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ELECTRICITY CONSUMPTION AND MANUFACTURING SECTOR OUTPUT IN NIGERIA: EVIDENCE FROM ARDL APPROACH

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ABSTRACT

Energy plays a crucial role to the prosperity of any nation. Energy demands and the continuous existence of the productive sectors of the economy in Nigeria is such that that must be given prompt attention for national progress and productivity to be achieved in these sectors. This paper tries to examine electricity consumption and manufacturing sector output in Nigeria from 1981 to 2019. By employing the Autoregressive Distributed Lagged Model (ARDL) estimation technique. The variables considered for the study include electricity supply, unit of labour and gross capital formation, government expenditure on power, inflation, as independent variables and Manufacturing sector output as dependent variable. Furthermore, the outcome of the ADF unit root test showed a mix order of integration among the variables employed. The study finds a stable long-run relationship amongst the variables ARDL Wald Test. Estimated results shows that electricity consumption has a positive relationship with manufacturing sector output in the short-run and a negative relationship in the long-run. However, there is a significant impact of electricity consumption and manufacturing sector output in Nigeria Based on the findings above, the study recommends that government and policy makers in Nigeria to present a working economic plan for the manufacturing sector which will increase energy generation to the country and mostly to the manufacturing sector as this will increase local contents and promote the activities of small and medium scale enterprise who depend on energy needs in carrying out their operations.

Contribution/ Originality: This study is one of very few studies which have investigated electricity consumption and its impacts on the manufacturing sector of Nigeria by providing evidence of energy needs of various productivity sector, and drafting meaningful policies on energy solution to the government. Undoubtedly, this study will contribute to existing literature.

1. INTRODUCTION

There is no doubt that constant power supply and increase in electricity consumption is a major move to social and technological advancement for any country (Ajanaku, 2007). In the world today there is no enterprise or any engagement of human capital that does not in one way or the other require power in all forms be it hydro, solar, wind etc. Nigeria is a country endowed with lots of energy sources, yet there has been a wide disparity in the country`s energy demand and supply.

These issues have been in existence since the last decades in Nigeria and still persistent (Odularu & Okonkwo, 2009). One of the major issues facing electricity generation among power generating firms in Nigeria is the issue that has to do with loss of power output and installations. This problem is majorly caused by vandalism of power installations non replacement of worn-out equipment's needed for power transmission. According to the National Electricity Regulatory Commission of Nigeria in 2018 45% of power output is lost all in the process of electricity transmission.

On record various democratic government in Nigeria have built several power plants since 1999 yet the Nigeria economy is yet to drive the full dividend from these huge investments made in the power sector in Nigeria. Ogundipe and Ayomide (2013) opines that most cottage firms which are meant to promote local content have been successfully wiped out due to the high cost of energy generation as for these industries to function optimally they need to run independent power generating plant.

A lot of work has been done in the power sector from 1999 till date. There have been various road maps for the power sector with the aim to diversify the economy through local content and stimulate the manufacturing sector Olufemi (2015). There has been a slight departure from government playing active role in electricity generation; many private sector initiatives have been encouraged in power generation. Also, more hydro stations have been built and commissioned to increase electricity generation, distribution and consumption need of households and the manufacturing sector, yet this has not translated into commensurate increase in electricity availability, consumption and productivity of manufacturing sector in the country (Salau, 2011).

However, this persistent and erratic electricity supply has affected the manufacturing sector which has led to a number of manufacturing firms shutting down production and some relocating to neighboring countries. A considerable number have relocated from Nigeria to other countries like Ghana, Republic of Benin, which guarantee stable power supply (e.g. Michelin).

Thus, issues of erratic power supply have in no small measure affected immensely various productive sectors of the economy of Nigeria and directly the manufacturing sector.

Over 2,500 Megawatt (Mw) is the current energy needs of the manufacturing sector (MAN, 2019) but the various installed distribution power companies can only supply 451 Mw as at 2018. This shortfall will invariably reduce electricity consumption in the manufacturing sector. The lingering problem of electricity in Nigeria is undoubtedly crippling the manufacturing sector which ought to be the main driver of the economy.

