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Electricity Supply and Economic Growth: The Nigeria Experience, 1980-2012

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Abstract

This study examines the impact of annual government expenditure in the power sector on electricity supply: and also scrutinizes the impact of electricity supply on two indexes of growth,(real GDP, and index of industrial production for the period 1980 -2012). Co-integration and parsimonious error correction model was used for data analysis and test of hypotheses. Results show that long run relationship exists between the dependent and the independent variables employed in the study. The short run results reveal that while recurrent expenditure exerts positive impact on electricity generation, the reverse is the case between the later and capital expenditure in the power sector. It was also discovered that mega watts of electricity generation which is the variable of interest exerts positive influence on real GDP and negatively impacted on index of industrial production, all of which are statistically insignificant. The paper recommends that, the corruption that is prevalent in the power sector must be checked. , officials found to have diverted money meant for a given project should be punished while the right technology and expertise should be engaged.

Key Word: Electricity Generation, Government Expenditure, Power Sector, Economic Growth, Index of Industrial Production

Introduction

Although Nigeria is rich in human and material resources, its economic and political developments have been fraught with crises since independence in 1960. Indices of the failure of the Nigerian state are today evident in the pervasive cases of hunger, inflation, budget deficits, debt overhang, street begging, prostitution, frauds, high crime rates in major cities, collapse of manufacturing industries, corruption in public service, stagnation in entrepreneurial development and above all, epileptic power supply (Fadeyi and Adisa, 2012). In the face of these crises it becomes difficult for sustainable development to take place in the country (NISER, 2000 and UNDP, 2006). Nigeria's power sector had operated for several decades as a state monopoly called National Electric Power Authority (NEPA) until 2005. NEPA controls electricity generation, transmission and distribution facilities with all the profound problems inherent in public monopoly. This over centralization made it impossible for electricity supply to keep pace with the growth in population and economic activities. Nigeria has the biggest gap in the world between electricity demand and supply, providing its population of over 160 million with less than 4000 megawatts of electricity. In contrast, South Africa with a population of less than 50 million people generates more than 40,000 megawatts while Brazil, an emerging economy like Nigeria, generates over 100,000 megawatts for its 201 million citizens (FG, 2013). Indeed, the gap in the power sector has far reaching implications for improving the business climate, sustaining economic growth and the social wellbeing of Nigerians. About 45 percent of the population has access to electricity, with only about 30 percent of their demand for power being met. The power sector is plagued by recurrent outages to the extent that some 90 percent of industrial customers and a significant number of residential and other non-residential customers provide their own power at a huge cost to themselves and to the Nigerian economy. Installed capacity is 8,000 megawatts, but only 4,000 megawatts is operable with only about 1,500 megawatts available to generate electricity. At 125 kWh per capita, electricity consumption in Nigeria is one of the lowest in the world (AfDB, 2009).

Following the Electricity Power Sector Reform (EPSR) Acts of 2005, NEPA ceases to exist and in its place, a transitional company named Power Holding Company of Nigeria (PHCN) unbundled into six generation companies with one transmission firm and eleven distribution companies as first step towards partial divestment of government assets. Between 2005 and 2013 when PHCN was sold to new owners, there was no remarkable improvement in power supply in Nigeria but at the same time government continue to inject several billions of naira into the sector annually. Power supply in the country is so epileptic that Nigerians spend enormous sums on self generated power, making the country's cost of electricity consumption one of the highest in the world. This is beside health hazard effect as many families have died of emission from generators. The high cost of power generation has made it difficult for many businesses to operate and this has further worsened the unemployment and poverty levels in Nigeria. The present administration on 1st November, 2013 handed over the unbundled PHCN to 18 successor companies made up of 6 Generation, 11 Distribution and 1 Transmission companies to new owners and thus signaling the end of PHCN. With this reform, government hopes that the power sector will drive GDP growth so that Nigeria will generate more than the irreducible 40,000 megawatts needed to make the nation become one of the world's twenty largest economy by 2020.

