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Electricity Supply and Output in Nigerian Manufacturing Sector

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Abstract

This research 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 2013 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. For the Nigerian manufacturing sector to serve as a catalyst for the transformation of the Nigerian economy, we recommend that adequate and stable electricity supply must be a policy focus if the desired output of the manufacturing sector is to be achieved.

Key Words: Electricity Supply, Output, Manufacturing, Cointegration, Vector Autoregression

1. Introduction

Nigeria is seen as one of the greatest developing nations in Africa with highly endowed natural resources including potential energy resources. However, increasing access to energy in Nigeria has proved to be not only a continuous challenge but also a pressing issue with the international community (Gbadebo & Chinedu, 2009). The Nigerian economy like other world economies relies greatly on energy consumption (Gbadebo & Chinedu, 2009). World economies are heavily reliant on energy and Nigeria is not an exception. As (Alam, 2006) put it, "energy is indispensable force driving all economic activities." In other words, the greater the energy consumption, the more the economic activity in the nation and as a result a greater economy emerges. The ability of a nation to fully develop and efficiently manage its available resources in order to achieve economic development is linked to energy efficiency. Modern technologies used in production, allocation and utilization of these resources are designed and tied strictly to the use of energy (Amadi, Amadi, & Anyim, 2013).

Manufacturing sector is the aspect of an economy that engages in the production of real goods by transforming raw materials through production process (Yahaya, Salisu, & Uma, 2015). Manufacturing is therefore the life force for sustainable economic growth; is a catalyst to the transformation of an economy from a raw material base into a more active and productive economy (Okonjo-Iweala & Osafo-kwaako, 2007). For an economy to achieve sustainable growth, it is imperative to have a sound manufacturing sector. A vibrant and well-efficient manufacturing sector is a necessary impetus for rapid and favourable economic growth. In modern economy where industrialization is taking pace and mass production is needed for domestic consumption and exports, electricity is regarded as primary factor that facilitates the efficiency and productivity of other factors of production, particularly labour and capital.

Though classical economists considered energy as an intermediate input in production, facilitating factors of production, (Alam, 2006) however argues that it serves as factor input in certain production circumstances. Beaudreau (2005) saw that the transformation of steam, fossil fuel and hydraulic power sources into a more usable form of energy such as electricity as a way forward for greater increase in speed, efficiency and consequently, productivity. Increase in the amount of electricity consumed by the manufacturing sector indicates increase in the speed of operation in manufacturing process which eventually leads to increase in output. In a similar vein, (Riker, 2011) concludes that improvement in the efficiency of electricity use significantly increases an industry's export. Thus, the relationship between electricity and production in machine-driven industry cannot be disentangled, if higher output is to be achieved.

The Nigerian manufacturing sector formally came into existence as a sub-sector of the economy in 1960. Yahaya, Salisu, & Uma (2015) observed that in the 1960s and 1970s, after the country's independence, the manufacturing sector developed positively as a result of Foreign Direct Investment (FDI). This continued hitherto 1980, and thereafter, the sector recorded low growth and development. They also showed that the performance of the manufacturing sector from 1970 to 1980 was satisfactory, afterward, declining trend was observed. The real output of the manufacturing sector declined by 25% from 1982 to 1986. This moribund trend persisted and became worsen as the power sector deteriorates by each day in the country. One of the major factors responsible for this trend is the inadequate and poor power supply which makes cost of production unbearable to remain in business.

Nigeria has recorded a great history of unstable and inadequate electric power supply (Adenikinju, 2003). This problem became more severe in manufacturing sector as the number of manufacturing firms leaving the country and shutting down became more pronounced. Over 800 companies including multinationals have been estimated to have relocated all or part of their manufacturing facilities outside Nigeria where they can get access to a more reliable power supply (Adenikinju, 2003). The problem of erratic power supply in Nigeria has virtually affected all the major sectors of the economy and particularly devastated the manufacturing sector. Report shows that Nigeria needed 40,000MW supply of electricity but only 4,600MW is made available (Report from Nigerian Television Authority (NTA), 2016). The current demand for electricity in the manufacturing sector is 2,500 Megawatt (MW) while the Power Holding Company of Nigeria (PHCN) is only capable of supplying 267 MW, amounting to a short fall of 2,233 MW. The installed capacity of the manufacturing firms' personal power generating plants is cumulatively 597 MW which can still not cover up for the short fall, instead, increase the cost of production and still have a short fall of 1,636 MW (Adenikinju, 2003).