However, the aim of this study is to examine if electricity consumption per capita has any significant impact with manufacturing sector output in Nigeria by drawing the long and short run relationships, which is so lacking in most scientific study on the subject matter of electricity consumption and manufacturing sector. Section one above tries to reveal the core problem surrounding the study. Thus, the other sections shall examine reviewed literature done by various scholars both within Nigeria and outside as presented. The third section shall discuss the methodology and techniques, section four shall discuss the results and findings, while the last section shall conclude the paper based on the empirical findings and shall propose possible policy recommendations.

2. LITERATURE REVIEW

Nnaji (2008) aggreed the electricity consumption to the manufacturing sector is an an important indicator to show the wheel of progress of the economy if its growing or declines in growth in the total megawatt of electricty either consumed or consumed to the sector. He further opined that the total electricity consumption per capita in kilowattt (Kw/H) is directly related to the state of industrial growth in such economy. It is however, noted that the poor nature of the state of energy generation and supply in Nigeria has imposed a sigificant cost to the manufacutring sector of Nigeria is has led to decrease in output and productivity (Adenikinju, 2005).

Table-1. Evidence from Selected Studies.

Authors	Study	Methodology	Country/period	Findings
Ugwoke, Dike, and Elekwa (2016)	Energy consumption and industrial production in Nigeria	Error Correction model (ECM)	Nigeria 1980 to 2014	Energy consumption coupled with trade openness that constitute imports and export has not impacted significantly to the industrial production in Nigeria
Adenire and Akpan (2012)	Effect of electricity consumption and industrial output in Nigeria	Vector Autoregressive (VAR)	Nigeria 1981 to 2010	Low level of electricity generation which has minimal impact on economic growth.
Odularu and Okonkwo (2009)	Contribution of energy consumption to economic performance for the Nigerian economy	Co-integration	Nigeria 1991 to 2008	There is a positive relationship between energy consumption and economic growth.
Odularu and Okonkwo (2009)	Energy generation and it effect of the Nigerian economy	Error Correction Mechanism (ECM), Co-integration	Nigeria 1980 to 2008	The long-run energy generation in Nigeria will contribute positive to the National economy thereby increasing the country`s GDP.
Shahbaz, Muhammed, and Talat (2015)	Energy consumption affects economic growth in Pakistan	ARDL	Pakistan 1981 to 2013	Renewable and non-renewable energy sources are of great essence to the energy demands in Pakistan
Ziramba (2009)	Energy consumption, industrial output and employment in South Africa	Cointegration and Granger causality techniques.	South Africa 1980 to 2005	There exist a bi-directional causality running in both direction and affecting energy consumption, industrial output in connection to employment needs in South Africa.
Qazi, Ahmed, and Mudassar (2012)	Imapct of energy consumption and industial output in Pakistan	VAR	Pakistan 1972 to 2010	In the long run energy consumption have the tendency of affecting industrial output positively thereby increasing productivity in the economy of Pakistan.

3. METHODOLOGY

3.1. Empirical Model

The study employs and the modified the model of Shahbaz et al. (2015) in order to an empirical relationship and connection to electric consumption and manufacturing sector in Nigeria where Government expenditure on power is o be used as the control variable. The model is set to determine Electricity consumption and manufacturing sector output in Nigeria as explained by Equation 1.

$$MSOt = F(ECt, GCFt, lF, INF, GEP) \quad (1)$$

Following Qazi et al. (2012); Odularu and Okonkwo (2009); Ogundipe, Opeyemi, and Oluwatomisi (2016) in order to reflect the influence hold by the stochastic variable, Equation 2 is explicitly transformed :

$$MSOt = \beta 0 + \beta 1ECt + \beta 2\,GCFt + \beta 3LFt + + \beta 4\,INFt + \beta 5GEPt + \mu \quad (2)$$

Where manufacturing sector output is measure as the total contribution of the manufacturing sector output by % of GDP denoted by MSO, Electricity consumption is denoted by EC, Gross Capital Formation is denoted by

GCF, labour force unit is represented by LF while Government Expenditure on Power is denoted by GEP. In order to divert from issues of endogeneity in the model and spurious estimation the test for stationarity becomes imperative in such situation thus, the Augmented-Dick-Fuller (ADF) unit root test.

