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An Empirical Analysis of Electricity Generation, Electricity Loss, Exchange Rate Fluctuation and Industrial Sector Productivity in Nigeria (1990-2015)

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Abstract
This study investigated the relationships among electricity generation, electricity loss, exchange rate fluctuation and industrial sector productivity in Nigeria over the period 1990 and 2015 using Augumented Dickey Fuller test, Phillips-Perron test, Johansen Cointegration test and Ordinary Least Square estimating technique. The study made use of time series data obtained from the Central Bank of Nigeria Statistical Bulletin of various issues, National Bureau of Statistics, International Energy Agency and International Energy Statistics. Empirical findings revealed that electricity generation has a statistically significant positive relationship with industrial sector productivity in Nigeria. The result further showed that a one megawatt increase in electricity generation would bring about 53.73 units rise in industrial productivity. The study also revealed that there exists a statistically significant inverse relationship between electricity loss and industrial productivity. A one megawatt of electricity lost would bring about 26.06 units reduction in industrial productivity. The analysis also revealed that exchange rate fluctuation has a statistically significant positive relationship with industrial productivity. Based on the estimated results, government should give room for private sector participation or involvement in electricity generation and supply chain to accelerate the present megawatts of electricity generated for industrial and domestic uses; current reform efforts in the power sector by the federal government should be vigorously pursued to bring significant improvements in electricity generation and supply in the country for industrial development; and budgetary allocation to the power sector must be substantially increased to tackle the numerous challenges facing it in the areas of electricity generation, electricity transmission and electricity distribution. In addition, mismanagement of funds by government officials in the power sector should be discouraged through appropriate sanction of the corrupt management members; approval should be given to various state governments proposing to have their own independent power projects by the federal government to boost electricity generation in the country for industrial development; existing electricity distribution channels must be effective and expanded in order to reduce to the barest minimum the incidence of electricity loss; and there should be establishment of a stable exchange rate regime capable of attracting both domestic and foreign investors to boost industrial sector productivity.
Keywords: Electricity generation, Electricity loss, Exchange rate fluctuation, Industrial sector productivity, Unit root, Ordinary least square, Cointegration, Nigeria

Introduction

Industrial sector is an integral part of the national economy that engages in the production of real goods by transforming raw materials through production process. Industrialization is seen as a catalyst to the transformation of an economy from a raw material base into a more active and productive economy. The achievement of sustainable economic growth and development by any economy depends, to a great extent, on the existence of a sound industrial sector. A vibrant, effective and efficient industrial sector is a necessary impetus for achieving rapid economic growth and development. In advanced economies where industrialization is vigorously pursued, electricity is regarded as primary factor that facilitates the efficiency and productivity of other factors of production. Adequate generation, transmission and distribution of electricity would serve as inducement for the citizens to be industrious at home and also encourage the small scale industries, medium scale industries as well as large scale industries to produce at their maximum capacities. Electricity constitutes the nucleus of operation and subsequently the engine of growth for all sectors of the economy.

Nigeria, the most populous country in Africa, is blessed by nature with abundant human and material resources. The economic and political developments of the country have been accompanied with crises since independence. Indicators of the failure of the Nigerian state are today evident in the pervasive cases of poverty, inequality, unemployment, exchange rate fluctuations, inflation, budget deficits, debt overhang, street begging, street hawking, child labour, human trafficking, frauds, prostitution, high crime rates in major cities, collapse of manufacturing industries, corruption in public service, stagnation in entrepreneurial development and erratic power supply (Fadeyi and Adisa, 2012). Due to the above mentioned challenges facing the country, it becomes extremely difficult for the Nigerian economy to achieve sustainable economic growth and development. This paper is motivated by the huge expenditure injected annually into electricity generation over the years, electricity

losses suffered, exchange rate fluctuations and their attendant impact on industrial sector productivity in Nigeria.

Electricity is generated from primary energy sources such as solar, water, waves, wind, oil, gas, coal, tide, etc. Nigeria is abundantly blessed with all these sources of energy. The country has an annual average daily sunshine of 6.25 hours, an average solar radiation of about 5.25 kilowatts/m^2/day and receives about 4.851 x 10^{12} kilowatts of energy per day from the sun (Odetunde, 2008; Solar Energy International, 2011). Proven crude oil reserves for the country as at 2013 was 37.2 billion barrels and proven natural gas reserve was 182 trillion cubic feet. The country is bounded on the south by Atlantic Ocean, River Niger, Benue and many others traverse the country from North to South. There are several waterfalls, abundant wind, tides and waves.

