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Original Paper

Electricity Consumption and Industrial Performance in Nigeria

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Abstract

Over the years, demand for electricity has continued to grow while supply has consistently declined. The shortages of electricity supply formed the major background for energy crisis in Nigeria. The reason for this is that, all efforts are concentrated at generating electricity from only two major sources, namely: hydropower and gas. Therefore, this study investigated the effects of electricity consumption and its implications on industrial performance in Nigeria. Time series data were used for the study, sourced from the Central Bank of Nigeria Annual Report, Statistical Bulletin, Publications of the International Monetary Fund and the National Bureau of Statistics which spanned from 1981 to 2019. The study employed Fully Modified Ordinary Least Squares Method and Descriptive Statistics to carry out the empirical analysis. The findings revealed that a unit rise in industrial electricity consumption and exchange rate contribute to industrial performance by 9.4% and 44% respectively. This indicator only reflects marginal impact of industrial performance in Nigeria compare to other countries. However, a percentage increase in gross fixed capital formation and gross domestic product reduced industrial performance by 0.018% and 0.020%. Meanwhile, capacity utilization signed positive but not statistically significant. The study concluded that irregular electricity supply has weakened industrial performance in Nigeria despite various energy resources available. Therefore, the study recommended well rounded energy mix option through government policies to complement the existing energy sources available in Nigeria, as well, as other renewable energy resources for industrial sector and domestic use.

Keywords

Industrial output, Industrial electricity consumption, Capacity utilization, Exchange Rate, Gross domestic product

1. Introduction

Over the years, Nigeria industrial development has been bedeviled by myriads of problems top among which is the erratic nature of electricity supply in the power sector. Every successive government had promised to do something drastic to stabilize the sector in other to drive growth in the industrial sector but all to no avail. Electricity crisis has become a matter of grave concern not only to Nigerians but also, to the international community especially many foreign investors. Demand for electricity has continued to grow while supply appears to have consistently declined in Nigeria despite government policies, and huge investment. The Federal Government is investing heavily in expanding the generation capacity and is encouraging investments in power production yearly. The threat in electricity supply to national economic sustainability, development and appreciable growth is conspicuously visible in Nigeria compare to the way each country of the world seeks and exploit various alternative energy sources, to generate electricity in the most economical-and environmentally friendly way.

The performance of the Nigerian power sector on the International Best Practices comparative rating is worrisome. Perhaps, no other sector feels it as much as the industrial sector wherein some notable international companies and organizations are on self-generate electricity throughout the day for all the 365 days in the year. The data for some countries within the Southern Africa Development Community (SADC) such as Botswana and South Africa are comparable to those of the United State of America (USA) and France. Libya, with a population of only 5.5 million, has a generating capacity of 4,600 megawatts, approximately the same as Nigeria which has a population of about 170 million (Lohor & Ezeigbo 2006; Oloja & Oretade 2006). South Africa, with a population of 44.3million has a generating capacity of 45,000 megawatts, almost eleven times the generating capacity of Nigeria which has three times the population of South Africa (Agbo, 2007). The United Kingdom (UK) with a population of 64 million generates 356,800 Giga Watts while Germany, with a population of 80.62 million generates 614,000 Giga Watts. Furthermore, Malaysia with a population of 28.33 million generates 118,000 Giga Watts. But Nigeria, with a population of over 170 million, generates meagre electricity energy of 0.54 Giga Watts.

According to the World Fact-book (2008), the comparative indicators between Japan and Nigeria showed that, Japan with a population of about 160 million people, zero natural resources, has a high-power generating capacity of 124 Giga Watts, 100% grid access. 5% carbon-emission rate, and 100% energy-conservation compliance. Whereas, in Nigeria. Despite the huge deposit of energy-resources such as crude oil, natural gas, coal, hydropower. Solar energy, fissionable materials for nuclear energy, has consistently suffered from energy-shortages which thereby, serves as a major impediment to both industrial and technological growth. Lack of access to adequate energy is most prevalent in Nigeria and is characterized by low-power generating capacity of 0.54 Giga Watts, less than 40% grid access, 60% carbon emission rate and 2% energy conservation-compliance.

The Council for Renewable Energy of Nigeria estimates that power outages brought about a loss of 126 billion naira (USS 984.38 million) annually. Apart from the huge income loss, it has also resulted in health hazards due to avoidable exposure to carbon emissions caused by constant use of 'backyard generators' in different households and business enterprises, leading to unemployment, high cost of living, and grave deterioration in living conditions. Energy Information Administration (2007) discovered that only 40% of Nigerians have access to electricity. However, majority of the electricity is supplied to the urban areas. In Nigeria presently, the total installed capacity of the generating stations has not equated the energy demand of the people due to poor infrastructure and policies despite the government's creasing investments in this sector.

