturing sector output grew by about 3.2 percent. Even though the percentage of manufacturing sector output growth was higher than percentage of total electricity consumed between 2012 and 2014, it is easily seen that on the average, their growth trajectory has been uniform. This confirms empirical linkage that long-run output growth is related to volume of energy consumed in Nigeria.

The manufacturing sector is a key driver of national economic development through technological innovations, job creation, and growth of the GDP. Electricity consumption remains a crucial input to industrial and manufacturing production. In Nigeria, several energy and power sector reforms have been carried out to stimulate the manufacturing sector growth to reach its maximum potential. In spite of these reforms, the Nigerian manufacturing sector has continued to under-perform due to unstable and unreliable power supply. The research question to be addressed in this study lies in ascertaining if there is a long relationship between electricity consumption and manufacturing sector output. Thus, understanding the long-run relationship between electricity consumption and manufacturing sector growth will help to identify whether improvements in electricity infrastructure through the reforms has enhanced the growth of the manufacturing sector. Therefore, the objective of this study is to ascertain if there is long-run relationship between power consumption and manufacturing sector output in Nigeria. We included data on labour force in manufacturing sector and credit to private sector in our model which to the best of our knowledge is non-existent in Nigeria.

Literature Review

Theoretical Overview

The connection between power consumption and manufacturing sector growth is embedded in the endogenous growth theory. According to Romer (1990), technology and innovation plays crucial role in economic growth. A standard production function can be augmented with energy expressed as Y = Af(K,L,E) where Y is output, K is capital, L is labour while E represents energy. A incorporates technological progress and innovation. In this production function, energy input incorporates electricity which is a crucial driver of industrial machinery, automation and general production efficiency in the energy-intensive manufacturing sector. This implies that there should be affordable and reliable electricity supply to enhance industrial output growth. This theory posits that, given efficient use of labour and capital, constant supply and utilization of electricity is required to enhance technological innovation which yields high manufacturing sector output. Generally, this theory suggests that sectors with constant access to electricity experience faster growth due to the acceleration of technological advancements.

Empirical Review

Modern economies depend largely on power to produce goods and service in commercial quantities. International competitiveness mostly depends on science and technology driven by electric power than on manual capacity of production. Velasquez and Picher (2010) hold the view that electricity as a source of power maintains a decisive position in determining economic growth rate of any country. In this regard, Nigeria experiences poor power consumption due to epileptic and unstable supply. This created energy gap which impedes growth of industrialization. Yahaya et al (2015) avows that in 2015, the demand for electricity by the manufacturing sector was 2500 megawatts while only 267 megawatts was supplied leaving a gap of 2,233 megawatts. In Adenikinju (2003) studied the cost of electricity infrastructure failure in 162 firms in Nigeria and found that manufacturing firms spend over 20 percent of their capital to provide private energy. Nwankwo and Njogo (2013) studied the effect of electricity supply on the industrial production of the Nigerian economy between 1970 and 2010, using a multiple regression approach based on endogenous growth model. The study concluded that the sluggish growth in the manufacturing sector is worsened by the crisis experienced in the power sector. Yahaya et al (2015) in their study on electricity supply and manufacturing output in Nigeria adopted the neoclassical traditional production function to investigate the relationship between electricity supply and manufacturing output in Nigeria. They adopted ARDL bound testing approach and concluded that there exists a long-run relationship between electricity consumption and the output of the manufacturing sector in Nigeria. They identified electricity consumption as a significant factor in the growth of the manufacturing sector output in Nigeria. Husaini and Lean (2015) investigated electricity consumption as a driver of manufacturing sector development of in Malaysia. They estimated an unrestricted error correction model and found that electricity consumption shares a long-run positive relationship with consumer price index and manufacturing sector output. They further found a unidirectional causality running from manufacturing output to electricity consumption indicating that manufacturing sector stimulate demand for electricity in Malaysia.

Ugwoke et al (2016) examined the impact of electricity supply on industrial output in Nigeria using data on electricity consumption, trade openness, industrial production, gross fixed capital formation, human capital development and institutional quality. They estimated Johansen error correction model. Their result showed that electricity supply and trade openness have negative impact on industrial production in Nigeria. Ezeh and Nnadi (2016) studied the impact of electricity supply on manufacturing sector output in Nigeria using time series data on manufacturing sector output, electricity supply, gross fixed capital formation and labour. They estimated Johansen co-integration and vector error correction model. Their result showed that, even though there is insignificant relationship between electricity and manufacturing output, there exist a long-run relationship between electricity supply and manufacturing sector output in Nigeria.