Review of extant empirical literature has shown that several studies have been done on the impact of electricity supply on economic development but not much study has been carried out on the relationship between government expenditure on electricity supply and economic development/industrial transformation thus, creating a huge research gap for empirical data. This study therefore intends to bridge this gap by investigating this relationship with the view of enriching the scanty empirical data that exist in this area. The objective of this paper thus is to investigate whether annual government huge expenditure on the power sector actually catalyzes economic growth and industrial production in Nigeria. Consequently, the sequence of the paper follows thus: section one introduces the paper, section two reviews related

literature. Section three described the methodology of the study while section four presents and analyses result of findings and section five concludes the paper with brief policy remark.

Empirical Review

Extant literature on the relationship between expenditure in power generation and economic development has shown mixed results. Ebohon (1996) examines the impact and causal directions between energy consumption and economic growth (proxied by GDP) and reports a simultaneous causal relationship between energy and economic growth for Tanzania. Shiu and Lam (2004) applies the error-correction model to examine the causal relationship between electricity consumption and real GDP for China during 1971–2000. Their estimation results indicate that real GDP and electricity consumption for China are co-integrated and there is unidirectional Granger causality running from electricity consumption to real GDP. Easo (2010) investigates the long-run and the causality relationship between energy consumption and economic growth for seven Sub-Saharan African countries during the period 1970–2007. Using the Gregory and Hansen testing approach to threshold co-integration, the study indicates that energy consumption is co-integrated with economic growth in Cameroon, Cote d'Ivoire, Ghana, Nigeria and South Africa. The test suggests that energy consumption has a significant positive long-run impact on economic growth in these countries before 1988; and this effect becomes negative after 1988 in Ghana and South Africa. Furthermore, causality tests suggest bi-directional causality between energy consumption and real GDP in Cote d'Ivoire and unidirectional causality running from real GDP to energy usage in the case of Congo and Ghana.

The investigation of the relationship between the consumption of crude oil, electricity and coal in the Nigerian economy (1970 to 2005) was conducted by Odularu and Okonkwo (2009). Their result obtained after applying the co-integration technique, showed that there exists a positive relationship between energy consumption and economic growth. However, with the exception of coal, the lagged values of these energy components were negatively related to economic growth. Dantama, et al. (2012)

examine the impact of energy consumption on economic growth in Nigeria over the period 1980–2010 using the autoregressive distributed lag (ARDL) approach to co-integration analysis. The results indicate a long-run relationship between economic growth and energy consumption. Both petroleum consumption and electricity consumption are statistically significant on economic growth but coal consumption is statistically insignificant. Also, the speed of adjustment in the estimated model is relatively high and contains the expected significant and negative sign.

Babatunde and Shuaibu (2008), examine the residential demand for electricity in Nigeria as a function of real gross domestic product per capita, the price of electricity, the price of substitute and population between 1970 and 2006. They employed the bounds testing approach to co-integration within an autoregressive distributed framework and found that in the long run, income, price of substitute and population emerge as the main determinants of electricity demand in Nigeria, while electricity price is insignificant. They also found that the relationship among the variables is more stable and significant. Tendler (1979) found in his research on some developing countries that the promotion of rural electrification projects in development assistance programmes of the World Bank would promote integrated rural development significantly by encouraging productive municipal as well as traditional household in electricity usages. In a similar joint research project, Butler, et al., (1980) discovered in Bolivia that the positive impact of rural electrification project was social and that electrical power did not appear to play a catalytic role in economic development nor was it a precondition for it. He however fails to note that electrification projects are linked to other development activities.

