PUBLIC SUPPLY OF ELECTRICITY AND ECONOMIC GROWTH IN NIGERIA

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Abstract
This study examined the effects of public supply of electricity on economic growth in Nigeria. In doing this, the work employed time series data spanning about forty-two years (1970-2014). Using the Vector Error Correction Mechanism (VECM), the result points to the fact that, Nigeria's national output could significantly and consistently improve in the face of available and sustained electricity supply. Our findings indicate that this can greatly be achieved through a targeted investment in the power sector, as this will enhance improvement in the manufacturing and other relevant subsectors of the real sector of the economy, since power itself must be considered a basic input if the economy must be industrialized. In line with this, the present efforts on the part of government are encouraged to be more honest, clear, target oriented and sustained.

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1. Introduction

In modern economies, electricity is a necessary requirement in the production of goods and services. It plays a crucial role in daily economic and social activities of the people, and in the functioning of the various sectors of the economy. Any country with poor supply of public electricity will experience sluggish growth and stunted development in the various aspects of its economy. Electricity subsector in Nigeria has been plagued with many constraining issues, such as inadequate-installed capacity, poor power generation, power loss in transmission and inadequate maintenance. These, among other constraining factors, have kept electricity supply in Nigeria quite below the demand for it. This imbalance between electricity supply and demand in Nigeria has lingered since 1970s. Thence, successive governments have made various efforts to meet the demand for electricity in Nigeria. One of such efforts has been increase in installed capacity (MW/h). For instance, installed capacity was stepped up from 804 MW/h in 1970 to 2330.5 MW/h in 1980. In 2014, installed capacity was raised to 12,323 MW/h. In the last few years, public electricity supply in Nigeria has been privatized with the aim of improving its generation and supply. However, the demand for electricity in Nigeria still is greater than the supply; it increases steadily with increase in population and urbanization. The inability of electricity supply to meet its demand in Nigeria has had some negative impacts on the growth of productivity. The unrivalled role of electricity in daily economic and social activity has compelled many households and business organizations to acquire power generating sets to either supplement or complement public supply of electricity. This has had some economic costs; it adds to costs of production of business organizations. Also, carbon mono-oxide emitted by the power generating sets pollutes the environment. To check the high production costs, many business organizations may operate below capacity, which usually results in low productivity.

This paper seeks to examine the impact of supply of public electricity on economic growth in Nigeria. The paper is structured into five sections. Section two reviews related literature. Section three presents some stylized fact on the Nigerian electricity sub-sector. Model specifications and method of data analysis are presented in section four. In section five results are presented and analysed, while recommendations and conclusion are in section six.

2. Theoretical and Empirical Overview

2.1 Theoretical Overview

Electricity is among economic infrastructural facilities that form the capital stock of an economy which provide the society with services necessary to conduct daily social and economic activities (Mody, 1997). Electricity is one of the essential economic infrastructural facilities required in a country for economic growth and development (Todaro, 1980; Aigbokan, 1999). In modern economies, electricity has been accorded priority due to its significant role in the functioning and growth of industries.

However, in Nigeria, for many years, in many parts of the country, electricity supply has been very inadequate - characterized by low installed capacity, low power generation, epileptic flow, protracted blackouts and incessant supply-fall. This has had negative effects on the economy. Samuel and Lionel (2013) observed this and suggested that some measures of technology should be put in place to cub power loss and boost electricity supply in Nigeria. Practically, there are many issues to consider when thinking about steady economic growth in Nigeria. One of such issues is electric power shortage. A functional power sector, together with chemical and iron and steel industries, are the indispensable factors in industrialization process of any nation (Ayodele, 1999, Olayemi, 2012). Iwayemi (1998) argued that for Nigeria to experience steady economic growth and move towards industrialization, there must be a remarkable improvement in electric power supply to stimulate production in the various sectors of the economy. One important indicator of a sustained economic growth is the megawatt of electricity consumed. A country's electricity consumption per capita in kilowatts per hour (KwH) is proportional to the state of industrialization of the country (Adenikinju, 2005, Ndebbio, 2006). Ekpo (2009), on this note, argued that for Nigeria as a nation to accelerate the pace of its industrialization, the country should first fix the power supply problem.