According to International Energy Agency (IEA) and International Energy Statistics (IES) (2015), the figures for electricity generated and electricity loss in 1990 were 13463 GWh and 3.902 billion kilowatts respectively. These figures rose astronomically to 15857 GWh and 5.981 billion kilowatts in 1995. This trend continues as electricity generated and electricity loss figures rose to 16089 GWh and 7.053 billion kilowatts in 1999. In 2006, electricity generated figure was 23110 GWh while electricity loss figure stood at 7.181 billion kilowatts. In 2010, electricity generated figure was 26121 GWh while electricity loss figure amounted to 4.497 billion kilowatts. In 2012, electricity generated figure stood at 28106 GWh while electricity loss figure was 2.485 billion kilowatts.

In Nigeria, the naira exchange rate witnessed a continuous slide in all the segments of the foreign exchange market (that is, official, bureau de change and parallel markets). In the official market, the exchange rate depreciates progressively from #8.0378 per us dollar in 1990 to #21.8861 per dollar in 1995 and further to #132.1470 in 2005. Similarly, it depreciated from #150.2980 per dollar in 2010 to #157.3112 per dollar in 2013. This trend continues as the naira exchange rate declined from #158.5526 per dollar in 2014 to #193.2792 per dollar in 2015.

It should however be noted that despite the huge expenditure injected annually by successive governments over the years into electricity generation in Nigeria, the electricity losses suffered due to distribution problem and the incessant naira exchange rate depreciations, the extent and magnitude of their impact on industrial sector productivity is undetermined. This research work is undertaken to provide answers to the following questions: what relationship exists between electricity generation in Nigeria over the years and industrial sector productivity? Do electricity losses suffered by the Nigerian economy due to distributive problem have negative or positive impact on industrial sector productivity? What nexus exists between exchange rate fluctuations and industrial sector productivity in Nigeria over the studied period? What are the trends of electricity generation and electricity losses in Nigeria?

Objectives of the Study

The overall objective of this study is to empirically examine the relationships among electricity generation, electricity loss, exchange rate fluctuations and industrial sector productivity in Nigeria over the period 1990 and 2015. The specific objectives of the study are to :

-determine the relationship between electricity generation and industrial sector productivity in Nigeria over the studied period.

–investigate the impact of electricity loss on industrial sector productivity in Nigeria over the studied period.

–examine the nexus between exchange rate fluctuations and industrial sector productivity in Nigeria.

Study Hypotheses

The hypotheses to be verified by this study are stated below:

1 H_0 : There is no statistically significant positive relationship between electricity generation and industrial sector productivity in Nigeria.

H_1 : There is statistically significant positive relationship between electricity generation and industrial sector productivity in Nigeria.

2. H_0 : Electricity loss has no statistically significant positive correlation with industrial sector productivity in Nigeria.

H_1 : Electricity loss has statistically significant positive correlation with industrial sector productivity in Nigeria.

3. H_0 : Exchange rate fluctuations have no statistically significant positive relationship with industrial sector productivity in Nigeria.

H_1 **:** Exchange rate fluctuations have statistically significant positive relationship with industrial sector productivity in Nigeria.

Literature Review

Several empirical studies have been undertaken about issues concerning electricity supply and its impact on manufacturing output or economic growth. However, this study concentrates its focus on the industrial sector productivity implications of electricity generation, electricity losses suffered and exchange rate fluctuations in a