Onakoya et al. (2013) evaluates the causal nexus between energy consumption and Nigeria's economic growth for the period of 1975 to 2010. Secondary time-series data were analyzed using co-integration and ordinary least square techniques. The study shows that in the long run, total energy consumption had a similar movement with economic growth except for coal consumption. The empirical results reveal that petroleum, electricity and the aggregate energy

consumption have significant and positive relationship with economic growth in Nigeria. The study recommends that government should encourage a level- playing field for all energy forms available in the country by diversifying its power-generation portfolio. Uzochukwu and Nwogwugwu (2012) analyzed federal government spending on the energy sector with special emphasis on the electricity sub-sector using descriptive statistics. The study found that despite the significant reforms and increase in spending in the sector, the outcome in terms of its reflection on production, transmission and distribution of electricity is far from the realization of the reform objectives. The study argues that the country lags behind other countries like Libya, Kenya and Ghana in per capita power production and consumption and this lack of access to electric power, and modern energy in general has a negative effect on productivity and has limited the economic opportunities available to Nigeria.

Akpokerere and Ighoroje (2013) investigate the effect of government expenditure on economic growth in Nigeria using a disaggregated approach. Data for the period (1977 - 2009) was used. The study finds that expenditure on education (EDU) and power (POW) have negative effect on economic growth and are significant in explaining this relationship. On the contrary, rising government expenditure on transport and communication (TRACO), and health (HEA) results to an increase in economic growth. The authors therefore advised that there should be public private participation in critical sectors of the Nigerian economy such as power and transport with high degree of transparency and accountability in government spending. Ubi and Effiom (2013) explore the relationship between electricity supply and economic development in Nigeria using annual time series data spanning 1970-2009. The paper employs co-integration technique and testing the results using ordinary least squares in the context of error correction mechanism (ECM). The results show that per capita GDP, lagged electricity supply, technology and capital are the significant variables that influence economic development in Nigeria and further argued that despite the poor state of electricity supply, it influences economic development with a very relatively low impact. The study recommended among

other things that the various power projects should be completed with state of the art technology as this will ultimately reduce power loss and boost electricity supply vis-à-vis economic development.

Model Specification

Three models were specified for the study and the first was intended to capture how government expenditure on the power sector influences power generation in Nigeria for the period 1999-2012. The short period covered was due to lack of reliable data of government expenditure in the power sector. The second and the third aspects of the study investigate impact of electricity supply on economic performance in Nigeria for the period 1980-2012, using two indicators of growth namely: real gross domestic product (GDP) and index of industrial production. The data which are in million of naira unless otherwise stated were culled from the Central Bank of Nigeria annual report and statement of account for various years and World Bank development indicators database. Thus:

Model 1

$$MWT = f(PSRE, PSCE).....(1)$$

The log stochastic form of equation (1) thus,

$$\ln MWT = \alpha_0 + \alpha_1 \ln PSRE + \alpha_2 \ln PSCE + \varepsilon.....(2)$$

- Where:
 MWT = Mega watts of electricity generated
 PSRE = Power sector recurrent expenditure
 PSCE = Power sector capital expenditure
 ε = error term
 α₀, α₁ and α₂ = constant and parameters to be estimated respectively
 ln = logarithmic form

The regression models below were anchored on simple growth theory and for simplicity, we assume that:

$$Y = Af(L, K).....(3)$$

- Where:
 Y = Output
 A = Total factor productivity -or efficiency parameter
 L = labour
 K = Capital

For the purpose of this study, we again

assumed that the impact of electricity supply on output operates through total factor productivity. Since this research work intends to investigate the impact of electricity supply on economic development in Nigeria by correctly specifying the model, it is further assumed that total factor productivity (A) is a function of electricity supply (MWT). Thus,

$$A = f(MWT, L, K) \dots \dots \dots (4)$$

Combining equations 3 and 4 and substituting for A. We have

$$Y = f(MWT, L, K) \dots \dots \dots (5)$$

Thus, Y is then replaced in model 2 and 3 accordingly

Model 2

$$GDP = f(MWT, L, K) \dots \dots \dots (6)$$

In log form, equation (6) becomes:

$$\ln GDP = \beta_0 + \beta_1 \ln MWT + \beta_2 \ln L + \beta_3 K + e \dots \dots (7)$$

Where:

GDP = Real gross domestic product at 1990 constant price

L = population (proxy for labour force)

K = capital (measured by gross fixed capital formation)