2.2 Empirical Overview

In a study by Odell (1965) to investigate the role of electricity in the development of the Columbian economy, he observed that electricity was very important for economic growth and industrialization. According to Odell (*ibid*), what is critically important for development is the capacity to consume energy produced and not the capacity to just produce it. That is, electricity should be supplied to meet the required demand. Also, in a survey of small enterprises in Ghana in 1991 with respect to factors affecting their operations, power outage was ranked number one (Steel and Webster, 1991). Thus, the issue of electricity supply, its adequacy and reliability is very important even at the micro level of the economy.

Oke (2006), Kessides (1993) and Atser (2008) variously identified the poor state of public electricity in Nigeria as the paramount hindering factor to expected competition among private firms; as running of private power generators by the firms increases costs of operations precipitously. Sambo (2008), in an assessment of the effects of electricity on socioeconomic development discovered that inadequate supply of electricity largely restricts the expansion of socioeconomic activities, limits growth and adversely affects quality of life. Sambo (*ibid*) recommended adequate and reliable electricity supply as an indispensable input for achieving socioeconomic development. Ukpong (1976), in assessing electricity consumption in Nigeria, and using a simple regression analysis established that there is a high positive relationship between electricity consumption and industrialization, which would lead to economic development. In other words, adequate electricity supply/consumption is very vital infrastructure in accelerating the growth of industries and by extension the national economy. However, Ukpong (*ibid*) observed that in Nigeria, the demand for electricity was far more than the supply, a trend which has protracted to this day. The poor state of public electricity in Nigeria has had a negative impact on its economic performance. According to Lee and Anas (1992), in a study of 179 manufacturing firms in Nigeria, most manufacturing firms in Nigeria produce quit below installed capacities. They also reported that manufacturing sub-sector in Nigeria spend not less than 50% of their variable cost-outlay on power. Thus, for the manufacturing sector in Nigeria to grow and bring about the expected economic growth, adequate and steady supply of public electricity is inevitable. Ukpong (1973) investigated the cost incurred by selected firms in Nigeria due to power outages for 1965 and 1966, using the production function approach, and discovered the corresponding costs of the power outage to the selected firms in the two years to be N1.68million and N2.75million, respectively.

3. Electricity Supply in Nigeria: Some Stylised Facts

The generation and supply of electricity is very critical to productivity in the manufacturing subsector and by extension, the entire economy. The performance of Nigeria's power sector is often analysed in terms of installed capacity, generation capacity, and consumption and transmission/distribution losses. Since power is critical to the productivity of any economy, the viability of the power sector in any economy should be of essence if such an economy must survive and grow. Table shows the Installed Capacity, Capacity Utilization, Electricity Generation, Electricity Supply and Power Losses in Transmission in Nigeria (1970-2014)

Table 1: Installed Capacity, Capacity Utilization, Electricity Generation, Electricity Supply and Power Losses in Transmission in Nigeria (1970-2014)

Year	Installed Capacity (mw/hr)	Electricity Generation (mw/hr)	Capacity Utilized (%)	Electricity Supply (mw/hr)	Power Loss in Transmission (mw/hr)	Power Loss as % of Electricity Generated
1970	804.7	176.6	21.9	145.3	31.3	17.7
1975	926.2	395.4	36.2	318.7	76.6	19.4
1980	2,330.5	815.1	36.5	536.9	278.2	34.1
1985	3,695.5	1,166.6	31.6	717.40	449.4	38.5
1986	4,016.0	1,228.9	30.6	841.80	387.1	31.5
1987	4,548.0	1,286.0	28.3	852.90	433.1	33.7
1988	4,548.0	1,330.4	29.3	853.50	476.9	35.8
1989	4,548.0	1,462.7	32.2	976.60	486.1	33.2
1990	4,548.0	1,536.9	33.8	898.50	638.4	41.5
1991	4,548.0	1,617.2	35.6	946.60	670.6	41.5
1992	4,548.0	1,693.4	37.0	993.00	700.4	41.4
1993	4,548.6	1,655.8	36.4	1,141.40	514.4	31.1
1994	4,548.6	1,772.9	39.0	1,115.00	657.9	37.1
1995	4,548.6	1,810.1	39.8	1,050.90	759.2	41.9
1996	4,548.6	1,854.2	40.8	1,033.30	820.9	44.3
1997	4,548.6	1,839.8	40.4	1,009.60	830.2	45.1
1998	4,548.6	1,724.9	37.9	972.80	752.1	43.6
1999	5,580.0	1,859.8	33.3	883.70	976.1	52.5
2000	5,580.0	1,738.3	31.2	1,017.30	721.0	41.5
2001	6,180.0	1,689.9	27.5	1,104.70	585.2	34.6
2002	6,180.0	2,237.3	36.2	1,271.60	965.7	43.2
2003	6,180.0	6,180.0	38.8	1,519.50	4,660.5	75.4
2004	6,130.0	2,763.6	45.1	1,825.80	937.8	33.9
2005	6,130.0	2,779.3	45.3	1,873.10	906.2	32.6
2006	6,999.5	2,638.1	37.7	1,742.90	895.2	33.9
2007	7,011.6	2,623.1	37.4	2,245.50	377.6	14.4
2008	7,011.6	2,403.2	34.3	2,108.00	295.2	12.3
2009	7,816.1	2,257.6	28.9	2,060.71	196.9	8.7
2010	8,820.7	2,981.9	33.8	2,383.08	598.8	20.1
2011	9,287.0	3,086.1	33.2	2,703.00	383.1	12.4
2012	9,937.0	3,268.0	32.9	2,898.50	369.5	11.3
2013	12,323	3,350.3	n.a	n.a.	n.a	n.a
2014	12,323	3,300.0	n.a	n.a	n.a	n.a