developing economy like Nigeria. Jonah et al. (2013) examined the impact of electricity supply on the industrial sector productivity of Nigeria between 1970 and 2010. Data for the study were obtained from the reports and bulletins of Central Bank of Nigeria. The study adopted multiple regression analysis and modern econometric methodology. Empirical results revealed that electricity supply in Nigeria does not significantly impact on industrial productivity of the country. However, the ADF test results indicated that all the variables for the study were stationary at first difference and that there is a possibility of convergence of industrial output to equilibrium at the nearest future with equilibrium line points of -0.945. This result depicts the poor state of electricity supply in the country, because economic expectations are that electricity supply should contribute positively and significantly to industrial sector growth and hence economic growth. Odell (1965) investigated the impact of electricity supply on economic growth and development of Columbia. The results revealed that electricity was very important for the growth and development of such a rapidly developing economy. Ukpong (1973) carried out a study on the cost of power outages to the industrial and commercial sector in Nigeria. He used the production function approach to evaluate the power outage cost between 1965 and 1966, with selected firms. From his estimate, he discovered the unsupplied electrical energy to be 130kwh and 172kwh between the periods. The corresponding costs of the power outage to the industrial sector in the two years were estimated at #1.68 million and #2.75 million respectively. The unsupplied electrical energy according to Ukpong, has a negative implication on the manufacturing productivity growth in Nigeria.

Ellahi (2011) examined the relationship between electricity supply, development of industrial sector and economic growth using endogenous growth theory for the period 1980 to 2009. The result using Auto regressive Distributed Lag (ARDL) shows that productivity level of the industrial sector in Pakistan is declining as a result of power shortage. The study recommended that electricity problem should be fixed to improve industrial growth. Mojekwu and Iwuji (2012) investigated the impact of power supply and macroeconomic variables on manufacturing sector performance in Nigeria using time series data from 1981 to 2009. The multiple regression analysis showed that power supply positively have significant impact on capacity utilization, while interest and inflation rate have adverse impact on capacity utilization in Nigeria. Olayemi (2012) investigated the impact of electricity crisis on manufacturing productivity growth in Nigeria. Time series data from 1980 to 2008 were analyzed using OLS multiple regression. The results showed that electricity generation and supply in Nigeria impacted negatively on manufacturing productivity growth. This was attributed to unnecessary government spending on non economic and unproductive sectors. They advised that electricity generation and distribution should be restructured through the initiative of independent power projects, that is, there should be a reform of the power sector. Ubi and Effiom (2013) investigated the relationship between electricity supply and economic development in the country. Time series data for the study were analyzed using modern econometric technique. Stationarity and cointegration tests were carried out and estimation technique adopted was the error correction mechanism. The results indicated that despite the poor state of electricity supply in the country, it influences economic development, although its impact is relatively very low. Based on this, they recommend among others that more power projects should be completed, that is, more power generation efforts should be made.

Alawiye (2011) whose study showed that the power sector in Nigeria impacts positively on industrial development. Ubi et al. (2012) conducted a study on the relationship between electricity supply and economic development over the period 1970 to 2009 using parametric econometric methodology of OLS. The study made use of time series data. The results revealed that technology, government funding, and the level of power loss were the statistically significant determinants of electricity supply in Nigeria. They recommended among others, the injection of more funds into the sector and more power plants to generate more electricity. Akinlo (2008) using the Auto Regressive Distributive Lag bound test showed that energy consumption has a significant positive long run impact on economic growth in Sub-Saharan African countries of Cameroun, Cote d'Ivoire, Gambia, Senegal, Sudan and Zimbabwe. Allcott et al. (2014) examined the relationship between electricity supply and industrial output for India over the period 1992 to 2010. The study adopted hybrid Leontif/Cobb-Douglas production function model and simulation calibrated to annual survey of industrial plants. Their analysis revealed that electricity supply shortage reduces average industrial output by five percent and raises energy cost by 0.24 percent of revenue, reduces productivity by 0.05 percent and reduces revenue by 0.78 percent.

Simeon (2012) examined electricity crisis and manufacturing productivity in Nigeria over the period 1980 to 2008. The study employed the ordinary least square multiple regression to analyze the time series data. Empirical findings revealed that electricity generation and supply in Nigeria under the reviewed period impacted negatively on the manufacturing productivity growth. The study recommended a reverse of the ugly trend of poor electricity supply through the initiative of independent power project as proposed by some states in Nigeria. Nwanko and Njogo (2013) conducted a study on the effect of electricity supply on industrial production in Nigeria over the period 1970 to 2010. Multiple regression methodology was employed to analyze the time series data. Empirical findings revealed a positive relationship between electricity supply and industrial production over the studied period. The study recommended that issues relating to electricity production and industrial development should be given priorities particularly in the budget scheme. Scott et al. (2014) used data from the

world bank enterprise surveys from six countries: Bangladesh, Nepal, Nigeria, Pakistan, Tanzania, and Uganda to study the impact of electricity insecurity on small and medium scale firms. Their statistical analysis showed that electricity insecurity negatively affects total factor productivity.