$\beta_0, \beta_1 - \beta_3$ = constant and parameters to be estimated

Model 3

$$IIP = f(MWT, L, K) \dots \dots \dots (8)$$

Thus, equation (8) becomes:

$$\ln IIP = \lambda_0 + \lambda_1 \ln MWT + \lambda_2 \ln L + \beta \lambda_3 K + V \dots \dots (9)$$

Where:

IIP = Index of industrial production

$\lambda_0, \lambda_1 - \lambda_3$ = constant and parameters to be estimated

Unit Root Test

The Augmented Dickey Fuller (ADF) and the Phillips-Perron tests were used to test for unit roots as in the equation below.

$$\Delta Y_t = C_i + \omega Y_{t-1} + C_2 t + \sum_{i=1}^p d_i \Delta Y_{t-1} + \epsilon_t \dots (10)$$

yt = relevant time series

Δ = an operator for first difference

t = a linear trend

ϵ_t = error term

The null hypothesis of the existence of a unit root is $H_0: \omega=0$. Failure to reject the null hypothesis leads to conducting the test on further differences of the series. Further differencing is conducted until stationary is reached and the null hypothesis is rejected. Akaike Information Criteria (AIC) and the Schwarz criterion (SC) were employed to determine the lag length.

Co-integration Test and Vector Error Correction Model

Engle and Granger (1987) pointed out that a linear combination of two or more non-stationary series may be stationary. If such stationarity exists then, time series are said to be co-integrated. The stationary linear combination is called the co-integrating equation and may be interpreted as a long-run equilibrium relationship between the variables. The co-integrating equation is

$$y_{1,t} = \beta_1 y_{2,t} + \epsilon_t$$

$$y_{2,t} = \beta_2 y_{1,t} + \epsilon_t \dots \dots \dots (11)$$

$$\Delta y_{1,t} = \gamma_1 (y_{2,t-1} - \beta_1 y_{1,t-1}) + v_{1,t}$$

$$\Delta y_{2,t} = \gamma_2 (y_{1,t-1} - \beta_2 y_{2,t-1}) + v_{2,t} \dots \dots (12)$$

In equation (12), the only right-hand side variable is the error correction term. In the long run equilibrium, this term is zero. However, if y_1 and y_2 deviated from long run equilibrium in the last period, the error correction term is non-zero and each variable adjusts to partially restore the equilibrium relationship. The coefficients γ_1 and γ_2 measure the speed of adjustment.

Presentation and Analysis of Results

Fig 1: Power Sector Recurrent and Capital Expenditure and Mega Watts of Electricity Generated