The manufacturing sector as a whole operates on more than 70% of energy it generates using generators; and operating these generators greatly increases the cost of manufacturing goods in the country (NACCIMA, 2012). This high cost of production makes it practically impossible for the firms to compete with their foreign counterparts whose goods are produced and imported into the country at comparatively less cost. The proportion of electricity in manufacturing production cost in Nigeria is 30% to 35% as compared to other countries which is 5% to 10% (MAN Survey, 2009) and (Yahaya, Salisu, & Uma, 2015). This implies that even when the electricity supply is relatively stable, manufacturing production is still relatively costly because of the electricity problem in the country. Manufacturing production cost in Nigeria costs nine times more the production cost of the same item in China, four times in Europe and South Africa, and two times in Ghana (Adenikinju, 2003). This implies that goods produce in Nigeria cannot compete for market with the same goods produce in these countries. Thus, manufacturing firms in Nigeria can neither gain market domestically nor internationally.

In a survey conducted by Marchat et. al. (2002) cited in (Yahaya, Salisu, & Uma, 2015) on Nigerian firms, it was found that 93.9% of the firms described electricity as their major problem while 97.4% of the firms have their private generators. The high cost of operating on generators caused about 800 firms to shut down only between 2009 and 2011. Therefore, the lingering electricity problem in the country is undoubtedly affecting the overall growth in the economy as well as the manufacturing sector. In addition, available statistics indicate that the industrial sector seems to be experiencing slow growth and one of the factors responsible to a considerable extent for this slow growth despite the policies and incentives is poor energy consumption (Ogunjobi, 2015). The manufacturing sector has always emphasized the need to improve various infrastructures, particularly, electricity which is in primary form of energy required for production. The major objective of this study is to empirically evaluate the impact of electricity supply on output in Nigerian manufacturing sector. Specifically, it also determines if there exists a long run relationship between electricity supply and output of the Nigerian manufacturing sector.

This work is organized into five sections: section one is the introduction, section two is the literature review, section three is the methodology, section four is the results and findings and section five as the conclusion of the work.

2. Literature Review

Right from the seminal work by (Kraft & Kraft, 1978) studies on energy consumption and economic growth nexus have figured prominently in the energy literature as also in (Nwosa & Akinbobola, 2012). Subsequently, studies in both developed and developing countries have been conducted on aggregate energy consumption and economic growth nexus but their findings have been inconsistent. Given these plethora of literatures, very few identifiable studies focused on electricity supply on the output of the manufacturing sector in Nigeria.

Ferguson, Wilkinson, & Hill (2000) in a study of over one hundred countries that represent over 90% of the World economy, revealed strong correlation between the amount of electricity use and GDP per capita at general level. When the countries were disaggregated, the correlation was found to be stronger and more pronounced in rich countries compared to poor countries.

Adenikinju (1998) in a study of 667 firms over the period of 1988 to 1990 found that the contribution of energy consumption (electricity) to the growth of manufacturing firms in Nigeria is not significant. However, the firms displayed mixed coefficient signs, but on the overall, the manufacturing sector coefficient is positive. However, in a later survey - based study among 162 firms on the costs of electric infrastructure failure on manufacturing firms in Nigeria by the same author, (Adenikinju, 2003) it reveals that the firms use between more than 20% of their capital in the procurement of private electricity generation equipments to facilitate the supply of electricity for their production activities.