Sources: 1. CBN *Statistical Bulletin* (2007), p.172; **2**. CBN *Annual Report* (2014), pp. 145-147
3 Ekpo and Bassey (2016)

From Table 1, in 1970, electric power installed capacity in Nigeria was 807.47 MW/h, out of which 21.9 percent capacity was utilized with 176 MW/h electricity generated. Out of this, 31.3 MW/h was lost in transmission while 145.3MW/h was actually supplied. In 2000, installed capacity was 5580.0 MW/h, out of which 31.2 percent was utilized. This generated 1738.3 MW/h of electricity with 721.0 MW/h lost in transmission. In 2010, installed capacity rose to 8820.7. Of this, 33.8 percent was utilized, and 2383.08 MW/h was supplied, out of which 20.1MW/h was lost in transmission. In 2012, installed capacity increased to 9937.0MW/h from 9287.0 MW/h in 2011. In 2012, 32 percent of the installed capacity was utilized which generated 3260.0 MW/h electricity, with 369.5MW/h (11.3 percent) lost in transmission. Between 2013 and 2014 installed capacity remained at 12323 MW/h. However, electricity generated dropped from 3350.3MW/h in 2013 to 3300MW/h in 2014. The highest electricity power installed capacity in Nigeria between 1970 and 2014 was 12323MW/h installed in 2013 and 2014. When Nigeria's highest capacity of 12323 MW/h is compared with 31.000MW/h, which South Africa installed in 2006 (Damme and Zwart, 2003), Nigeria's inadequacy in public supply of electricity is beyond doubt. Between 1970 and 2014, the highest capacity utilized of all installed capacities was 40.5 percent in 2005. The very low capacity utilization, which engendered inadequate electricity supply may have contributed to the below 55 percent average manufacturing capacity utilization since 1970 (CBN, 2014).

4. Theoretical framework/Model Specification

Several attempts have been made by different authors to determine the productivity effects of capital by estimating availability. One of the prominent frameworks that has been used extensively for this purpose has been the Cobb-Douglas production function which relates output to labour and capital inputs. For the purpose of this study, electricity supply has been proxied as capital. Aschauer (1989, 1990) was among the pioneering works to investigate the productivity effects of public capital in USA in an attempt to explain the productivity slowdown in the 1970s. Aschauer (1989) found that 1% increase in public capital stock increased private capital productivity by 0.39% which suggested that public capital is an important factor of production.

Within the framework of the Cobb-Douglas production function, the impact of electricity generation on industrial output productivity can be modeled as follows;

$$Y_t = f(AK^{\gamma}L^{\varphi}) \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (1)$$

$$\alpha, \beta > 0$$

Where Y_t represents the quantity of output of a particular good in period t, K is the capital usage during the same period, L denotes the hours of labour input, while A is used to indicate the level of technological efficiency with which the inputs are being combined; A, γ and φ are all positive parameters.