Osobase and Bakare (2014) investigated the nexus between electricity generation, supply and manufacturing sector performance in Nigeria using time series data from 1975 to 2011. The variables utilized include index of manufacturing production, electricity generation, government capital expenditure, inflation rate, exchange rate and capacity utilization. The study employed the correlation analysis, granger causality test and Johansen cointegration test for the empirical analysis. Empirical analysis revealed a weak positive nexus between electricity generation and index of manufacturing production in Nigeria. The granger causality test showed a unidirectional causality between electricity generation and index of manufacturing sector production. Bright et al. (2015) investigated the impact of electricity supply on economic growth for the period 1980 to 2010 using error correction model. Empirical results from the study revealed that there was no long run relationship between per capita income and the explanatory variables. Yahaya et al. (2015) examined the relationship between electricity supply and manufacturing output in Nigeria using the time series data from 1971 to 2010. The study employed autoregressive distributed lag bounds testing approach to cointegration. Empirical findings revealed long run relationship between the variables and showed significant and negative error correction term. Manufacturing output is found to be positively dependent on electricity in both short run and long run. The study recommended that electricity supply must be increased if the productive capacity of the manufacturing sector is to be improved.

Literature Review on Exchange Rate Fluctuation and Industrial Sector Productivity

several studies have been conducted on the relationship between exchange rate fluctuation and manufacturing productivity or economic growth. But very few studies have been conducted on the nexus between exchange rate fluctuation and industrial sector productivity in Nigeria. It should be mentioned that manufacturing productivity is a subset of industrial sector productivity. Therefore, conducting a study on the correlation between exchange rate fluctuation and industrial sector productivity is broader or wider in scope. Industrial sector productivity is made up of manufacturing productivity, solid minerals productivity and petroleum productivity. Ubok-Udom (1999)) examined the relationship between exchange rate fluctuation and growth of domestic output in Nigeria over the period 1971 and 1995. He expressed growth of domestic output as a linear function of variations in the average nominal exchange rate. He further used dummy variables to capture the periods of currency depreciation. The empirical result showed that all coefficients of the major explanatory variables have negative signs. David et al. (2010) investigated the impact of exchange rate fluctuations on Nigerian manufacturing industry. They employed multiple regression econometric tools which revealed a negative relationship between exchange rate volatility and manufacturing sector performance. Eichengreen and Lebland (2003) carried out their research in twelve countries and found strong inverse relationship between exchange rate stability and economic growth.

Aliyu (2011) asserted that appreciation of exchange rate results in increased imports and reduced export while depreciation would expand export and discourage import. Also, depreciation of exchange rate tends to cause a shift from foreign goods to domestic goods. Hence, it leads to diversion of income from importing countries to countries exporting through a shift in terms of trade, and this tends to have impact on the exporting and importing countries' economic growth. Azu and Naziri (2015) examined the relationship between exchange rate fluctuation and sustainable economic development in Nigeria over the period 2004 and 2014 applying those variables that adjudged to make up equilibrium exchange rate thereby defining how interrelated are real exchange rate, gross domestic product, export, import, foreign exchange reserve and foreign direct investment. The research shows that the tendency of increasing foreign direct investment would definitely pressurize for the appreciation of the naira, likewise would gross domestic product growth. Ayodele (2014) examined the impact of exchange rate on the economic performance of Nigeria using the ordinary least squares method. The study covered the period of 13 years from 2000 to 2012. Empirical findings revealed that exchange rate of naira to dollar has negative correlation with the gross domestic product. Though the Nigeria gross domestic product keeps increasing every year, the negative impact had not allowed the GDP to grow maximally as expected.