Comparing the present and ever-increasing population with the total capacity available power stations reveals that Nigeria is not able to meet the energy needs of the people. The demand is projected to rise from 5,746 MW in 2005 to 297,900M\V in 2030 which translates to the construction of 1 K686MW every year to meet this demand (Sambo, 2008). The projections for continued rapid energy demand imply some severe problems for the future-resource depletion, energy degradation and environmental problems due to dependency on only two sources of energy form (hydropower and gas) for generating electricity.

Over the last four decades, the gap between energy-supply and demand in Nigeria has been growing and is expected to continue, Inefficiency to boost electricity-supply has been responsible for the gap between the demand and supply of electric-power due to the poor maintenance of existing hydro-plants, and the loss of power transmission in Nigeria. In addition, indicators such as constant blackouts and persistent reliance on self-generating plants are pointers to underutilization of resources in Nigeria industrial sector. Based on these premises, existing relationship between industrial electricity consumption and industrial performance in Nigeria has not been adequately addressed. Against this background, this study is most relevant and indeed timely.

Studies have traced the collapse of Nigeria's industrial sector development, small and medium scale businesses, and economic standstill to the inadequate and erratic state of the country's energy policy. However, most researchers focused on disaggregate energy consumption-economic growth nexus e.g., Ogunleye and Ayeni (2012); Aldnlo (2009), While some of the studies centered on aggregate energy-supply to industrial sector which were problem oriented e.g., Nwosa and Akinbobola (2012); Liew, Nathan and Wong, (2012). Furthermore, a handful of studies focused on a simile energy source in isolation to industrial output in Nigeria which the findings do not give the extent of the impact of electricity consumption on industrial performance in Nigeria (Ogunjobi, 2015; Nwajinka, Essien, & Igweonu, 2014; Osobase & Bakare, 2014; Nwachukwu, Ezedinma, & Jiburum, 2014). Therefore, this study seeks to fill this significant gap by examining the effects of industrial electricity consumption on industrial performance and investigate other energy-resources available in Nigeria yet to be explored and harnessed, and enhance energy-security as well as to broaden the nation's energy-supply-mix option. One then wonders, to what extent, has electricity consumption contributed to the industrial performance in Nigeria?

The objective of this study therefore is to examine the effects of electricity consumption on industrial performance in Nigeria economy.

2. Review of Literature

Electricity consumption is the energy distributed and used to different sectors of the economy while energy demand is the electricity that the end users require to meet all their needs, while electricity demand is what should actually be supplied, Energy is a necessary condition for an industrial and economic survival. For developing nations, the growth in the utilization of energy is directly and closely related to expansion in industrialization (World Bank, 2005). However, electricity generation and supply (distribution) in Nigeria has not really expanded industrialization as perceived by World Bank (2005).

Energy is widely regarded as a propelling force (behind tiny economic activity and indeed industrial production. Qjinnaka (2008) argued that the consumption of energy tracks with the national product. In modern economy where industrialization is taking pace and mass production is needed for domestic consumption and exports, electricity is regarded as primary factor that facilitates the efficiency and productivity of other factors of production, particularly labour and capital, Meanwhile, Ndebbio (2006) argued that electricity supply drives industrialization process.

Industrialization as explained by Udah (2010) is a deliberate and sustained application, combination of an appropriate technology, infrastructure, managerial experts and other important resources for production. Industrialization has attracted considerable interest in development economics in recent time, industrial production of a country accelerates the pace of structural transformation and also brings about diversification of economies, enables a country to fully utilize its factor endowment and depend less on foreign supply of finished goods.

A lot of empirical literatures exist on electricity and its effect on the economic performance. However, this study narrows its focus on the relationship it has with Industrial development. Ogunjobi (2015) used time series data for the period between 1980 and 2012. The data collected are then analyzed using co-integration and error correction technique to estimate the short-run and long-run dynamics of the research models, respectively. The result established that in the long-run, there is a significant positive relationship between industrial growth and electricity-consumption, electricity-generation, labour employment, and foreign exchange rates while it showed a negative relationship between industrial growth and capital input proxy by gross capital formation. The study, therefore, recommends that government should take an urgent approach towards reforming electricity-supply in such a way as to increase industrial production and lo monitor the privatization-policy of the electricity sub-sector to provide employment so as to reduce the high rate of unemployment in Nigeria. However, the study never takes a look at sources available for energy generation in Nigeria.

In the same vein, Ziramba (2009) assessed the relationship between disaggregate energy consumption and industrial output in South Africa by undertaking a co-integration analysis using annual data from 1980 to 2005. The study investigated the causal relationships between the various disaggregate forms of energy consumption and industrial production.

The study showed that industrial production and employment are long-run effects, forcing variables for electricity-consumption. The study applied the Toda and Yamamolo (1995) Statistical Inference in Vector Auto-regressions and Granger-causality test for the analysis. And, it was found that bi-directional causality between oil consumption and industrial production existed. There is also evidence of causality between employment and electricity consumption as well as coal consumption causing employment.