The Cobb-Douglas function demonstrated above has proved very useful and amenable to applied economic research both at the microeconomic and macroeconomic levels. This is because it can easily be linearized by logarithmizing the parameters γ andφ. This is done by taking natural logarithm of both sides of the equation, and denoting lowercase variables as the natural logarithm of the respective upper case variables, the following equation results

$$logY_t = logA + \gamma logK_t + \varphi logL_t \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (2)$$

Equation 2 above can be expressed in lower case alphabets form as below,

$$y_t = a + \gamma k_t + \varphi l_t \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (3)$$

The lower case alphabets represent the logarithm of the variables. In this case γ and φ are the output elasticities of capital and labour respectively.

The coefficients α and β are the output elasticities of the factor inputs and can be interpreted as respective factor shares in total output. Also equation 3 can be intuitively interpreted as a fundamental growth accounting equation which decomposes the growth rate of output into growth rate of Total Factor Productivity (TFP) plus a weighted sum of the growth rates of capital and labour. The coefficients α and β are expected to assume positive signs.

Equation 3 forms the basis for the empirical model specification and estimation of this study. Building from the conceptual and analytical framework presented above, we can now turn to specification of the econometric mod

The model can be re-specified in econometric form as follows

$y_t = \alpha + \gamma k_t + \varphi l_t + \lambda_i X' + \mu$ ………………………………. (4)

Where y_t denotes the growth rate of output, k_t and l_t are as earlier stated while X' is a column vector including some relevant control variables included in the model such as trade openness, inflation, credit to manufacturing sector and government expenditure, we include two indicators of financial deepening in the regression equation; money supply as a share of GDP, and credit to private sector as a share of GDP. Finally, μ is the stochastic error term that captures the effect of unobserved and unmeasured influence from other factors on the specified regressand. The data being in annual time series, we add the subscript t to each variable to obtain a standard econometric model as indicated above.

To show the analytical framework for measuring the impact capital productivity, we first show the partial factor productivity measure and define productivity as the average product of capital; that is y/k. Taking the total differential, we obtain;

$$\dot{y} = \gamma \dot{k} + \psi \dot{l} + \sum_j \lambda_i \dot{X}' + \alpha + \mu \dots\dots\dots\dots\dots (5)$$

Where $\dot{y} = (1/y)(dy/dt), \dot{X}' = (1/X')(dX'/dt), j = 1,2 \dots\dots J, \dot{l} = (1/l)(dl/dt)$ are the rates of change in y_t, k, l and X'. Similarly, $\lambda_j = \partial Inf(.)/\partial In X'$ is the measured effect of the control variables subsumed in X'.

The preceding equations decompose the sources of output growth rate into rates of change. Since terms are expected to be positive for a well-behaved production function, an input contributes positively (negatively) to output growth when its usage increases (decreases).

Using (5) we can express productivity growth as:

$$y^{\cdot} - (\dot{k} + \dot{l}) = (\gamma -)\dot{k} + (\psi - 1)\dot{l} + \sum_j \lambda_i \dot{X}' + \alpha + \mu \dots\dots\dots\dots (6)$$

which decomposes productivity growth into (i) growth rates of capital and labour inputs, (ii) other growth inducing variables included in the model (iii), technical change, and (iv) a miscellaneous component due to unmeasured inputs.

4.1. Econometric Methodology

3.1.1. Testing for Unit Root

Before embarking on the estimation of the model in equation (4), there is need to first check whether the variables in the model are stationary or non-stationary, in other words, whether the individual series possess unit root properties. In doing so, we adopt the augmented approach suggested by Dickey and Fuller (1979) unit test as well as that of Phillips-Perron (Phillips and Perron, 1988). This is within the framework of the equation specified below.

$$\Delta y_t = \mu + \beta t + \psi y_{t-1} + \sum_{i=1}^{k} \phi \Delta y_{t-1} + \varepsilon_t \dots\dots\dots\dots\dots (7)$$

Where, μ is a constant, t time trend while ε_t error term. The term $y_{t-1}$is the lagged value of the series y. The above equation is a time and linear trend version of the specification underlying the unit root test exercise. Estimating equation (8) by standard OLS allows us to test the null hypothesis of y_t containing a unit root, $H_0: \psi = 0$ against the alternative that the process is stationary, that is $H_1: \psi < 0$.

Interestingly, a point to note about the ADF and PP test is that they have the same distribution for large samples; hence they use the same hypothesis (Heilmann, 2010).

