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The Impact of Electricity Supply on Economic Growth, 1980-2010: An Error Correction Method

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Abstract
The paper titled the impact of electricity Supply on economic growth in Nigeria examines the relationship between per capita income (a proxy for economic growth) and electricity consumption in Nigeria. The study employs an error correction model and results show that there was no long run relationship between per capita income and the explanatory variables. And in the short run while electricity consumption, government expenditure and investment exert positive impact on per capita income, the relationship between the later and export is negative. Finally the ECM observed the usual negative slope with very high speed of adjustment. The study recommended among other things that corruption prevalent in the power sector must be checked.
Keywords: Electricity Consumption, Government Expenditure, Per capita income, Co-integration and Error Correction Model

1 Introduction

With the collapse of the World Bank and International Monetary Fund policy's on Structural Adjustment Programme (SAP) in Africa, many questions have been raised by scholars on the factors impeding economic development in leading African nations including Nigeria (Jega, 2003). They argued that economic liberalization in other parts of the world have continued to yield anticipated results, increasing global trade and technological advancements such that by the end of the 21st century some emergent economies have appeared on the global capitalist markets. It is no gainsaying the fact that the likes of Indonesia, China, Japan and Malaysia are now making new waves in the global markets. While this thinking continues about global capitalist development, researches conducted by the United Nations and the World Bank has shown that Nigeria's economic development is routinely constrained by some inherent cultural factors (NISER, 2000).

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 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). Our interest in this paper is not all the problems measured, but the huge expenditure injected annually into the power sector and its attendant impact on the Nigerian economy.

Nigeria's power sector had operated for several decades as a state monopoly then 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 of which about 1,500 megawatts is available to generate electricity. At 125 kWh per capita, electricity consumption in Nigeria is one of the lowest in the world (AfDB,

2009).

The objective of this paper thus is to investigate whether annual government huge expenditure on the power sector actually worth it by measuring the impact of power supply on key indice of growth in Nigeria. Consequently, the sequence of the paper is clear. Following the introduction, section two contains brief review of related literature. In section three, the method of study is unveil. Whilst section four presents and analyses result of findings, section five concludes the paper with brief policy remark.

2. Review of Related Literature

The literature is beset with studies on the relationship between energy consumption and economic growth. 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. Esso (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 economic growth has a significant positive long-run impact on energy consumption 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. The authors 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 determinant of electricity demand in Nigeria, while electricity price is insignificant. They also found that relationship among 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 should be linked to other development activities.

Onakoya et al. (2013) evaluate 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 government total capital expenditure (TCAP), total recurrent expenditures (TREC), government 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 in power and transport with high degree of transparency and accountability in government spending. Ubi and Effiom (2013) explores 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.

3. Model Specification

The econometrics approach for the study is co-integration and error correction model as adopted by Ubi and Effiom. The data for the study were sourced from Central Bank of Nigeria Statistical Bulletin (2010) and Annual Report and Statement of Account for various years.the model is specified thus;

PCY = f(ELCON, GEX, INV, EXP) ……..(1)

In log stochastic term, equation becomes;

$InPCY = \beta_0 + \beta_1 InELCON + \beta_2 InGEX + \beta_3 InINV + \beta_4 InEXP + V_t$……(2)

Where:

InPCY = log of per capita income

InELCON = log of electricity consumption

InGEX = log of government Expenditure

InEXP = log of export

β_0 = constant and $\beta_1 - \beta_4$ = parameters to be estimated

V_t = white noise error

A positive relationship between PCY and all the variables is expected. The general ECM specification is presented thus:

$$\Delta InPCY_t = a_0 + \sum_{i-1}^{n} a_{1t}\Delta PCY_{t-1} + \sum_{i-1}^{n-1} a_{2t}\Delta InELCON_{t-1} + \sum_{i-1}^{n-1} a_{3t}\Delta InGEX_{t-1} + \sum_{i-1}^{n=1} a_{4t}\Delta InINV_{t-1}$$

$$\sum_{i-1}^{n-1} a_{5t}\Delta InEXP_{t-1} + \lambda ECM_{t-1} \text{…….....(3)}$$

3.2 Econometric Framework

According to Engle and Granger (1987), a linear combination of two or more non-stationary series may be stationary. If such linear combination exists, the non-stationary 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. A vector error correction (VEC) model is a restricted vector auto-regression (VAR) that has co-integration restrictions built into the specification. The VEC specification restricts the long-run behavior of the endogenous variables to converge to their co-integrating relationships while allowing a wide range of short-run dynamics so that 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.