Opaluwa et al. (2010) examined the effect of exchange rate fluctuations on the Nigerian manufacturing sector over the period 1986 to 2005. The econometric tool of regression was used for the analysis. Empirical findings from the study revealed that exchange rate fluctuation has a statistically significant negative relationship with manufacturing sector productivity. Jongbo (2014) investigated the impact of real exchange rate fluctuation on industrial output in Nigeria. The results showed that real exchange rate plays a significant role in determining the industrial output. The study further revealed that the capacity utilization ratio is low due to epileptic power supply, lack of adequate and appropriate technology and so on. Ismaila (2016) examined exchange rate depreciation and Nigeria economic growth during the SAP and post SAP period over the period 1986 to 2012. The study employed the Johansen cointegration test and error correction model analyses. The results show that broad money supply, net export and total government expenditure have significant impact on real output

performance in the long run while exchange rate has direct and insignificant effect on Nigeria economic growth in both short and long run. This implies that exchange rate depreciation during the sap period has no robust effect on Nigeria economic performance. Lawal (2016) investigated the effect of exchange rate fluctuations on manufacturing output in Nigeria from 1986 to 2014. Data were analyzed through the multiple regression analysis using autoregressive distribution lag. Empirical findings from the study revealed that exchange rate fluctuations have long run and short run relationship on manufacturing sector output. The result showed that exchange rate has a positive relationship on manufacturing sector output but not significant. Ugwu (2017) examined the impact of exchange fluctuation on the performance of manufacturing firms in Nigeria using firms' profitability as a proxy for performance within the period 1986 to 2016. The estimation technique adopted for the study was multiple regression method based on ordinary least squares technique. Empirical findings from the study revealed that there is a statistical significance between exchange rate fluctuations on the profitability of manufacturing firms in Nigeria.

Data and Methodology

The data for this study were sourced from Central bank of Nigeria Statistical Bulletin of various issues, International Energy Agency and International Energy Statistics. The method that was employed in analyzing the data is simple regression analysis. Electricity generation, electricity losses, exchange rate fluctuations and inflation rate are exogenous or explanatory variables while industrial sector productivity is the endogenous or dependent variable

Description of Variables

Industrial Sector Productivity- This is the **dependent or endogenous variable** in the model which is to be influenced by a number of **exogenous or explanatory variables** which include electricity generation, electricity loss, exchange rate fluctuations and inflation rate. Industrial sector productivity represents the aggregate output produced by manufacturing industries, solid minerals industries and petroleum industries. Industrial sector productivity is a function of several other factors in the Nigerian economy such as electricity generation, electricity supply, existence of modern technology, availability of labour, organized market, existence of financial institutions, efficient road network, government regulations, availability of raw materials, exchange rate, inflation rate, climatic condition and others too numerous to mention.

The exogenous or independent or explanatory variables included in the model are:

Electricity Generation- This is the total megawatts of electricity generated by the Power Holding Company of Nigeria over the studied period. Electricity is generated from primary energy sources such as solar, water, waves, wind, oil, gas, coal, tide, etc. Nigeria is abundantly blessed with all these sources of energy. This variable theoretically is expected to have positive impact on industrial productivity. The higher the megawatts of electricity generated and supplied by the Power Holding Company of Nigeria, the greater would be the industrial sector productivity while the converse is true.

Electricity Loss- This is the total megawatts of electricity lost due to distributive problems by the Power Holding Company of Nigeria. The variable theoretically should exert negative impact on industrial sector productivity in Nigeria. The greater the megawatts of electricity lost due to distribution challenges, the lower will be industrial sector productivity. But the lower the megawatts of electricity lost, the higher the industrial sector productivity would be.

Exchange Rate- Exchange rate is the price of one currency in terms of another. It is the price at which one country exchanges its currency for other currencies. The increase or decrease of real exchange rate indicates strength and weakness of a country's currency in relation to foreign currency and it is a standard for illustrating the competitiveness of domestic industries in the world market. In Nigeria, the naira exchange rate witnessed a continuous slide in all the segments of the foreign exchange market. This variable is expected to exert a negative impact on industrial sector productivity.

Inflation Rate- This is defined as a persistent and sustained increase in the general price level over a long period in an economy. It is a sustained rise in the general level of prices of goods and services in an economy over a period of time. This variable theoretically is expected to have an inverse relationship with industrial sector productivity in the Nigerian economy.

Random Variable- This variable takes care of other exogenous variables influencing the endogenous variable which are not included in the model. It represents the unexplained part of the model.