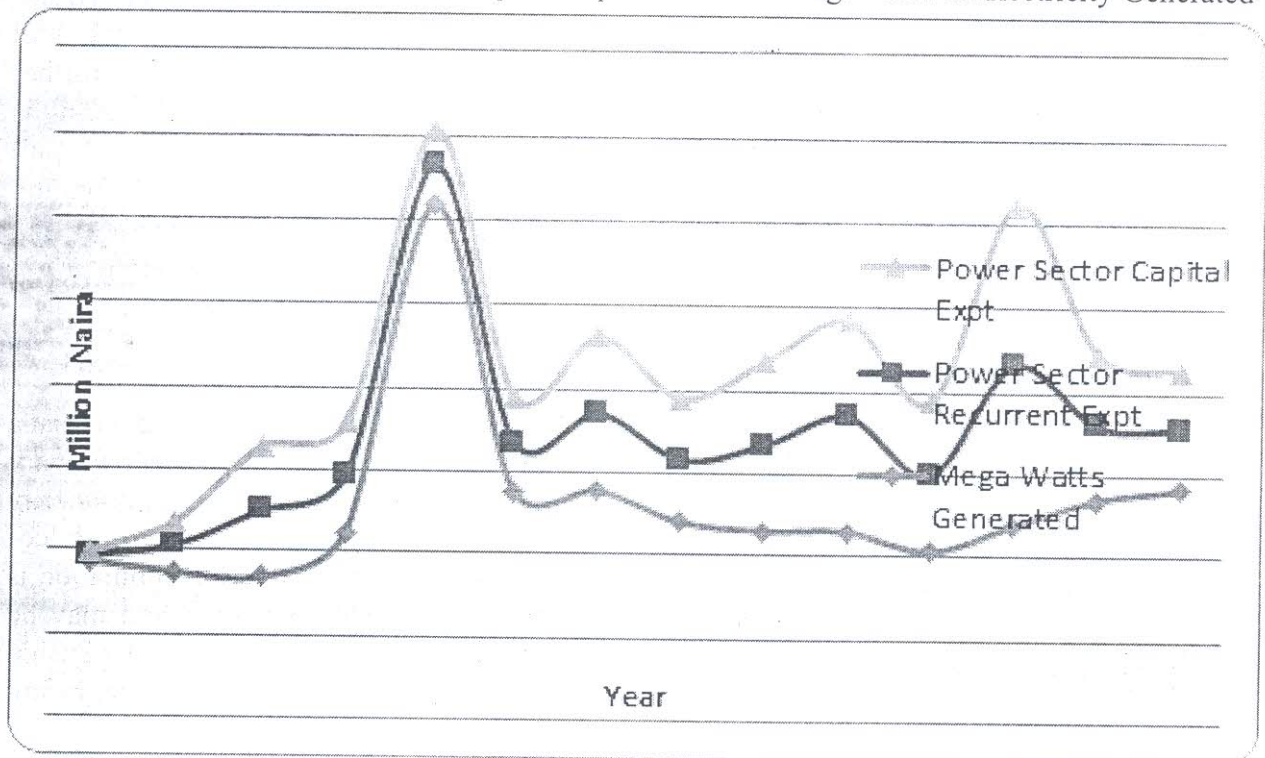
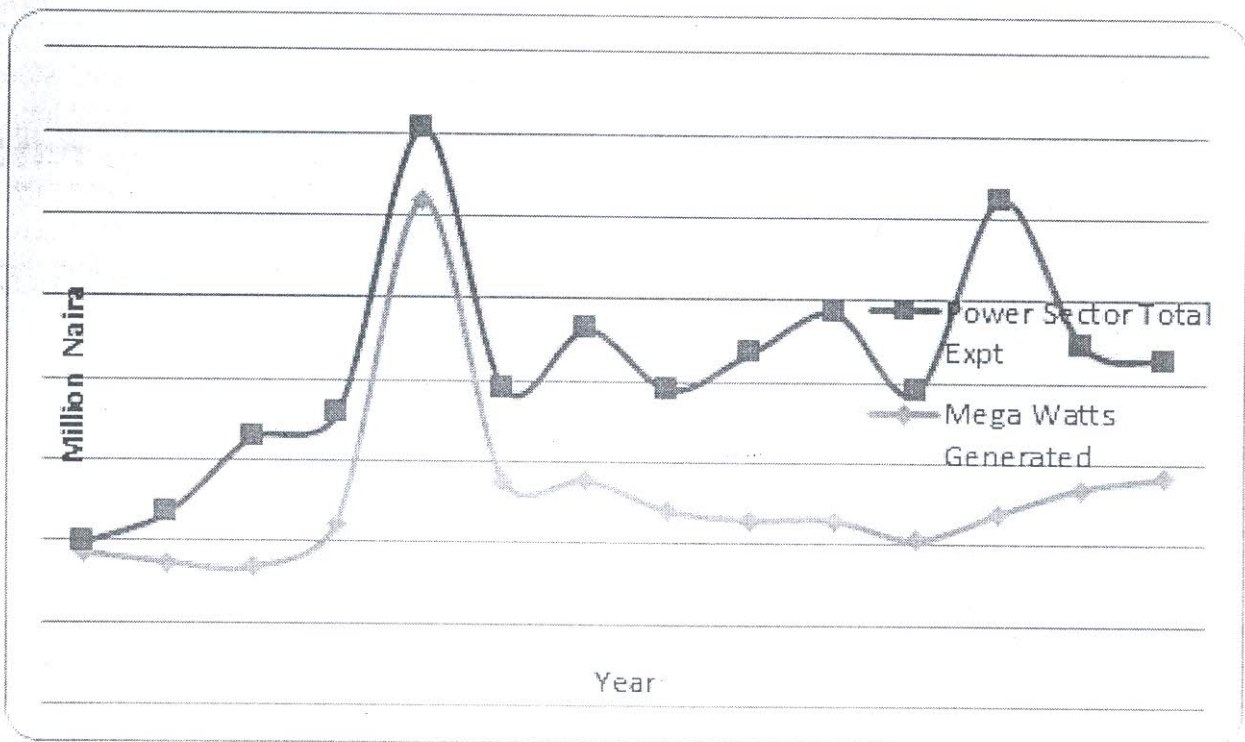