Autoregressive Distributed Lag model commonly known as (ARDL) is best used to estimate both short and long run relationship within a given estimate in a model. however, it is commonly applied while there is a mixed order of cointegration in the unit root test the ARDL approach becomes necessary to apply, the approach also estimate stochastic trends in the long-run i.e. (cointegration). The ARDL technique presents us with a view of how short run individual variable behaves when they are individually affected by the endogenous variable within the model (Onwe, Adeleye, & Okorie, 2019). The selected ARDL (k) model is stated in Equation 3

$$Yt = \delta 0 + \sum_{i=1}^{k} a_1 Xit + \sum_{i=1}^{k} a_2 X2t + \sum_{i=1}^{k} a_3 X3t + \sum_{i=1}^{k} a_n Xnt + \upsilon It \quad (3)$$

$$Xs\ (X1t, X\ , X3t, \ldots\ldots\ldots Xnt)$$

The generalized form of the ARDL model is specified as follows in Equation 4 below:

$$lnMSOt = \Psi o + \sum_{j=1}^{p} \beta j lnMSO_{t-j} + \sum_{i=0}^{q} \alpha i \ln EC_{t-i} + \sum_{k=0}^{q} \gamma k lnGCF_{t-k} + \sum_{m=0}^{q} \varphi m lnINF_{t-m} + \sum_{n=0}^{q} \phi n lnGEP_{t-n} + \varepsilon_t \quad (4)$$

Where ψo is the constant and $\beta_j, \alpha_i, \gamma_k, \varphi_m, \phi_n$ are the parameters to be estimated and ε_t becomes the white noise.

The bounds test for co-integration, is performed using the conditional ARDL (p, q) model as specified below in Equation 5 and 6 below:

$$\Delta lnMSO_t = \vartheta lnMSO_{t-1} + \delta lnEC_{t-1} + \theta lnGCF_{t-1} + \phi lnINF_{t-1} + \psi lnGEP_{t-1} + ln\varepsilon_t \quad (5)$$

$$\Delta lnMSO_t = \sum_{j=1}^{p} \beta j \Delta lnMSO_{t-j} + \sum_{i=0}^{q} \alpha i \ln \Delta EC_{t-i} + \sum_{k=0}^{q} \gamma k ln\Delta GCF_{t-k} + \sum_{m=0}^{q} \varphi m ln\Delta INF_{t-m} + \sum_{n=0}^{q} \phi n ln\Delta GEP_{t-n} + \varepsilon_t \quad (6)$$

The error correction term (ECT) which explains the short run and long run representation of ARDL model is specified in Equation 7 as:

$$lnMSOt = \phi ECT_{t-1} + \sum_{j=1}^{p} \beta j lnMSO_{t-j} + \sum_{i=0}^{q} \alpha i \ln EC_{t-i} + \sum_{k=0}^{q} \gamma k lnGCF_{t-k} + \sum_{m=0}^{q} \varphi m lnINF_{t-m} + \sum_{n=0}^{q} \phi n lnGEP_{t-n} + \varepsilon_t \quad (7)$$

To ascertain that the estimation is free from problem of endogeneity and other estimation issues a stability test is conducted this test shall include various test to check for the presence of autocorrelation and the presence of Heteroscedasticity. In like manner to check for a functional form of correctness of estimation the Ramsey's Reset test is conducted this is to ensure that the estimation is robust and reliable, again the normality test is conducted to test if the model is normally distributed. Similarly, the CUSUM and CUSUMQ is to test if the estimate is stable

4. DATA ANALYSIS AND DISCUSSION

4.1. Unit Root Test

Table 2 ADF Unit Root Result Test at Level and First Difference.

Table-2. ADF unit root result.

Variable	ADF		Order of Integration
	Level	First Difference	
LMSO	-4.939	-7.144***	1(0)
LEC	2.692	-6.301***	1(1)
LGCF	-3.096	-6.983***	1(1)
LLF	-2.253	-4.800***	1(1)
LGEP	-1.421	-7.019***	1(1)
INF	-2.912	-5.778***	1(1)

Note: *** represents significance at 1%, 5% and 10%.