In (Yahaya, Salisu, & Uma, 2015) it was found that there exists long run relationship between electricity and manufacturing output in Nigeria. The study identifies electricity supply as a significant factor in the growth of the manufacturing sector in Nigeria. Nwankwo & Njogo (2013) concluded in their study that electricity generation and industrial production can promote economic development since both variables showed some positive impact on economic development while electricity variable too can impact positively on the industrial sector through adequate flow. This will definitely improve the performance of the industrial sector.

Ogunjobi (2015) studied the effects of electricity consumption on industrial growth in Nigeria. It was found that there exist co-integration relationship between electricity consumption and industrial growth in Nigeria. The study further established positive relationship between industrial growth and labour employment, electricity generation, electricity consumption and foreign exchange rate in the long-run while it had a negative relationship with capital input.

The work of (Nwosa & Akinbobola, 2012), which examined a one-to-one causal nexus between aggregate energy consumption and sectoral output in Nigeria for the period covering 1980 to 2010. From the result of the unit root test and the Engel and Granger co-integration estimate, it was revealed that the variables were not co-integrated. Consequently, the causality nexus between the pair of variables were analyzed using the bi-variate VAR granger causality approach. Base on the analysis, it was revealed that bi-directional causation exists between aggregate energy consumption and agricultural output while a unidirectional causation was found from service output to aggregate energy consumption.

Enang (2010) studied the relationship between economic development, electricity supply and industrialization in Nigeria over the period of 1970 to 2008, and reveals the existence of long run relationship between the variables. Similar significance of electricity supply on growth was established by the same author, (Enang, 2011). In a related study by (Ekpo, Chuku, & Effiong, 2011), using ARDL bound testing over the period of 1970 to 2008 on real GDP per capita, population, electricity consumption and industrial output; it was found that all the variables are significant in influencing GDP per capita.

In an attempt to explore the area of the impact of electricity, numerous literatures only reveal 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.

3. Methodology

The time series data were adopted in this empirical work. To avoid spurious regression analysis, the Augmented Dickey Fuller (ADF) unit root test was adopted to determine the level of integration or stationarity of the time series data. A stationary time series refers to the series with a constant mean, constant variance, and constant autocovariances for each given lag (Brooks, 2008). Given the level of stationarity of the variables, the Johansen Cointegration test was carried out to determine the long-run relationship of the variables in the model with its implied vector error correction mechanism (VECM) to reconcile the short-run disequilibrium. Finally, the Vector Autoregression (VAR) tests were also carried out to determine the impact of the causal relationship among the variables using the unrestricted VAR function, impulse responses analysis and variance decomposition procedures.

3.1 Model Specification

The theoretical framework of this study is hinged on the neoclassical traditional production function following the empirical studies by (Beaudreau, 2005; Beaudreau, 1995; Enang, 2011 & Enang, 2010). The neoclassical production function, particularly (Cobb & Douglas, 1928) expresses the technical relationship between given level of output and a given quantity of physical inputs. A change in output is as a result of variation in the physical inputs. The production function has only two factor inputs in production, but with the emergence of empirical evidence identifying energy or electricity as an independent and primary factor inputs in production process, there is departure from the neoclassical thinking of production function to that which includes energy as an independent factor of production (Alam, 2006). To this respect, our model for manufacturing sector's output constitutes an explicit inclusion of electricity supply as primary and independent factor of production.

$$MFO_t = f\left(ES^{\gamma}K^{\theta}L^{\delta}\right) \tag{3.1}$$

Where

MFO = Manufacturing sectors output

ES = Electricity supply

K = Gross fixed capital formation

L = Labour force

f = Function

γ, θ and σ are the respective contributions of ES, K and L to manufacturing sector's output (MFO). Labour and capital are treated as additional variable to avoid the possible biased findings as a result of exclusion of relevant variables (Wolde-Rufael, 2010). The production function in equation 1 is an exponential function, there is need to log the data in order to linearly express the equation. The estimation of time series properties can best be done through VAR model expressed in log – linear form with time trend or intercept (Pesaran, Shin, & Smith, 2001). Thus, taking the log of equation 1 and transforming it to econometric regression model to be estimated, we have equation 2.