Fig 1 reveals that while both recurrent and capital expenditure budgeted for the power sector are rising continuously, electricity

generated per mega watt does not keep pace with the expenditure increase in Nigeria.

Fig 2: Total Power Sector Expenditure and Mega Watts of Electricity Generated



It can be seen from both figures that electricity generation in Nigeria is in the range of 3000 mega watts between 1999-2012 and this

explains why majority of the citizens does not have access to power supply while most firms operating in Nigeria do not fair better.

Table 1: Results of Stationarity

A. ADF (Trend & Intercept (1980-2012))				Phillips-Peron (PP) (Trend & Intercept)		
Variable	Level	1 st Diff	2 nd Diff	Level	1 st Diff	2 nd Diff
LGDP	-1.7173	-4.2605*	-6.8675**	-8.9617**	-33.2762**	-49.0047**
LMWT	-3.0676	-4.9322**	-6.6091**	-3.6443*	-7.7653**	-14.9992**
LIPP	-2.7701	-3.3819	-5.7074**	-2.7956	-5.7455**	-13.5107**
LL	-1.3217	-3.8526	-6.1110**	-1.2772	-5.7255**	-11.4356**
K	-2.8037	-4.0925*	-4.6328**	-3.6632*	-8.9517**	-16.0572**
Critical Value						
1%	-4.2949	-4.3082	-4.3226	-4.2826	-4.2949	-4.3082
5%	-3.5670	-3.5731	-3.5796	-3.5614	-3.5670	-3.5731
10%	-3.2169	-3.2203	-3.2239	-3.2138	-3.2169	-3.2203
B. ADF (Trend & Intercept (1999-2012))				Phillips-Peron (PP) (Trend & Intercept)		
LPSRE	-3.4167	-4.1049*	-2.832657	-4.5134*	-4.5558*	-5.3546**
LPSCE	-3.8103	-4.4461*	-2.911087	-4.9756**	-4.4822*	-4.7419*
Critical Value						
1%	-4.9893	-5.1152	-5.2735	-4.8870	-4.9893	-5.1152
5%	-3.8730	-3.9271	-3.9948	-3.8288	-3.8730	-3.9271
10%	-3.3820	-3.4104	-3.4455	-3.3588	-3.3820	-3.4104

**(*) Stationary at 1%(5%) respectively

Table 1 presents the results of unit root test. The results in panel A and B which include trend and intercept reveal that all the variables are non stationary at level but at integration of first or second order differencing, stationarity were

achieved. The level of stationarity however was either at 5 or 1 percent confidence level as indicated by the asterisk (*). This enabled us to conduct co-integration test as shown in table 2 below.