Data and Methodology

The research work made use of secondary data collected from Central Bank of Nigeria's Statistical Bulletin, National Bureau of Statistics, International Energy Agency and International Energy Statistics for the period 1990 and 2015. The empirical measurement covers the sample period between 1990 and 2015. Augumented Dickey Fuller unit root test, Phillips-Perron unit root test, Johansen Cointegration test and Ordinary Least Square

(OLS) Regression technique were employed to carry out an extensive analysis of the endogenous and exogenous variables which include Industrial Sector Output (INDQ), Electricity Generation (ELEG), Electricity Loss (ELEL), Exchange Rate Fluctuation (EXGR) and Inflation rate (INFR).

Model Specification

For the purpose of analysis, data for this research work are secondary data obtained from the Central Bank of Nigeria's Statistical Bulletin, National Bureau of Statistics, International Energy Agency and International Energy Statistics for the period 1990 and 2015. The mathematical representation of the variables identified from this model is presented as follows:

INDQ = f(ELEG, ELEL, EXGR, INFR), where (1)

INDQ =Industrial Output

ELEG =Electricity Generation

ELEL= Electricity Loss

EXGR= Exchange Rate

INFR = Inflation Rate

The regression analysis of Ordinary Least Square (OLS), Augumented Dickey Fuller (ADF) unit root test, Phillips-Perron (PP) unit root test and Johansen Cointegration test were employed to examine the relationships among industrial sector productivity, electricity generation, electricity loss, exchange rate fluctuations and inflation rate in Nigeria over the period 1990 to 2015. Specifically, the estimated regression equation is of the following form:

$INDQ = b_0 + b_1ELEG + b_2ELEL + b_3EXGR + b_4INFR + U$ (2)

b_1, b_2, b_3 and b_4 are elasticity of the parameters of the respective variables.

The Apriori Test Expectation

An apriori argument, reason or probability is based on assumed principles or facts, rather than actual or observed fact. These in economic terms are based on economic theory and they seek to determine whether the expected is equal to the observed, i.e. whether the economic expectations are in line with actual observations in the analysis. Therefore, from the OLS linear equation, it was expected that the following conditions are obtainable: $b_0 > 0$, $b_1 > 0$, $b_2 < 0$, $b_3 < 0$ and $b_4 < 0$

Table 1 AUGUMENTED DICKEY FULLER TEST STATISTICS OF THE VARIABLES

VARIABLE	ADF STATISTICS	1%	5%	10%	ORDER OF INTEGRATION	MAXIMUM NO. OF LAG
INDQ	-4.193248	-2.664853	-1.955681	-1.608793	I(1)	9
ELEG	-6.098096	-3.769597	-3.004861	-2.642242	I(1)	9
ELEL	-7.074908	-3.737853	-2.991878	-2.635542	I(1)	9
EXGR	-3.811171	-2.664853	-1.955681	-1.608793	I(1)	9
INFR	-4.089233	-2.664853	-1.955681	-1.608793	I(1)	9

SOURCE: Author's Computation using E-view 7.1

Table 2 PHILLIPS-PERRON TEST STATISTICS OF THE VARIABLES

VARIABLE	PP STATISTICS	1%	5%	10%	ORDER OF INTEGRATION	MAXIMUM NO. OF LAG
INDQ	-4.803562	-3.737853	-2.991878	-2.635542	I(1)	2
ELEG	-7.482073	-4.374307	-3.603202	-3.238054	I(1)	2
ELEL	-7.036987	-3.737853	-2.991878	-2.635542	I(1)	2
EXGR	-3.798730	-2.664853	-1.955681	-1.608793	I(1)	2
INFR	-8.406862	-3.752946	-2.998064	-2.638752	I(1)	2

SOURCE: Author's Computation using E-view 7.1

Unit root tests are conducted for the variables using the Augumented Dickey Fuller test and the Phillips-Perron test and the results are presented in the table 1&2 above. Note that the Mackinnon (1996) critical values for the Augumented Dickey Fuller test and the Phillips-Perron test estimation at 1%, 5% and 10% significance levels are stated in the tables above. Stationary (unit root) test conducted for the set of variables enumerated above revealed that all the variables are I(1) variables (Integrated of order 1). That is, they are not stationary at levels but are all stationary at their various first differences.