$$LOG(MFO_t) = \beta_0 + \gamma LOG(ES_t) + \theta LOG(K_t) + \delta LOG(L_t) + u_t \tag{3.2}$$

Where

$LOG(MFO_t)$ = Natural log of manufacturing output at time t

$LOG(ES_t)$ = Natural log of electricity supply at time t

$LOG(K_t)$ = Natural log of Gross fixed capital formation at time t

$LOG(L_t)$= Natural log of labour force at time t

u_t = Error term or residual term

γ, θ and δ are the respective coefficients of $LOG(ES_t)$, $LOG(K_t)$ and $LOG(L_t)$

The data were collected from the Central Bank of Nigeria Statistical Bulletin (2014), World Bank Development Indicators for Nigeria and International Energy Statistics (2015), which spans the period of 1981 to 2014.

4. Results and Findings

The relationship between electricity supply and output of the Nigerian Manufacturing sector is examined in this work following the methodological procedure as stated above using Eviews econometric package for all the necessary tests.

Table 4.1: Summary of Augmented Dickey-Fuller (ADF) Unit Root Test

Variable	**Level data**	**1st Difference**	**2nd Difference**	**Order of Integration**
MFO	0.408165	-3.138599	-4.859009	*I*(1)
ES	-2.128156	-5.267863	-8.140528	*I*(1)
K	1.114862	-3.264866	-6.640575	*I*(1)
L	1.821694	0.089976	-3.582694	*I*(2)

1% Critical Value* -3.6661
5% Critical Value -2.9627
10% Critical Value -2.6200

Table 4.1 shows results of the ADF tests and it suggests that only L series is stationary after taking its second difference while MFO, ES and K became stationary after their respectively first differences.

Having ascertained the level of stationality of the variables, this set the pace for co-integration using the Johansen Cointegration test.

Table 4.2: Summary of Johansen Cointegration Test

Equation	**Null Hypothesis**	**Alternative Hypothesis**	**Eigen value**	**Likelihood Ratio**	**5% critical Value**	**1% critical Value**
LOG(MFO)	Series: LOG(MFO) LOG(ES) LOG(K) LOG(L)					
	R = 0	R = 1	0.865839	90.05846	47.21	54.46
	R = 1	R = 2	0.779158	47.87541	29.68	35.65
	R = 2	R = 3	0.433335	16.15891	15.41	20.04
	R = 3	R = 4	0.182484	4.231190	3.76	6.65

Source: Computed using Eview package

The tests of the long-run properties of the variables were also examined using Johansen Cointegration test as shown in Table 4.2. The Likelihood Ratio (LR) indicates four cointegrating equation at 5% significance level. This implies that long-run relationships exist between the variables. From the result of the vector error correction model (VECM), the short-run disequilibrium was reconciled.

Table 4.3 below shows that from the LOG(MFO) model, the first lagged value of LOG(MFO) and first and second lagged value of LOG(L) are respectively statistically significant while other lagged variables in the model are not statistically significant.

From the electricity supply, LOG(ES) model, the second lagged values of LOG(ES) and second lagged value of LOG(K) are respectively statistically significant, while other lagged variables in the model are not statistically significant.

The model of LOG(K) suggests that only the first lagged value of LOG(K) is statistically significant while other response variables are not statistically significant.

LOG(L) model shows that the first and second lagged values of LOG(L) are respectively statistically significant but other lagged variables in the model are not statistically significant.