Table 2: Co-integration Result on Power Sector Expenditure

Null Hypothesis	Alternative Hypothesis	Statistical Value	5 percent critical value	1 percent critical value	Eigen value
Trace Statistics					
r = 0	r > 0	48.28	29.68	35.65	0.94
r > 1	r > 1	15.07	15.41	20.04	0.63
Max-Eigen Statistics					
r = 0	r = 1	33.22	20.97	25.52	0.94
r < 1	r = 2	12.00	14.07	18.63	0.63
Long Run Regression Results Normalized on MWT					
LMWT = 1.00 - 9.55 LPSRE + 10.20 LPSCE					
(-5.9) (6.7)					
Log Likelihood = 23.2					

Thus, it can be seen from table 2 that there is a long run relationship between mega watts of electricity generated and government expenditure in the sector over the last one decade. However, the long run results normalized on mega watts of electricity generated shows that while recurrent expenditure in the power sector exerts negative impact on electricity generation the relationship between the later and power sector capital expenditure in Nigeria is positive.

Both variables are also statistically

significant with coefficient of elasticity greater than unity. This means that a small change in government expenditure to the power sector will likely lead to more than proportionate change in electricity generation. With co-integration confirmed the over-parameterized error correction model estimates whose results were not shown revealed that although the models look fairly well estimated, they appear cumbersome to be interpreted in their present form. Thus, table 3 depicts the parsimonious error-correction model

whose interpretation is easy and straight forward. It shows short run impact of the independent variables on the dependent variable.

Table 3: Parsimonious Error Correction Model

Method: Least Squares

Dependent Variable: DLMWT

Variable	Coefficient	Std error	t-statistic	Prob
Constant	0.087818	0.105657	0.831164	0.4437
DLMWT(-2)	0.251960	0.290789	0.866469	0.4258
DLPSRE	1.723018	1.466255	1.175115	0.2929
DLPSCE	-2.053642	1.505333	-1.364244	0.2307
DLPSCE(-1)	-0.274717	0.236088	-1.163620	0.2971
ECM(-1)	-0.945724	0.365538	-2.587212	0.0490
R ² = 0.69; F-stat = 2.17; DW = 1.74				

Table 3 shows that both recurrent and capital expenditure in power sector explain about 69 percent of electricity generation. The F-stat shows that the model is significant while DW of 1.74 reveals absence of serial correlation. The ECM carries the usual negative sign and is statistically significant with a very high speed of adjustment of about 95 percent. This shows that whenever the system is out of equilibrium, it is returned back with a speed of about 95 percent as

shown in the coefficient of the ECM. On the part of the variables, PSRE and PSCE have elastic coefficients while that for PSCE lag 1 is inelastic. Also, while the impact of PSRE is positive on electricity generation, PSCE and its lag are negative. However, lag 2 of mega watts of electricity is positively correlated with its current value. Finally, all the variables are statistically insignificant in explaining electricity generation in Nigeria between 1999 and 2012.

Table 4: Co-integration Result for Indices of Growth (Real GDP and IIP)

Null Hypothesis	Alternative Hypothesis	Statistical Value	5 percent critical value	1 percent critical value	Eigen value
<i>Trace Statistics</i>					
r = 0	r > 0	67.34	59.46	66.52	0.70
r > 1	r > 1	31.20	39.89	45.58	0.36
<i>Max-Eigen Statistics</i>					
r = 0	r = 1	36.13	30.04	35.17	0.70
r < 1	r = 2	13.51	23.80	28.82	0.36

Table 4 shows that both trace and max-eigen-value tests indicate 1 co-integrating equation at both 5 and 1 percent levels respectively. This means that long run relationship exists between real GDP and mega

watt of electricity generation (MWT), labour (L) and capital (K) on the one hand while long run relationship exists between IIP and the same independent variables on the other hand.