Akinbola et al (2017) investigated the link between power supply and business industrial development in Nigeria. They estimated Johansen co-integration on industrial output, electricity consumption, electricity production, growth rate of labour force, real gross fixed capital formation and telephone lines per hundred population. Their result showed that electricity condition as a function of government policies exert a long run negative impact on industrial output and business viability.

Asaleye et al. (2021) investigated the long-run impact of electricity consumption and manufacturing sector performance in Nigeria. They estimated a canonical cointegration regression on manufacturing sector output, electricity consumption, credit to manufacturing sector, manufacturing labour force, manufacturing market capitalization, interest rate and exchange rate. In the output equation, their result showed a negative relationship between electricity consumption, interest rate, exchange rate and credit on manufacturing sector output. They further argue that this may have emanated from high cost of electricity. Zou (2022) studied the relationship between energy consumption and industrial sector growth in China. The study estimated an error correction model with granger causality between energy consumption, aggregate GDP, value added in industrial, wholesale and retail trades, agriculture, construction and transport. The result of the study showed that there is long-run relationship between energy usage and key industrial sectors.

He also found that there is unidirectional long-run causality running industrial, construction, and wholesale and retail sectors to energy consumption. He further tested the energy conservation hypothesis and found that energy-saving measures in industrial, construction, and wholesale and retail sectors enhance their respective long-run growth.

Research Methodology and Empirical Analysis

The data used for this study were sourced from the CBN statistical bulletin covering from 1981 to 2018. This timeline was chosen in order to exclude economic crisis occasioned by the Covid-19 pandemic period which may affect the result. The time series data set include manufacturing sector output (MAN), total electricity consumption (ELEC), gross fixed capital formation (CAP), labour force in manufacturing sector (LAB), monetary policy rate (MPR) and private sector credit (PSC). All variables have been transformed into their natural logarithm except monetary policy rate.

Following the theoretical and empirical connection of the variables, we hypothesize the functional relationship amongst the variables as follows

$$LNMAN = f\,(LNELEC, LNCAP, LNLAB, MPR, LNPSC) \quad (1)$$

Where;

LNMAN = natural log of manufacturing sector output

LNELEC = natural log of total electricity consumption

LNCAP = natural log of gross fixed capital formation

LNLAB = natural log of labour force in manufacturing sector

MPR = monetary policy rate

LNPSC = natural log of private sector credit

We specify our longrun econometric model as follows;

$$\text{LNMAN} = \beta_0 + \beta_1 \text{LNELEC}_t + \beta_2 \text{LNCAP}_t + \beta_3 \text{LNLAB}_t + \beta_4 \text{MPR}_t + \beta_5 \text{LNPSC}_t + \varepsilon_t \quad (2)$$

We utilized the bounds test to cointegration approach based on the Autoregressive Distributed Lag (ARDL) framework as proposed by Pesaran et al (2001) to test for the existence of long run equilibrium relationship. The ARDL model has the following advantage: it can be implemented for I(0) and I(1) time series variables in a single-equation set-up; different variables in the model can be assigned different lag-lengths; it is possible to implement this model for short time series; it is simple to implement and interpret. Following model (2), a generic unrestricted error correction model (UECM) can we formulated as follows:

$$\Delta y_t = \sum_{j=1}^{p-1} \beta_j \Delta y_{t-j} + \sum_{j=1}^{p-1} \alpha_j \Delta x_{t-j} + \phi\left[y_{t-1} - \{\beta + \delta_i x_{t-1}\}\right] + \varepsilon_t \quad (3)$$

Where Δy_t is difference stationary natural log of manufacturing sector output (LNMAN), Δx_t is a vector of difference stationary explanatory variables (LNELEC, LNCAP,LNLAB, MPR,LNPSC), β and α are short-run coefficients of the regressors in our model, δ_i represents long-run coefficients of the first lag of the explanatory variables, ϕ shows the speed of adjustment to long-run equilibrium relationship while ε_t is a white noise error term. A generic model akin to equation (2) which is represented by the term in the bracket is the long-run equilibrium relationship which can be written as follows:

$$y = \beta + \delta_i x + u_t \quad (4)$$

From equation (4), u_t is distributed as an I(0) process before cointegration can be concluded. Bounds testing approach to cointegration as proposed by Pesaran et al (2001) is based on the F- statistics or Wald test which is non-standard under the asymptotic distribution. The test is couch under the null hypothesis of no cointegration between the examined variables, irrespective of whether they are distributed as purely I(0) or I(1). To implement the bounds test, the null hypothesis is tested on equation (3) based on the joint significance test performed as follows:

$H_0 : \delta_i = 0$ and $H_0 : \delta_i \neq 0$

Pesaran et al (2001) constructed two sets of critical values for significance test at a given level. One set assumes that all the variables are I(0) while the second assumes that they are all I(1) processes. If the calculated F-statistics exceeds the upper critical bounds value, the null hypothesis of no cointegration is rejected. If the calculated F-statistics lies below the lower critical bounds value, the null hypothesis of no cointegration is not rejected and if the calculated F-statistics fall between the lower and upper critical bounds value, the test is inconclusive. After the identification of a long-run relationship, the short-run and long-run dynamic model for equation (3) can be estimated from the following ARDL specification

$$\Delta LNMAN_t = \gamma_0 + \sum_{i=1}^{k} \gamma_1 \Delta LNMAN_{t-i} + \sum_{i=0}^{k} \gamma_2 \Delta LNELEC_{t-i} + \sum_{i=0}^{k} \gamma_3 \Delta LNCAP_{t-i} + \sum_{i=0}^{k} \gamma_4 \Delta LNLAB_{t-i} + .. \sum_{i=0}^{k} \gamma_5 \Delta MPR_{t-i} + \sum_{i=0}^{k} \gamma_6 \Delta LNPSC_{t-i} + ec_{t-1} + \eta_t$$

(5)

Where ec_{t-1} is the first lag of the stationary residual from long-run equation (4). Further tests are performed to check the stability of the estimated parameters on the model.

Result Presentation and Analysis

Unit root test must be conducted before ARDL model estimation. Therefore we carried out unit root test using Augmented Dickey-Fuller (1979) (ADF) to confirm that none of the series are distributed as I(2) stochastic process. The test is based on a null hypothesis of non-stationarity in the series. The result of the test at level and first difference of the series are presented in Table 1.

Table 1: ADF Unit Root Test

Variables	Specification	Test statistic	Prob value	Remark
LNMAN	Constant, trend	-2.40	0.36	Nonstationary
LNELEC	Constant, trend	-4.05	0.01	Stationary
LNCAP	Constant	-3.03	0.04	Stationary
LNLAB	Constant	-1.20	0.66	Nonstationary
MPR	Constant	-3.24	0.02	Stationary
LNPSC	Constant	-0.63	0.85	Nonstationary
Δ**LNMAN**	Constant	-5.25	0.00	Stationary
Δ**LNLAB**	Constant	-6.02	0.00	Stationary
Δ**LNPSC**	Constant	-4.10	0.00	Stationary

Judging by 5 percent level of significance using the probability values, we reject the null hypothesis of nonstationary if the prob-value is less that than 0.05. The result of the ADF unit root tests indicate that LNELEC is trend stationary while LNCAP and MPR are level stationary. LNMAN, LNLAB and LNPSC are nonstationary at level but became stationary at their first difference. This shows a mixture of level stationary and difference stationary series as none of the variables selected for the ARDL model is an I(2) process which indicate that bounds test can be implemented.

We estimated an error correction model with maximum lag length selected based on Akaike Information Criterion (AIC). The appropriate lag order for this study is ARDL (4,4,3,3,3,3) from which we obtained the result of the Bounds test as presented in Table 2.

Table 2: ARDL Bounds Test for Cointegration

F-Statistics	(LNMAN/LNELEC,LNCAP,LNLAB,MPR,LNPSC)			4.67*'**
Critical Values Bounds				
5%		10%		
I(0)	**I(1)**	**I(0)**	**I(1)**	
2.62	3.79	2.26	3.35	
Note: k = 5, * = 5%, ** = 10%				

Given that the computed F-statistics of 4.67 is greater than the upper critical bounds at both 5 and 10 percent levels of significance of 3.79 and 3.35 respectively, we conclude that the variables in our model are cointegrated. Therefore, a long-run equilibrium relationship exists among the selected variables in our model. Given the existence of a long-run relationship, we estimate the long-run model of equation (4) from where we extracted the restricted error correction term of equation (5). Table 3 presents the result of the long run model.