Table 4.3: Vector Autoregression Estimates

	LOG(MFO)	LOG(ES)	LOG(K)	LOG(L)
LOG(MFO(-1))	0.672649	-3.355258	0.035336	-0.005920
	(0.22600)	(2.51145)	(0.61511)	(0.00516)
	(2.97633)	(-1.33599)	(0.05745)	(-1.14755)
LOG(MFO(-2))	0.043928	2.157360	-0.291622	0.000420
	(0.15364)	(1.70734)	(0.41816)	(0.00351)
	(0.28592)	(1.26358)	(-0.69739)	(0.11973)
LOG(ES(-1))	0.000482	0.378497	0.006113	3.47E-05
	(0.01642)	(0.18243)	(0.04468)	(0.00037)
	(0.02939)	(2.07479)	(0.13683)	(0.09253)
LOG(ES(-2))	-0.307137	0.039565	-0.661354	0.001886
	(0.22137)	(2.45998)	(0.60250)	(0.00505)
	(-1.38745)	(0.01608)	(-1.09768)	(0.37322)
LOG(K(-1))	-0.131857	-0.305109	0.507793	0.000393
	(0.08505)	(0.94510)	(0.23147)	(0.00194)
	(-1.55039)	(-0.32283)	(2.19374)	(0.20251)
LOG(K(-2))	0.144321	-4.384437	-0.244132	0.001732
	(0.09659)	(1.07335)	(0.26289)	(0.00220)
	(1.49418)	(-4.08480)	(-0.92866)	(0.78541)
LOG(L(-1))	21.50227	44.88983	35.79564	1.495088
	(8.70930)	(96.7831)	(23.7042)	(0.19879)
	(2.46889)	(0.46382)	(1.51010)	(7.52103)
LOG(L(-2))	-20.84675	-1.945014	-26.78106	-0.499068
	(8.37636)	(93.0833)	(22.7980)	(0.19119)
	(-2.48876)	(-0.02090)	(-1.17471)	(-2.61034)
C	-3.272161	-605.2270	-121.3919	0.012912
	(15.1495)	(168.351)	(41.2326)	(0.34578)
	(-0.21599)	(-3.59503)	(-2.94407)	(0.03734)
R-squared	0.975764	0.833358	0.986121	0.999900
Adj. R-squared	0.960849	0.730809	0.977579	0.999839
Sum sq. resids	0.104099	12.85524	0.771137	5.42E-05
S.E. equation	0.089485	0.994417	0.243553	0.002042
F-statistic	65.42351	8.126422	115.4544	16323.19

On the whole, the F-statistic showed that the lagged variables in the respective models are jointly statistically significant. The R^2 of the models respectively showed a robust performance.