Table 5: Parsimonious Error Correction Model

Method: Least Squares

Dependent Variable: DLGDP

Variable	Coefficient	Std error	t-statistic	Prob
Constant	0.038545	0.015162	2.542263	0.0179
DLGDP(-1)	0.255229	0.196461	1.299133	0.2062
DLMWT	0.047396	0.039520	1.199306	0.2421
DLL(-1)	0.151755	0.226769	0.669204	0.5098
DK(-2)	-2.170008	2.121008	-1.025103	0.3155
ECM(-1)	-0.165811	0.075934	-2.183637	0.0390
R ² = 0.49; F-stat = 4.46; DW = 1.93				

It can be seen in table 5 that lag 1 of real GDP is positive and statistically significant. It shows that one percent increase in previous year real GDP increases current year GDP performance by about 26 percent as revealed in the coefficient of elasticity. Similarly, the impact of mega watts of electricity generation (MWT) on real GDP is positive but insignificant with a somehow low coefficient of elasticity of about

0.05 percent. Also, labour (lag 1) and capital (lag 2) were similarly insignificant but while the impact of labour on real GDP is positive that of capital is negative. The ECM takes the normal negative sign and is statistically significant with the speed of adjustment of about 17 percent. Finally, about 49 percent of real GDP is explained by the independent variables.

Table 6: Parsimonious Error Correction Model

Method: Least Squares

Dependent Variable: DLIIIP

Variable	Coefficient	Std error	t-statistic	Prob
Constant	0.035029	0.016328	2.145369	0.0423
DLIIP(-2)	0.129666	0.191563	0.676884	0.5050
DLMWT(-1)	-0.066750	0.054926	-1.215285	0.2361
DLL(-1)	-0.297122	0.334566	-0.888084	0.3833
DK(-1)	-1.55E-08	3.46E-08	-0.447348	0.6586
ECM(-1)	-0.212362	0.100708	-2.108687	0.0456
$R^2 = 0.18$; F-stat = 1.04; DW = 2.22				

A cursory look at table 6 reveals that apart from lag 2 of IIP (index of industrial production) which exert positive impact on its current value, MWT, L and K exhibit negative impact on IIP with none of the variables statistically significant. Of interest are the mega watts of electricity generation which with a unit increase in MWT, IIP decreases by about 0.067 percent. As in the models above, the ECM observes the usual negative sign and also statistically significant. The R^2 is low which shows that the independent variables explained only about 18 percent of IIP.

Discussion of Results and Implications to Research and Practice

Based on the results of data analysis, it was observed that power generation is not proportionate to government total expenditure in this sector. It was observed that, while recurrent expenditure exerts positive impact on electricity generation, the reverse is the case between the later and capital expenditure in the power sector. The mega watts of electricity generation was seen to exert positive influence on real GDP and negatively impacted on index of industrial production. Neither situation was statistically significant. The negative relationship between

IIP and mega watt generation (electricity supply) reflects the reality of the Nigeria situation where most industries have folded up due to high operational cost of doing business in the land. This has negatively affected economic growth that has tended to be in sympathy with declining industrial environment. The reason for this trend may be as a result of negative effect which the modern energy in general has on productivity and has limited the opportunities available in Nigeria. This agrees with the result of earlier findings by Ebohon (1996) who observed that insincerity, corruption, misplaced priority are the bane of power sector nightmare in Nigeria. It further agrees with the opinion of Akpokerere and Ighoroje (2013) who study the impact of expenditure on education and power sector performance and came to the conclusion that corruption, low expenditure on education and technology are the fundamental causes of power sector failure in Nigeria. The implication of this finding is that it may take Nigeria so many years more to transform the power sector or reposition it in such a way as to catalyze industrial production or power economic growth if Nigerians who are given charge of this sector do not change their attitude or are not held responsible for their inaction in this sector. More

researches should therefore be conducted regularly in areas like solar and wind energy in order to regularly keep check on the activities of key players in this sector and also bring to public notice the amount of financial waste in this sector.

Conclusion and Recommendation

With the continuous epileptic power supply in Nigeria and its attendant enormous sum of self generated power, cost of electricity consumption will still remain one of the highest in the world, thus making the transformation agenda of the present administration a mirage if epileptic power supply continues to prevail in the Nigerian economy. It is recommended therefore that corruption prevalent in the power sector must be checked. Any official found to have diverted money meant for a given project should be punished to serve as deterrent to others while the right technology and expertise should be engaged. The new owners of the power sector must be constantly monitored and any one found wanting should have his ownership revoked so that more competent investors can take over.

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