Table 3: Long Run Model Result

Variable	Coefficient	t-Statistic	Prob.
LNELEC	0.55	2.207	0.0583
LNCAP	0.99	4.363	0.0024
LNLAB	0.31	5.271	0.0008
MPR	0.02	0.006	0.0222
LNPSC	-0.02	0.044	0.6902
C	0.78	0.584	0.5748

From Table 3, with the exception of LNPSC, all the estimated coefficients of the long-run model are positively signed and statistically significant. The value of the estimated coefficient of LNELEC of 0.55 implies that a percentage growth in electricity consumption will lead to about 0.55 percent increase in manufacturing sector output. This implies that power sector reforms can enhance electricity supply to the manufacturing sector. This finding is in line with Yahaya et al (2015) who found existence of long-run relationship between electricity consumption and industrialization in Nigeria. This equally implies that power sector reforms can improve electricity supply to stimulate growth of manufacturing sector output. The value of the estimated coefficient of LNCAP of 0.99 shows that a percentage increase in gross fixed capital formation will cause about 0.99 percent rise in manufacturing sector output. This finding corroborates Ugwoke et al (2016) who found a significant relationship between manufacturing sector output and capital formation. The coefficient of LNLAB shows that a percentage increase in manufacturing sector employment leads to 0.31 percent increase in manufacturing sector output while the coefficient of MPR implies 0.02 percentage rise in increase manufacturing sector output. However, the coefficient of LNPSC, though negatively signed is statistically insignificant in long-run. This finding aligns with Asaleye et al. (2021) who found a negative relationship between manufacturing sector output and credit to the manufacturing sector. This implies that private sector credit is not robust enough to stimulate growth in manufacturing sector output.

To find the short-run dynamic equilibrium relationship of equation (5), we estimated the error correction model (ECM) based on the selected ARDL model. The result is presented in Table 4.

Table 4: Short-run Error Correction Model Result
Dependent Variable: DLNMAN

Variable	Coefficient	t-Statistic	Prob.
D(LMAN(-1))	0.249	1.344	0.2156
D(LMAN(-2))	-0.187	-1.449	0.1854
D(LMAN(-3))	0.468	3.074	0.0152
D(LNELEC)	-0.550	-2.313	0.0494
D(LNELEC(-1))	-0.310	-1.227	0.2547
D(LNELEC(-2))	-0.331	-1.555	0.1585
D(LNELEC(-3))	-0.329	-1.816	0.1068
D(LNCAP)	0.293	1.471	0.1793
D(LNCAP (-1))	0.033	0.193	0.8514
D(LNCAP (-2))	-0.223	-1.543	0.1612
D(LNLAB)	0.054	1.512	0.1689
D(LNLAB (-1))	-0.018	-0.353	0.7332
D(LNLAB (-2))	-0.084	-1.817	0.1066
D(LNPSC)	0.002	0.026	0.9797
D(LNPSC(-1))	0.201	1.511	0.1691
D(LNPSC(-2))	-0.133	-1.574	0.1540
D(MPR)	0.009	2.033	0.0764
D(MPR(-1))	-0.007	-1.090	0.3074
D(MPR(-2))	-0.003	-0.780	0.4575
CointEq(-1)	-0.839	-5.024	0.0010

The result of the error correction model from Table 4 indicate that the estimated error correction term ec_{t-1} *(CointEq(-1))* is negatively signed and statistically significant at all conventional levels of significance. The speed of adjustment of short-run deviations from the equilibrium path is about 83 percent. Thus, there is 83 percent adjustment of previous year`s disequilibrium as a result of shock from the explanatory variables back to long-run equilibrium in the current year. The estimated short-run coefficient of LNELEC shows a negative and statistical significance relationship with manufacturing sector output. A plausible explanation to this is the intermittent grid failures which can affect manufacturing production process. This supports Adenikinju (2003) finding that electricity infrastructure failure negatively affects manufacturing output growth. However, the coefficient of lags of LNELEC, though negative in the short-run, are statistically insignificant. Apart from the coefficients 3rd lag of LNMAN and MPR that are statistically significant, other short-run coefficients are statistically insignificant. This justifies the need to implement long term reforms in the related determinants of manufacturing sector in order to achieve sustainable manufacturing sector output growth.