Table 3
Date: 12/20/17 Time: 10:39
Sample (adjusted): 1992 2015
Included observations: 24 after adjustments
Trend assumption: No deterministic trend (restricted constant)
Series: INDQ ELEG ELEL EXGR INFR
Lags interval (in first differences): 1 to 1

Unrestricted Cointegration Rank Test (Trace)

Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	0.05 Critical Value	Prob.**
None *	0.706426	88.14221	76.97277	0.0055
At most 1 *	0.602481	58.72717	54.07904	0.0182
At most 2 *	0.575788	36.58687	35.19275	0.0351
At most 3	0.432001	16.00635	20.26184	0.1741
At most 4	0.096334	2.431086	9.164546	0.6913

Trace test indicates 3 cointegrating eqn(s) at the 0.05 level
* denotes rejection of the hypothesis at the 0.05 level
**MacKinnon-Haug-Michelis (1999) p-values

Unrestricted Cointegration Rank Test (Maximum Eigenvalue)

Hypothesized No. of CE(s)	Eigenvalue	Max-Eigen Statistic	0.05 Critical Value	Prob.**
None	0.706426	29.41505	34.80587	0.1912
At most 1	0.602481	22.14030	28.58808	0.2667
At most 2	0.575788	20.58051	22.29962	0.0853
At most 3	0.432001	13.57527	15.89210	0.1118
At most 4	0.096334	2.431086	9.164546	0.6913

Max-eigenvalue test indicates 1 cointegrating eqn at the 0.05 level
* denotes rejection of the hypothesis at the 0.05 level
**MacKinnon-Haug-Michelis (1999) p-values

Table 3 above presents the cointegration result for the variables. Here, it could be observed that the variables in the equation are cointegrated. The existence of cointegration suggests that there is a long-run relationship among the variables in the equation. Trace test and Max-eigenvalue test indicate cointegration at 5% levelof significance respectively. As a result of this, an ordinary least square regression was estimated because the variables are stationary at their various first differences.

Table 4
Dependent Variable: INDQ
Method: Least Squares
Date: 12/19/17 Time: 19:01
Sample: 1990 2015
Included observations: 26

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	8537.700	755.6259	11.29884	0.0000
ELEG	0.053738	0.030559	1.758472	0.0932
ELEL	-260.6827	76.31487	-3.415884	0.0026
EXGR	20.11980	4.107611	4.898175	0.0001
INFR	-1.554408	10.10740	-0.153789	0.8792

R-squared	0.877184	Mean dependent var	10264.90
Adjusted R-squared	0.853791	S.D. dependent var	2010.955
S.E. of regression	768.9357	Akaike info criterion	16.29893
Sum squared resid	12416503	Schwarz criterion	16.54087
Log likelihood	-206.8861	Hannan-Quinn criter.	16.36860
F-statistic	37.49692	Durbin-Watson stat	1.903826
Prob(F-statistic)	0.000000		

Table 5 Presentation of Regression Result
Dependent Variable : INDQ **Sample : 1990-2015**

Variables	**Estimated Coefficient**	**T-Value**	**Apriori Expectation**	**Inference**
Constant term	8537.700	11.29884	$b_0 > 0$	Correct sign and significant
ELEG	0.053738	1.758472	$b_1 > 0$	Correct sign and significant
ELEL	-260.6827	-3.415884	$b_2 < 0$	Correct sign and significant
EXGR	20.11980	4.898175	$b_3 > 0$	Incorrect sign and significant
INFR	-1.554408	-0.153789	$b_4 < 0$	Correct sign and significant
Significant at 5%		$R^2 = 0.87$		DW = 1.9