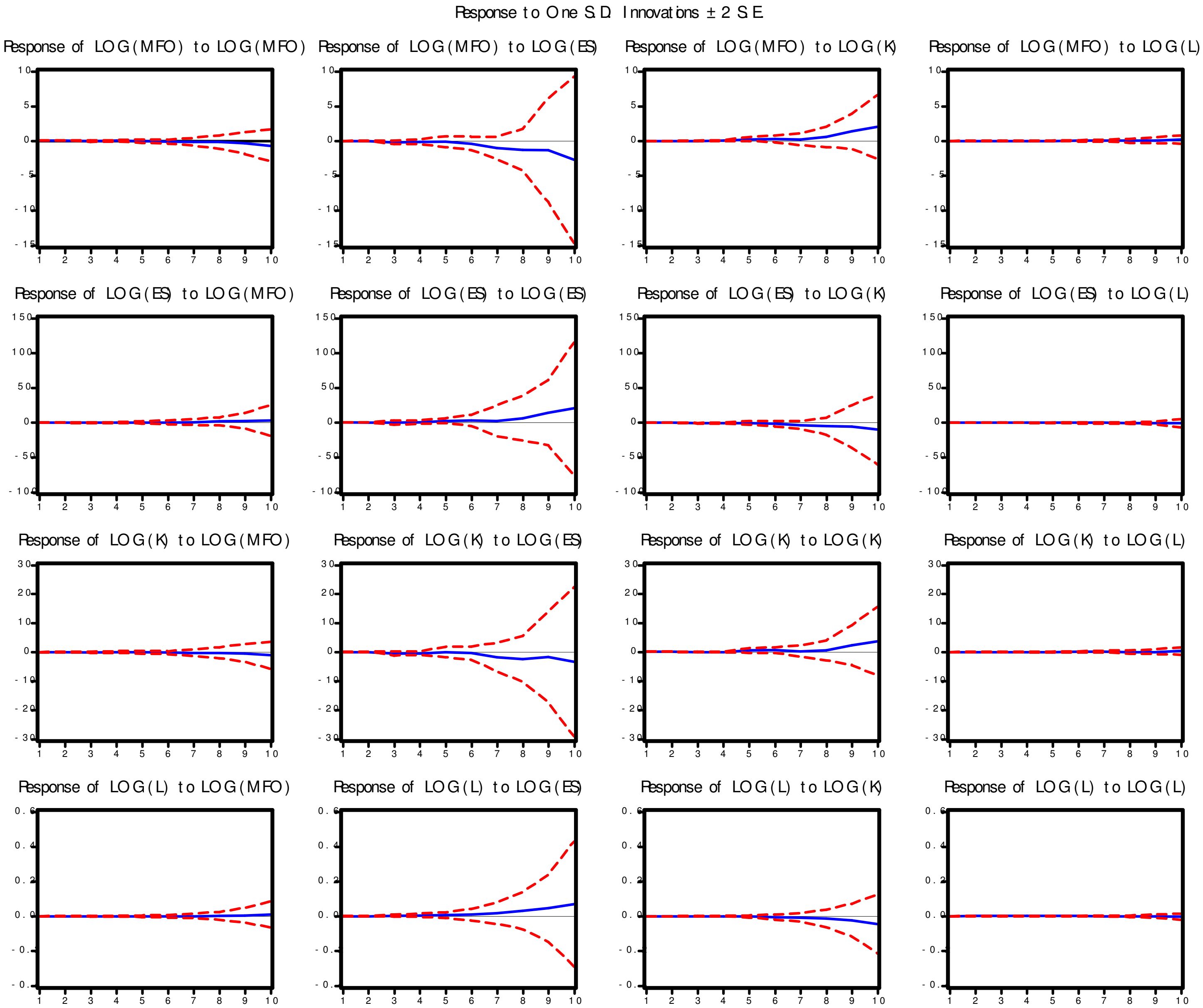

Figure 4.1: Impulse Response Analysis of VAR

Table 4.4: Variance Decomposition

Variance Decomposition of LOG(MFO):

Period	S.E.	LOG(MFO)	LOG(ES)	LOG(K)	LOG(L)
1	0.068788	100.0000	0.000000	0.000000	0.000000
2	0.103337	86.48784	3.962312	4.881591	4.668256
3	0.234579	16.87471	80.40224	0.947573	1.775478
4	0.280035	14.66932	81.42890	2.631692	1.270095
5	0.395058	7.930648	46.38172	44.90819	0.779442
6	0.626602	5.377642	52.64410	40.96053	1.017728
7	1.197390	2.968391	80.61027	15.87006	0.551284
8	1.833224	1.995030	80.72857	17.01883	0.257569
9	2.685763	2.218063	62.47022	35.13377	0.177949
10	4.367056	3.145553	61.47726	35.04537	0.331824

Variance Decomposition of LOG(ES):

Period	S.E.	LOG(MFO)	LOG(ES)	LOG(K)	LOG(L)
1	0.764414	3.855843	96.14416	0.000000	0.000000
2	0.843846	5.505819	93.79395	0.395117	0.305118
3	1.145145	4.165736	51.85281	43.81570	0.165749
4	1.640651	4.343588	54.39948	40.56221	0.694725
5	3.195081	2.495241	84.61355	12.49611	0.395090
6	4.645751	1.606950	84.04025	14.16566	0.187145
7	6.564628	1.921900	59.38634	38.56690	0.124864
8	10.61787	3.291360	58.83478	37.50144	0.372420
9	18.96022	2.770235	76.79647	20.11097	0.322322
10	29.93145	2.174291	78.00986	19.63798	0.177867

Variance Decomposition of LOG(K):