4.1.2 Test for Cointegration

The cointegration procedure requires time series system to be non-stationary at their levels. If a non-stationary series has to be differenced *d* times to become stationary, then it is said to be integrated of order *d*: i.e. I(*d*), (Engle and Granger, 1987). When both series are integrated in the same order, we can proceed to examine the presence of cointegration.

For this analysis, empirical studies had been employed such as the Engle and Granger (1987), Johansen (1988) and Johansen and Juselius (1990) method. The Johansen and Juselius test, applies the maximum likehood procedures of the VAR model to determine the number of co-integrating vector.
Engle and Granger (1987) demonstrated that once a number of variables (say, y_t and x_t) are found to be co-integrated, there always exists a corresponding error-correction representation which implies that changes in the dependent variable are a function of the level of disequilibrium in the co-integrating relationship (captured by the error-correction term) as well as changes in other explanatory variable(s). The short-term variation can be predicted by using ECM

$$y_t = \tilde{\alpha} + \tilde{\beta}x_t + \tilde{\mu_t} \dots \dots \dots \dots \dots \dots \dots \dots \dots \dots \dots (8)$$

Next is to obtain the residual from the estimation of equation 9 at the non-difference level of the variables. The residual is obtained by subtracting the fitted values from the actual values. This is shown below in equation 10.

$$\tilde{\mu_t} = y_t - \tilde{\alpha} - \tilde{\beta}x_t \dots \dots \dots \dots \dots \dots \dots \dots \dots \dots (9)$$

The last step is to test them for stationarity using the standard Dickey-Fuller test. This procedure is called the Cointegration Regression Dickey-Fuller (CRDF) test. If the errors are believed to be auto-correlated, using the ADF is more appropriate and this procedure is subsequently called the Cointegration Regression Augmented Dickey-Fuller (CRADF) test. If the residual is stationary at levels, it can be concluded that the variables are cointegrated. However, a major set-back of the Engle-Granger procedure for the cointegration test is that it is applicable to only bivariate models. For multivariate models the procedure developed by Johansen is more appropriate.

4.1.3 Vector Error Correction Modelling (VECM)[1]

If the series are co-integrated, Granger representation theorem states that an error correction model (ECM) describes the dynamic relationship. The VECM is a restricted VAR designed for use with non-stationary series that are known to be cointegrated. The VECM has cointegration relations built into the specification so that it restricts the long-run behavior of the endogenous variables to converge to their co-integrating relationships while allowing for short-run adjustment dynamics. The co-integration term is known as the error correction term since the deviation from long-run equilibrium is corrected gradually through a series of partial short-run adjustments. The advantage of ECM framework lies in its strength of capturing both the short run dynamics and long run equilibrium relation between two series. Durr (1993) observed that the error correction model are appropriate when the dependent variable is known to exhibit short run changes in response to changes in the independent variables.
The justification behind the use of the VECM approach is that identification and testing for the significance of the structural coefficients, underlying the theoretical relationships, is consistently obtained by this approach (Rao, 2005). Traditionally, the VECM framework treats all variables as endogenous; however, it limits the number of variables to those relevant for a particular theory.
Specifying the VECM equation, we proceed as in Engle and Granger (1987). This exercise is shown below in the following equation;

$$\Delta y_t = \rho y_{t-1} + \sum_{j=1}^{\rho} \phi_j \, \Delta y_{t-j} + v_t \dots \dots \dots \dots \dots \dots (10)$$

Where y_t stands for each variable under consideration in our model, ρ is the number of lags for the correlation-free residuals, y_{t-j} indicates the vector of deterministic variables in the model and ϕ_j is the corresponding vector of coefficients. Similarly, Δy_t is the first difference for each variable under consideration in the model.
It should also be noted that $\Delta y_t = y_t - y_{t-1}$, the first difference of the time series of the variable, the lag order ρ is a second order parameter characterizing the transient dynamics in the system.
We can in the same vein utilize the VECM framework as specified above in calibrating the empirical model for this study.

4.1.4 Granger Causality Test

The Granger causality analysis will be employed to determine the direction of causality in the model. In doing this a Vector Autoregressive (VAR) model will be employed to evaluate for the presence of as well as the direction of causality. This can be done as follows:

$$y_t = \phi_0 + \phi_1 \sum_{j=1}^{\rho} \phi_j \, k_{t-1} + \phi_2 \sum_{j=1}^{\rho} \phi_j \, y_{t-1} + \varepsilon_t \ldots\ldots\ldots (10a)$$

$$k_t = \psi_0 + \psi_1 \sum_{j=1}^{\rho} \phi_j \, y_{t-1} + \psi_2 \sum_{j=1}^{\rho} \phi_j \, k_{t-1} + \varepsilon_t \ldots\ldots\ldots (10b)$$

The causality equations specified above show the current values of the variables as dependent on their lagged values.