Let us consider a two variable system with one co-integrating equation and no lagged difference terms. The co-integrating equation is

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

$$y_{2,t} = \beta_2 y_{1,t} + \varepsilon_t \text{ ……(4)}$$

and the VEC is

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

$$\Delta y_{2,t} = \gamma_2 (y_{2,t-1} - \beta_1 y_{1,t-1}) + \nu_{2,t} \text{ ……(5)}$$

In Equation (3), λ 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 nonzero and each variable adjusts to partially restore the equilibrium relationship. The coefficients y_1 and y_2 measure the speed of adjustment.

4.0 Presentation and Analysis of Results

Table 1 which contains results of unit root test revealed that the variables were non stationary at level but at integration of order 1 stationarity was achieved at 5 % confidence level. The results also show that apart from per capita income tested with only intercept, other variables have intercept and trend include in test equation.

Table 1: Results of Stationarity

Variable	Order	ADF Test	Mickinnon (5%)	Included in Test Equation
LPCY	1	-3.2327	-2.9798	Intercept
LELCON	1	-5.1643	-3.5796	Intercept and trend
LGEX	1	-4.5674	-3.6027	"
LINV	1	-3.8506	-3.5943	"
LEXP	1	-5.0258	-3.5943	"

The major aim of the test in table 2 is to find out whether a linear combination of variables that are integrated of the same order is stationary. If co-integration exists, then there is a long run relationship between the variables.

Table 2: Co-integration Result based on Unit Root test of Residual

Variable	**ADF**	**5 % Critical Value**
ECM	-3.0199	-5.0236

After running the OLS estimation, the residual of the equation was tested for unit root and was discovered to be non stationary at 5% level. This was due to the fact that the absolute value of the observed variable is less than the absolute critical value. This means that the null hypothesis which states that the residual of the co-integrating regression equation is non stationary cannot be rejected at the 5 % levels of significance. By this, it is evident that there is no long run relationship between the variables in the growth equation. This means that per capita income and the explanatory variables have not be growing together over the last three decades.s

Table 3: Error Correction Model

Method: Least Squares

Dependent Variable: DLPCY

Variable	Coefficient	Std error	t-statistic	Prob
Constant	0.0072680	0.014581	0.49845	0.624
DLELECT	0.071213	0.11347	0.62757	0.538
DLGEX	0.033324	0.027320	1.2198	0.238
DLINV	0.0078547	0.050753	0.15476	0.879
DLEXP	-0.0060545	0.023828	-0.25409	0.802
ECM(-1)	-0.62397	0.23392	-2.6674	0.016
$R^2 = 0.46$; F-stat = 3.1; DW = 2.0				

Table 3 is the short run analysis between per capita income and the explanatory variables. It was discovered that the impact of electricity consumption (ELECT), government expenditure (GEV and investment (INV) on per capita income is positive. For example, a one percent increase in electricity consumption increases per capita income by 0.07 and vice versa. On the other hand, the relationship between per capita income and export is negative. None of the variables is statistically significant. The empirical evidence of the ECM shows that per capita income adjusts towards its equilibrium with a very high speed of 62 percent per month and is statistically significant. The ECM further reveals that the economy is below its equilibrium value and for the error term to resort to the equilibrium, PCY will have to increase by 0.62 percent in the current period. Table 3 also shows that the explanatory variables explain about 46 percent of per capita income. The F-start reveals that the entire equation is statistically significant while the DW statistics depicts absence of serial correlation.

5. Conclusion and Recommendation

Nigeria's power sector had operated for several decades as a state monopoly with huge expenditure commuted to it annually by the government. And yet the country 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. With epileptic power supply in Nigeria and its attendant enormous sums on self generated power, cost of electricity consumption in Nigeria is one of the highest in the world.

The study titled *the impact of electricity Supply on economic growth* examined the relationship between per capita income (a proxy for economic growth) and electricity consumption in Nigeria. Other

variables employed in the study include government expenditure, investment and export. Employing an error correction model, it was discovered that there was no long run relationship between per capita income and the explanatory variables. And in the short run while electricity consumption, government expenditure and investment exert positive impact on per capita income, the relationship between the later and export is negative with none of the variables statistically significant. Finally the ECM observed the usual negative slope with very high speed of adjustment.

The major conclusion in this study is that electricity generation and or consumption has the potential to induce growth in the Nigerian economy but is not making any impact at the moment. Thus, the transformation agenda of the present administration in Nigeria is likely to be a mirage if epileptic power supply continues to prevail in the economy. It is recommended therefore that corruption prevalent in the power sector must be checked. Any official found to have diverted money meant for given project should be punished to serve as deterrent to others while the right technology and expertise engaged. The new owners of the power sector must be constantly monitored and any one found wanting should have his ownership revoked and more competent investors take over.

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