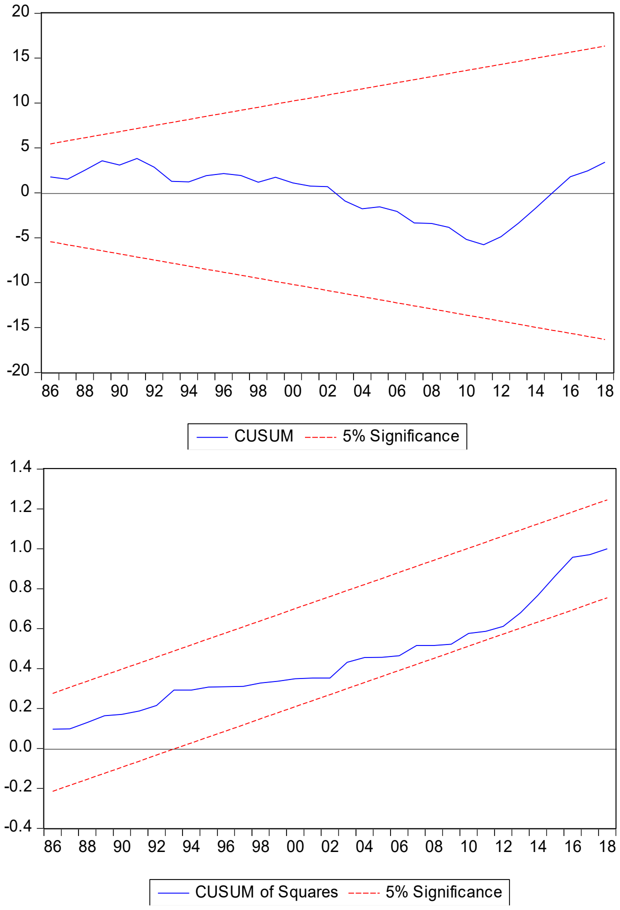
Stability Test

In order to check the stability of our selected model for the given period, we performed the Breusch-Godfrey Serial Correlation LM Test and CUSUM/CUSUM of squares stability tests. The result of the serial correlation as shown in Table 5 shows that the probability value of 0.0545 is greater than the 5 percent level of significance which indicate the absence of serial correlation in the residual. Therefore, we do not reject the null hypothesis of no serial correlation. Figure 1 reports the CUSUM/CUSUM of squares stability. At 5 percent level of significance, the CUSUM and CUSUM of squares test statistics lies within the critical bounds which confirms that the coefficients of the estimated model is stable within the period selected for this study.

Table 5: LM test for serial correlation

F-statistic	4.914	Prob. F(2,6)	0.0545
Obs*R-squared	21.11	Prob. Chi-Square(2)	0.000

Figure 1: Plot of Cumulative Sum of Recursive Residuals.



Conclusion and Recommendation

This study focused on the long-run relationship between power consumption and manufacturing sector output in Nigeria. The motivation for this study is based on the theory that growth in manufacturing sector output depends on availability and access to energy which remains the engine of real sector growth. Electricity remains an integral part of overall energy need of the Nigerian economy. Given that several power sector reforms have been implemented, we investigated the long-run relationship between power consumption and manufacturing sector output. We utilized data set from CBN statistical bulletin (2018) covering between 1981 and 2018 on the following variables: manufacturing sector output (MAN), total electricity consumption (ELEC), gross fixed capital formation (CAP), labour force in manufacturing sector (LAB), monetary policy rate (MPR) and private sector credit (PSC). We estimated an Autoregressive Distributed Lag model based on the bounds testing approach to cointegration. The result from the ARDL model indicate that the variables for this study are cointegrated and that short-run deviations from equilibrium are corrected up to 83 percent annually. This shows that power supply and power consumption are real drivers of the manufacturing sector. This validates the need to carry out a more robust and sustainable power sector reform. Previous reform efforts prior to this study period failed to achieve desired results as current electricity generation and distribution fall below the power demand particularly the manufacturing sector. Furthermore, a thriving manufacturing sector depends on capital formation and a productive labour force. Investment in infrastructure and capital asset will boost manufacturing sector output. The long-run positive relationship between manufacturing sector output and labour force reinforces the importance of human capital development in the sector. Thus, there is the need to invest in education, technical training and skills improvement in the manufacturing sector in order to achieve growth in the sector. Improvement in the manufacturing sector depends on access to credit. So far, there is weak financial sector support in terms of cost of borrowing which stifles manufacturing sector productivity. Thus, there is need to make credit accessible to manufacturing sector investors at a competitive interest to boost manufacturing sector growth. Given our findings, we recommend that government should implement a sustainable power sector reform that prioritizes the manufacturing sector. This will stimulate growth and reduce cost of energy and indirectly reduce price of manufactured products. This is achievable through improvement in power sector infrastructure to forestall incessant power outages. This will guarantee sustainable power supply and reduce overall cost of production. We equally recommend creating a conducive environment for investment in the manufacturing sector. This can be achieved through implementation of a favourable monetary policy rate to allow manufacturers access to credit.