5. Presentation and Analysis of Empirical Results/Findings

The models earlier stated were estimated using the relevant time series econometric frameworks as were earlier stated and the results are hereby presented. First are the unit root and cointegration tests results.

5.1. Unit Root Test Analysis

This section analyses the time series properties of data for the period covered in the study (1970-2012). The unit root test was carried out using the Augmented Dickey-Fuller and Philips-Perron frameworks. The result is reported in table 1.

Table1: Unit Root Test Result

	ADF Test **Ho**:Unit Root			PP Test **Ho**:Unit Root		
Series	**Level**		**Diff.**	**Level**		**Diff.**
	V_u	**V_t**	**V_u**	**V_u**	**V_t**	**V_u**
MAN	-1.5027[1]	-1.6194[1]	-3.6832[1]‡	-1.6953[2]	-1.5869[0]	-6.5118[0]†
ELEC	-2.3882[0]	-2.8885[0]	-8.0542[0]†	-2.5116[6]	-0.1776[3]	-8.2256[3]†
EMP	-3.0443[3]	-0.0800[1]	-3.7968[0]‡	-2.1657[0]	-0.3927[4]	-3.8048[3]‡
MSS	-2.9135[1]	-0.3753[2]	-4.0143[1]‡	-1.7158[0]	-0.0088[2]	-3.9313[3]‡
CPS	-2.8305[1]	-0.0859[0]	-4.5616[0]†	-2.2245[3]	-0.0773[6]	-4.4341[1]†
GEXP	-2.0866[0]	-1.0219[1]	-7.3004[0]†	-2.1951[3]	-1.1873[1]	-7.2877[1]†
INF	-3.1591[0]	-2.0977[0]	-6.4572[1]†	-2.9729[5]	-3.0294[5]	-13.0591[39]†
TOP	-3.5073[0]	-1.9727[0]	-8.3098[0]†	-3.3073[0]	-1.7776[2]	-8.6144[5]†

Note: † and ‡ denote asymptotic significance at the 1% and 5% levels of significance respectively. Vu represents the most general model of the unit root test specification with a drift and trend, while V_t is the model with a drift and without trend. Figures in parenthesis are the optimal lag length selected using the Schwarz information criterion (SIC).

Table 1 reports the ADF and PP test statistic for the lag levels and first difference of the variables. The results of the ADF and PP tests reveal that most variables contain a unit root (a non-stationary situation), implying that the null hypothesis of the presence of a unit root at level cannot be rejected, even at 1% level of significance. However, at first difference, the variables were found to be stationary. Having established that all variables were integrated of order 1(1), we proceeded to testing for cointegration of the variables.

5.2. Cointegration Test Analysis

Johensen cointegration test procedure was employed to examine the nature of the long run equilibrium relationship, being that it has been confirmed that the variables are integrated of the same order 1(1). The result is reported in Table 2.

Table 2: Cointegration Test Results

H0: No Cointegration						
Trace Test				**Max. Eigen Value Test**		
	Critical Value at			**Critical Value at**		
	Trace	**5%**	**1%**	**Max**	**5%**	**1%**
$r = 0*$	399.60	159.53	171.09	145.69	52.36	58.66
$r \leq 1*$	253.91	125.61	135.57	92.28	46.23	52.31
$r \leq 2*$	161.63	95.73	104.96	72.10	40.08	45.87
$r \leq 3*$	87.52	69.81	77.82	51.84	33.87	39.37
$r \leq 4$	35.68	47.85	54.68	18.73	27.58	32.72
$r \leq 5$	16.94	29.79	35.45	12.74	21.13	25.86
$r \leq 6$	4.63	15.49	19.94	3.25	14.26	18.52
$r \leq 7$	1.38	3.84	6.63	1.38	3.84	6.63

Note: * denotes 1% level of significance.

The result from both the trace and maximum Eigen value statistic indicates that there are four cointegrating equations in the model. The results suggest that there is a significant long run equilibrium relationship among variables included in the model. Following sequentially, the trace and Eigen value statistic show the rejection of the null hypothesis up to at least three (3) cointegration equations. However, for higher cointegration equations, we fail to reject the null hypothesis on the basis of this result, it was concluded that there is a maximum of two cointegration relationships in the specified model.