From the results shown in Table 2, our unit root indicate a mix of *I*(0) and *I*(1) series with the results on electricity consumption (EC), Gross capital Formation (GCF), Labour Force (LF), Government expenditure of power (GEP), and Inflation (INF) are all in the order of cointegration of *I*(1) while the results on manufacturing sector output is in order of 1(0).The results show that the series are integrated of different order; 1(1) and 1(0) Therefore, the variables are fit to be used for the analytical purpose and forecasting likewise for the purpose which they were gathered upon which the Autoregressive distributed lag (ARDL) approach comes into play.

4.2. ARDL Bounds Testing for Cointegration

Table-3. ARDL Bound Test.

Model Specification	Period	Optimal Lag	F- Statistics
MSO F(EC, GCF, LF, GEP, INF)	1982-2019	ARDL (1, 1, 1, 0, 1, 0)	8.558541
Critical Value Bounds	10%	5%	1%
I0 Bound (K=5)	2.26	2.62	3.41
I1 Bound (K=5)	3.35	3.79	4.68

Note: Optimal lag length for the ARDL model was chosen based on Schwarz criterion (SIC); indicate 5% level of significant.

Results from the ARDL bound test Table 3 above indicates that the null hypothesis of no cointegration is rejected given that the F-statistics of the bound test is higher than the critical value of I(0) and I(1) regressor as all level of significance i.e. 1%, 5% and 10% respectively. The choice of using the critical value was suggested by Narayan (2005). However, the findings reveal that there is a long run effect forcing all electricity supply and consumption variables to relate unconditionally with the productivity of the manufacturing sector in Nigeria in the Long run period within the period under review.

Table-4. ARDL long and short run results.

Variable	Coefficient	Std. Error	T-statistic	Prob.
LEC	-4.468663	1.781882	-2.507833	0.0185
LGCF	0.533614	0.295952	1.803044	0.0826
LLF	3.678705	1.930211	1.905856	0.0674
LGEP	-0.114329	0.140329	-0.814721	0.4224
INF	-0.008486	0.008068	-1.051737	0.3022
C	-39.559361	32.892399	-1.202690	0.2395
Short run Estimate				
D(LEC)	2.721180	2.511274	1.083585	0.2881
D(LGCF)	-0.609856	0.280866	-2.171344	0.0389
D(LLF)	3.262217	1.864613	1.749541	0.0916
D(LGEP)	0.208477	0.124050	1.680586	0.1044
D(INF)	-0.007525	0.006929	-1.086042	0.2871
ECM (-1)	-0.886784	0.140479	-6.312563	0.0000

From the results of Table 4. The long run results show that the variables of gross capital formation and labour force unit are all positively related to manufacturing sector output in Nigeria such that a unit increase in these variables will bring about (5.3%, and 36%) increase respectively to manufacturing sector output in Nigeria with findings is in line with Adenire and Akpan (2012); Odularu and Okonkwo (2009) and Lookman (2014). This result conforms to apriori expectations based on theoretical evidence of growth models. The error correction term (denoted Adjustment,) is found to be negative and statistically significant -0.8867 the term shows the speed of adjustment process to restore equilibrium following a shock in the long-run equilibrium relationship. This means that the system corrects its previous period disequilibrium at a speed of 88% annually. With a negative sign, fractional and a statistically significant ECM (-1) as shown by the probability value of 0.000, it is obvious that the model has a significant speed of adjustment. Hence, this ECM (-1) upholds the Granger Representative Theorem (GRT) which holds that a negative and statistically significant error correction coefficient is a necessary condition for the variables to be co-integrated thus all condition is satisfied.

The short run results above show that the variables electricity consumption, labour force and government expenditure on power are all positively related to manufacturing sector output in Nigeria such that a unit increase in these variables will bring about proportional increase to the manufacturing sector in Nigeria. this findings candidates with the findings of Shahbaz et al. (2015) for Pakistan, Ziramba (2009) for South African, Noor and Siddiqi (2012) for South Asia Countries.