Author`s contribution: Nwosu Chinedu estimated the model and interpreted the results. Emeh Kenneth sourced for the data for the model and wrote the abstract and conclusion. Ndukwe Obinna reviewed the relevant literature and provided the references while

Akobundu Precious and Ikechukwu Precious contributed in the conceptualization of the topic and articulated the introduction of the paper.

References

Abiola, J.A., Adedoyin, I.L., Henry, E.I., Adenike, O.O., Akinyomade, O.O., Olayemi, M.S., and Chisaa, O.I. (2021). Electricity consumption and manufacturing sector performance: evidence from Nigeria. In: *International Journal of Energy Economics and Policy*, 11(4),195 - 201.

Adenikinju, A. F. (2003). Electric infrastructure failures in Nigeria: a survey-based analysis of the costs and adjustment responses. *Energy Policy, 31(14)*, 1519–1530.

Adenikinju, O. (2005). Analysis of the cost of infrastructure failure in a developing economy: The case of electricity sector in Nigeria. *AERC Research paper*, 148.

Akinbola, O. A., Zekeri, A., and Idowu, H. A. O. (2017). The power sector and its impacts on industrialization of businesses in Nigeria. *Archives of Business Research, 5(12),* 294-305.

Central Bank of Nigerian's *Statistical Bulletin* ,2018.

Dickey, D.A. & Fuller, W.A. (1979). Distribution of the estimators for autoregressive time series with a unit root. *Journal of the American Statistical Association*, (74), 427–431.

Ebomuche, N.C., Nwosu. C.A., Emeh, K.O., and Ndukwe, O.P. (2023). Real Sectors Performance as a Precursor to Economic Restructuring in Nigeria. *International Journal of Research and Innovation in Social Science*,7(7), 777-788

Ezeh, Matthew Chinedu and Kenneth U. Nnadi (2016). Electricity supply and output in Nigerian manufacturing sector. *Journal of Economic and Sustainable Development*,7(6), 43-67

Husaini, D.H. and Lean, H.H. (2015). Does electricity drive the development of manufacturing sector in Malaysia? *Frontier in Energy Research*, 3(18), 1-7 doi: 10.3389/fenrg.2015.00018

Jiang, M. M., Chen, B., and Zhou, S. Y. (2011). Embodied energy account of Chinese economy. *Procedia Environmental Sciences*,5, 184-198. http://dx.doi.org/10.1016/j.proenv.2011.03.066

Nwankwo, Olivia C.and Njogo Bibiana O. (2013) Effect of Electricity Supply on Industrial Production within the Nigerian Economy (1970-2010) *Journal of Energy Technology and Policy*, 3(4), 14-38

Pesaran, M.H., Shin, Y. and Smith, R.J (2001). Bounds testing approaches to the analysis of level relationships. *Journal of Applied Econometrics*, (16),289-326.

Romer, P. M. (1990). Endogenous technological change. *Journal of Political Economy*, 98(5), S71-S102.

Ugwoke, T.I., Dike, C.K. and Elekwa, P.O. (2016). Electricity consumption and industrial production in Nigeria. *Journal of Policy and Development Studies,* (10), 8-19

Velasquez, J. R. C., & Pichler, B. (2010) China's increasing economy and the impacts on its energy. *Estudios Gerenciales*, 26(117), 131-143.

Yahaya Y., Salisu, B. M. and Umar, B. (2015). Journal of Economic and Sustainable Development ,6(17),33-55.

Zou, G. (2022). The relationships between energy consumption and key industrial sector growth in China. *Energy Reports,* 8 (1), 924–935.