Again, the specification of the lag length is a sensitive issue for testing for the cointegration equations. Hence the optimal lag length for the Vector Autoregressive (VAR) model specification for the cointegration test was determined using the Akaike Information Criterion (AIC), Schwarz Information Criterion (SIC), Hannon-Quinn Information Criterion (HQ), and Final Prediction error (FPE). The result for the optimal lag length Selection is presented in Table 3.

Table 3: Optimal Lag-length Selection

Lag	FPE	AIC	SIC	HQ
0	4.0179	205.99	206.33	206.12
1	3.7871*	187.45	190.49	188.55
2	2.1569*	181.887*	187.63*	183.97*

Note: * indicates the lag length selected by each criterion. FPE = Final prediction Error. AIC = Akaike Information. SIC = Scharwz Information Criterion. HQIC = Hannon Quinn Information Criterion.

It is obvious from the table that the optimal lag length for the VAR model is 2. This conclusion is derived from the fact that all the information criteria adopted chose 2 as their optimal lag length since it gave the minimum value for each criterion.

5.3. Vector Error Correction

Having found at least 3 statistical cointegrating vectors, as obtained in the Johensen cointegration test, we moved to estimating the VECM using two lags as selected by the criterion. The result is presented in Table 4.

Table 4 reports the results of the VECM as estimated. Section A in the table shows the coefficient of the cointegrating equations, while the coefficients of the speed of adjustment are reflected in section B. Section C presents the relevant diagnostic test of the VECM. The long-term variables that explain manufacturing sector output (which is adapted in this work to proxy national [real sector] productivity) are ELEC, EMP, MSS, CPS, GEXP, TOP and INF. Evidence from the table shows that electricity contributes positively to national productivity in Nigeria (measured with the productivity in the manufacturing [real] sector). The coefficient is also significant at 1 percent level of significance; this portrays a strong positive linkage between electricity generation and supply on Nigeria's productivity. The result specifically, indicates that a kilowatts increase in electricity generation will bring about a 2.42 percent increase in national productivity.

Table 4: VECM Estimates/Short Run Dynamics

Section(A) CE(s)	MAN	ELEC (-1)	EMP (-1)	MSS (-1)	CPS (-1)	GEXP (-1)	TOP (-1)	INF (-1)
Cointegrating Coefficient	1.00	2.42*	-56.83*	3.73*	1.38**	-1.04*	0.02	-0.009
S.E		(0.335)	(5.32)	(0.749)	(0.846)	(0.308)	(0.008)	(0.005)
T-stats.		[6.822]	[-10.68]	[4.988]	[1.636]	[-3.398]	[3.058]	[-0.721]
Section (B)	ΔMAN	$\Delta ELEC$	ΔEMP	ΔMSS	ΔCPS	$\Delta GEXP$	ΔTOP	ΔINF
Error Correction Term(ECT)	-0.156	-0.022	-0.001	-0.037	-0.044	-0.192	-6.185	-3.388
S.E	(0.05)	(0.03)	(0.000)	(0.033)	(0.032)	(0.047)	(2.820)	(3.198)
T-stats.	[-3.123]	[0.639]	[0.592]	[-1.104]	[1.377]	[-4.110]	[-2.193]	[-0.721]
Section (C)								
R^2	0.5244				**J - B**	**Stats.**	9.1900	[0.9050)
Adj. R^2	0.3394				**White**	**Test**	1201.477	[0.2861)
F-stats.	2.3620				**VEC LM**	**Test**	64.463	[0.4603)
D-W	1.8923							

Note: The figures in () represents standard errors, those in [] are the t-statistic while those in [) are the probability values. * and ** indicate significance at the 1% and 5% level respectively.