Period	S.E.	LOG(MFO)	LOG(ES)	LOG(K)	LOG(L)
1	0.187221	7.208378	0.099263	92.69236	0.000000
2	0.216582	5.390402	3.927289	87.73711	2.945196
3	0.508292	5.029279	77.61230	15.94265	1.415772
4	0.644863	3.153781	85.72231	10.24267	0.881238
5	0.837162	2.299772	50.89885	46.27849	0.522893
6	1.157363	4.858908	34.78123	59.27930	1.080560
7	2.165544	3.612123	76.69124	18.88027	0.816373
8	3.293719	2.075333	85.80701	11.75422	0.363435
9	4.398724	1.923065	62.01422	35.85535	0.207367
10	6.711404	3.504988	49.80949	46.26512	0.420396

Variance Decomposition of LOG(L):

Period	S.E.	LOG(MFO)	LOG(ES)	LOG(K)	LOG(L)
1	0.001570	17.54354	38.64145	0.076801	43.73821
2	0.002724	10.07476	42.64877	0.274409	47.00206
3	0.004497	4.251691	62.15287	2.277441	31.31800
4	0.007470	1.541426	78.87033	2.441661	17.14658
5	0.010371	0.919288	85.24151	1.568506	12.27070
6	0.014441	0.482554	83.64885	8.292919	7.575681
7	0.023679	0.553018	84.74931	11.72967	2.968002
8	0.041182	0.717475	87.04304	11.24676	0.992719
9	0.066783	0.916935	82.61276	16.09257	0.377743
10	0.106828	1.414435	74.76515	23.65219	0.168229

Ordering: LOG(MFO) LOG(ES) LOG(K) LOG(L)

Figure 4.1, which shows the impulse response analysis of VAR model suggests that the response of the lagged value of the LOG(MFO), LOG(ES), LOG(K) and LOG(L) to the LOG(MFO) is indeterminate. About the same period, the response of LOG(MFO) and LOG(K) shows negative to LOG(ES) and the response of LOG(ES) and LOG(L) showed positive to LOG(ES). LOG(K) at same period responded positively to LOG(MFO), its own shock and negatively to LOG(ES) and LOG(L) and the response of LOG(L) to all the variables is indeterminate.

Table 4.4 shows the Cholesky Ordering variance decomposition of the VAR model. It shows the percentage extent of the transmission of the lagged explanatory variables on the endogenous variables. The variance decomposition results of LOG(MFO) suggest that a positive transmission of the one period lagged value of LOG(MFO) brings about 100% variation in current LOG(MFO) known as own shock, while other variables do not have any shock on the LOG(MFO), but their respective impacts were shown in subsequent periods.

The extent of variables transmission on the LOG(ES), LOG(K) and LOG(L) at the various periods are shown also in the Table 4.4.

5. Conclusion

This research has empirically examined the electricity supply and the output of the Nigerian manufacturing sector using data spanning the period of 1981 to 2013. Time series data were presented and analysed through the Augmented Dickey-Fuller (ADF) unit root, Johansen cointegration and its implied vector error correction method and Vector Autoregression Tests using impulse response and variance decomposition analysis. The study found that there exist a long run relationship between electricity and manufacturing output in Nigeria. It also identified that electricity supply is not statistically significant to the manufacturing sector output in Nigeria. This is not uncorrelated with the outages in electricity supply in Nigeria. The growth of the Nigerian manufacturing industry is heavily anchored on adequate and stable electricity supply.

For the Nigerian manufacturing sector to serve as a catalyst for the transformation of the Nigerian economy as identify by (Okonjo-Iweala & Osafo-kwaako, 2007) in (Yahaya, Salisu, & Uma, 2015), we emphatically recommend that adequate and stable electricity supply must be a policy focus if the desired output of the manufacturing sector is to be achieved. With the presently weak manufacturing sector, the country's visionary policy of being among the 20 industrialized economies in the world by the year 2020 is certainly a mirage. If the country must achieve this vision, this study recommends that more attention should be given to the electricity sector in the country in order to galvanize the manufacturing sector. This will not only spur the manufacturing sector but create employments, reduce poverty and general price level. It is also recommended that further research be directed towards the effect of electricity supply on other subsectors of the Nigerian economy.

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