Source : Author's Computation, 2017

Empirical Findings
The short run result in table 4 shows that there is a positive correlation between electricity generation and industrial sector productivity in the Nigerian economy, given the coefficient of 0.053738, which is statistically significant with a t-value of 1.758472. This can be interpreted as a one megawatt increase in electricity generation would bring about 53.73 units rise in industrial sector productivity. This suggests that there is a positive relationship between electricity generation and industrial productivity which is in conformity with apriori theoretical expectation. This implies that electricity generation is a significant factor that can facilitate the growth of industrial sector productivity. From the estimated results, there is an inverse relationship between electricity loss and industrial sector productivity in Nigeria, given the coefficient of -260.6827 which is statistically significant with a t-value of -3.415884. This suggests that a one megawatt of electricity lost would bring about 26.06 units reduction in industrial sector productivity which is also in compliance with economic theory. The coefficient of exchange rate in the estimated regression equation is 20.11980 which is statistically significant with a t-value of 4.898175. This implies that a one unit rise in exchange rate would increase industrial sector productivity by 20.11 units. This negates the apriori theoretical expectation that there is an inverse relationship between exchange rate and industrial sector productivity. The results further showed that there is a negative relationship between inflation rate and industrial sector productivity, given the coefficient of -1.554408 which is statistically significant with a t-value of -1.153789. This implies that a one unit rise in inflation rate would reduce industrial sector productivity by 15.54 units. This is in conformity with apriori theoretical expectation that there is an inverse relationship between inflation rate and industrial sector productivity.

The coefficient of determination (R^2) indicates that over 87 percent changes in the industrial sector productivity are explained by Electricity generation (ELEG), Electricity loss (ELEL), Exchange rate (EXGR) and Inflation rate (INFR) taken together. This is a nice fit as the unexplained variation is just 13 percent. The remaining 13 percent could be attributed to some other forces affecting industrial sector productivity. The Adjusted coefficient of Determination (R^2) is 0.85 and this shows that 85 percent variation in industrial sector productivity (INDQ) is caused by variations in Electricity generation (ELEG), electricity loss (ELEL), exchange rate fluctuations (EXGR) and inflation (INFR). This model as specified is statistically significant given its F-test to be 37.49692. The F-statistic value of 37.49692 is high enough, this shows the overall significance of the model and this indicates that collectively, all the explanatory variables are important determinants of industrial sector productivity.

The value of Durbin-Watson is 1.903826 for the model. This falls within the determinate region and this implies that the model is free from autocorrelation problem. Since electricity generation exerts a statistically significant positive relationship with industrial sector productivity in the model, thus, null hypothesis is rejected which states that there is no significant positive relationship between electricity generation and industrial sector productivity in Nigeria. But, electricity loss have statistically significant inverse relationship with industrial sector productivity in the model, thus, the null hypothesis is accepted which states that there is no significant positive relationship between electricity loss and industrial sector productivity in Nigeria. Since exchange rate exerts a statistically significant positive relationship with industrial sector productivity in the model, thus, null hypothesis is rejected which states that there is no significant positive relationship between exchange rate fluctuation and industrial sector productivity.

Conclusion and recommendations

This paper investigated the industrial sector productivity implications of electricity generation, electricity loss and exchange rate fluctuations in Nigeria. Empirical analysis was conducted by applying the multiple regression of the ordinary least square technique to the annual data on the Nigerian economy for the period 1990 to 2015. The model was found to be significant and most of its estimates are as expected. Findings from the study revealed that electricity generation has statistically significant positive relationship with industrial sector productivity which is in conformity with apriori theoretical expectation. The result further showed that there is an inverse relationship between electricity loss and industrial productivity which is in line with economic theory. Exchange rate is found to be positively related with industrial sector productivity in Nigeria which is contrary to apriori theoretical expectation. Based on the estimated results, the following recommendations are made:

-Government should give room for private sector participation or involvement in electricity generation and supply chain to accelerate the present megawatts of electricity generated for industrial and domestic uses.

–Current reform efforts in the power sector by the federal government should be vigorously pursued to bring significant improvements in electricity generation and supply in the country for industrial development.

–Budgetary allocation to the power sector must be substantially increased to tackle the numerous challenges facing it in the areas of electricity generation, electricity transmission and electricity distribution.

–Mismanagement of funds by government officials in the power sector should be discouraged through appropriate sanction of the corrupt management members.

–Approval should be given to various state governments proposing to have their own independent power projects by the federal government to boost electricity generation in the country for industrial development.

–Existing electricity distribution channels must be effective and expanded in order to reduce to the barest minimum the incidence of electricity loss.

–There should be establishment of a stable exchange rate regime capable of attracting both domestic and foreign investors to boost industrial sector productivity.

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