The parameter estimate for labour employment has a negative but statistically significant value, implying an inverse relationship between labour employment and national productivity (with regards to manufacturing [real] sector of the economy in this case). This could reflect the fact that adequate attention has not been given the real sector. Accordingly, and as expected, the coefficients of money supply and credit to private sector assume positive and significant values at 1 percent and 5 percent levels, respectively. This result is in line with the monetarist theory and the Hugh Patrick's finance-led hypothesis. It indicates the fact that if the country can properly harness and employ the available credit and money supply openings, in expanding investment in the entire real sector in general, the national output will record tangible growth. Also, we found from the result, that government's total expenditure on the economy fails to contribute positively to the increase in national productivity. This result is however not surprising given the fact that a bulk of government expenditure has traditionally been misappropriated (through corruption- a phenomenon that characterizes the Nigerian economy). Interestingly, the result for the parameter estimate for trade openness shows that this variable exerts positive effect on national (real sector) productivity. However, the effect was weak, as reflected in the rather remote value of the coefficient. This result suggests insufficient connection as well as underutilisation of the external sector funding by the different sectors of the Nigerian economy, so as to boost national productivity. If external funding openings are therefore harnessed properly to boost power supply and real sector output, Nigeria's trade horizon can be widened with its attendant benefits. Finally, the effect of inflation, on the other hand, was rather negative, though minimal, on national productivity.

As earlier stated, section B of table 4 reports result for the error correction from the VECM. The error correction terms, which measure the coefficient of adjustment, are negative and statistically significant especially MAN, GEXP, and TOP. Specifically, evidence from the table shows, that the speed of adjustment back to equilibrium for MAN, GEXP and TOP in the short term are 15.6 percent, 19.2 percent and 6.18 percent respectively. However, the velocities of return to equilibrium, in the case of ELEC, EMP, MSS, CPS and INF, are not significant which implies that the speed of adjustment for these variables is not rapid. The R^2 value of 0.5244 indicates that the equation has a fairly good explanatory power. It implies that approximately 52 percent of the systematic variation in the dependent variable (MAN) is explained by the set of variables in the VECM. In the same vein, the F- statistic reinforces the influence of the explanatory variables in the model. The Durbin–Watson (D-W) statistic further strengthens this outcome with a value of 1.8923, showing that there is no evidence of serial correlation in the model. Before the estimated result can be adopted for a reliable inference for economic and policy fine-tuning, the model must be checked for accuracy and adequacy in its specification. This is done by using some of the VECM diagnostic test criteria. First in line is the Jacque-Bera test for normality in the estimated residual. The result, as reflected in section C of table 4, reveals that the residuals from the error term are normally distributed. Thus, the null hypothesis of normality in the distribution of the residuals is accepted. Second is the White test for heteroscedasticity. As in the former, the null hypothesis of no heteroscedasticity in the residuals was accepted, leading to the conclusion that the residuals are homoscedastic, with constant mean and variance. Finally, the VEC LM test result shows that the residual passes autocorrelation test and can be concluded that the residual is serially uncorrelated. The finding from the LM test further lends support to the position reflected by Durbin-Watson statistic result reported above.

6. Conclusions and Recommendation

From the foregoing analysis, it is clear that improvement in power supply can boost national productivity. This is reflected in the positive relationship between MAN and ELEC as shown by their coefficients. Each time power supply improves by 1 percent; national output improves by about 2.42 percent. The negative relationship reflected by the employment-output relations indicates the steady rise in unemployment level due to shrinking productive sector, occasioned by the epileptic supply of power – the main driver of the productive sector. For the negative signs reflected in the case of government expenditure, the call is for a conscious effort at channelling government expenditure appropriately to fulfil purposes. Money supply elasticity is positive and significant. This shows that, with adequate public power supply, a properly harnessed money supply (especially in the area of real sector investment) will greatly enhance national output. In addition, credit to private sector assumes the same trend as money supply, further confirming that national productivity can be enhanced if investment in the real sector (with concerted attention to improvement in the manufacturing and power subsectors) is adequate. Trade openness shows a positive elasticity, though very insignificant. This indicates globalized trade possibilities, pointing to the fact that Nigeria would have accessed major trade benefits if a robust real sector - which depends on power supply as one major boost - was in place. Thus, since trade is most effective in a diversified and effectively industrialized economy, the role of steady and adequate public power is inevitable

Public power supply in contemporary societies is imperative in the functioning and growth of their economies. The Nigerian government, at the federal, state, and local levels, should make the provision of steady and adequate public power one of its topmost projects. This should form part of the contract terms between the government and the private companies responsible for public supply of electricity in Nigeria. The private companies should be directed by the government to increase installed capacity in their respective districts, increase power generation and supply and carry out timely and adequate maintenance. This will enhance the quality of electricity supply; and consequently, productivity in Nigeria.

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