However, it's discovered from the results that gross capital formation and inflation is negatively related to manufacturing sector in Nigeria. Thus, the overall level of significant shows that the entire influence is statistically significant given the p value of the F-statistic (0.00) is less than 0.05 which shows that all the independent variables employed for the study are all significant to manufacturing sector output from the year under review. Overall the long and short run estimate all agrees that there is positive impact of energy generation and consumption since 1981 till date aligning with the findings by Obasan and Adediran (2010); Odularu and Okonkwo (2009); Olusanya (2012).

Table-5. Diagnostic tests.

Specifications	Stat/P-value	Conclusion
Durbin Waston	1.784	No Autocorrelation
Bruesch Godfrey (Autocorrelation)	0.2760/0.5990	No Higher Autocorrelation
Bruesch Pagan (Heteroscedasticity)	15.697/0.1752	No Heteroscedasticity
ARCH LM	0.4049/0.5241	No Conditional Heteroscedasticity
Jarque Bera Normality	9.289/0.1012	Evidence of Normality

Table 5 shows that the model employed for the study exhibit stable characteristic.

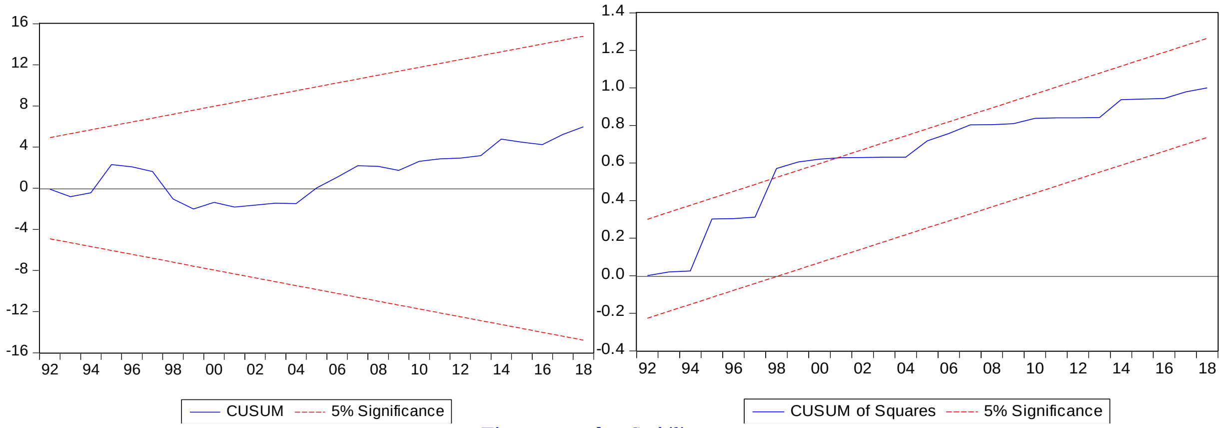

Figure-1 and 2. Stability test.

The CUSUM and CUSUM Square reveals that the mode is stable and lies within the acceptable region at 5% significance level within its boundaries see Figures 1 and Figure 2.

5. CONCLUSION AND RECOMMENDATION

In conclusion the manufacturing sector has shown strong growth in recent years by analysing electricity consumption and manufacturing sector output in Nigeria from 1981-2019 using the Autoregressive Distributed Lag (ARDL) estimation method. Nonetheless, the manufacturing sector in Nigeria is been faced with lots of challenges which has crippled productivity of the sectors these challenges are in the issues of inadequate power supply, nonfunctional power installations and poor plant maintenance which has made the manufacturing sector of Nigeria reductant and may the sector vulnerable to winks of shocks. Evidently manufacturing firms rely heavily on expertise and foreign capital inputs if they must produce at an optimal level.

However, the prospects to improve manufacturing sector performance is not too far from reality if the energy needs and demands to the sectors is given a total and rapid attention. If the government can show total commitment and concern in judicial spending of funds to the manufacturing sector in the areas of adequate supply and distribution of energy needs to the manufacturing sector. The paper therefore recommends that to facilitate a rapid growth in the sector increase its contributions to the country`s national income and output and ensure there is increased productivity and maximal capacity utilization in the manufacturing sector.

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