Meanwhile, Liew, Nathan and Wong (2012) analyzed the interdependence between energy-consumption and sectoral outputs in Pakistan for the period of 1980 to 2007. The study utilized the Johansen-Juselisus co-integration approach and the Granger causality test. The co-integration estimate revealed that energy consumption exhibited long-run relationships with the agriculture as well as with services output. However, there is no evidence of long run relationship observed between energy-consumption and industrial output. Furthermore, the causality estimate revealed a bi-directional causal relationship between energy consumption and agricultural output while a unidirectional causation was observed from services and industrial output to energy consumption.

Mojekwu and Iwuji (2012) analyzed the impact of power-supply and macro-economic variables on the manufacturing sectors performance in Nigeria, using time series data from 1981-2009. The multiple regression analysis (MRA) showed that power-supply has a positive significant impact on capacity utilization, while interest and inflation rates have adverse impacts on capacity-utilization in Nigeria. The R^2 of 88.54 percent shows changes in capacity utilization as a result of the predictor variables. It was recommended that, the on-going power-reform of privatizing the sub-sector should be fully undertaken by the government and a single-digit lending and inflation rates should be adequately sustained.

However, Osabase and Bakare (2014) investigated the relationship between electricity generation/supply and the manufacturing-sectors performance, using time-series data from 1975-7011. The variables utilized included: index of manufacturing production, electricity-generation, government's capital expenditure, inflation rate, exchange rate, and capacity-utilization. The study employed correlation analysis, the Granger Causality test and Johansen Co-integration test for the empirical analysis. The correlation result 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's production. Further tests show three co-integration equations at five percent level for the trace statistics; but, no co-integration at five and one percent level for the Max-Eigen test. In view of the findings, it is observed that irregular electricity supply has been a major bane to output growth in the manufacturing sector. Therefore, it was recommended that the power sector, by means of guided private sector initiative, should be given more attention for the growth of the nation's economy.

The most significant effect of electricity supply on industrial outfits and their productivity is cost. Cost is a variable input in-the measurement of profit. Profit is only realizable where cost of production is less than revenue. As a fixed cost therefore access to sufficient and affordable supply of electricity is a crucial determinant of productivity and growth. It is observable that industries suffer operation and maintenance costs arising out of power fluctuations (Lai et al., 2008). In the views of Odularu and Okonkwo, (2009), only 40% of Nigerians have access to electricity (Energy Information Administration, 2007). However, majority of the electricity is supplied to the urban areas. According to the encyclopedia on energy (2006), energy is a vital ingredient to economic and industrial growth and that this has been discovered for as long as economic data has been compiled.

Velasquez and Pichler (2010) reiterated that sufficient and affordable supply of energy (in this case, electricity) has had a decisive significance for industrial productivity and economic growth. Since a country's economic growth is a composite of economic activities of enterprises, the less cost they have to tolerate, the better a country's chance at harnessing their input towards greater levels of gross domestic product and growth. Okpara (2011) consents that industrial productivity can contribute immensely towards economic growth and poverty reduction.

Oke (2006) attributed the non-competitiveness of Nigeria's export goods to poor infrastructure especially electricity supply, which drives the running cost of firms. Archibong (1997) argued that the positive side of SAP could not be fully established due to administrative bottlenecks, rigidities and poor infrastructure, especially electricity supply. This undermined the effectiveness of fiscal and other incentives designed to stimulate the growth and diversification of the economy.

Ndebbio (2006) submitted that one important indicator whether a country is industrialized or not is the megawatt of electricity consumed. He further argued that a country's electricity consumption per capita in kilowatt hours (KWH) is proportional to the state of industrialization of that country. Ekpo (2009) elaborated on the folly of running generator economy and its adverse effects on investment. He strongly argued that for Nigeria to jump start and accelerate the pace of economic growth and development, the country should fix power supply problem. Aigbokan (1999) opined that fixing the energy sector is tantamount to shifting the production possibility curve of the country's economy.

3. Research Methodology

The study adopts a framework based on the conventional neo-classical aggregate production technology by Ghali and El-Sakka (2004), where energy, capital, and labour, are taken as separate inputs, that is:

$$Y_t = f(K_t, L_t, E_t) \quad (1)$$

Where *Y* = real gross domestic product (GOP); *K* is the capital stock; *L* is the level of employment; *E* is total energy consumption, and the subscript / denotes the time period.

Taking the differential of equation (1) yields;

$$dY_t = Y_k dK_t + Y_t dL_t + Y_E dE_t \quad (2)$$

Where: d7is the partial derivative of 7 with respect to its ith argument. On dividing equation (2) through by Y and re-arranging the resulting -expression, we obtain the following growth equation:

$$Y = aKt + bLt + cEt \quad (3)$$

Where a dot on the top of a variable means that the variable is how in a growth rate form. The constant parameters *a, b* and *c* are 'the elasticities of output with respect to capital, labour, and' energy, respectively. The relationship between output and capital, labour, and energy inputs described by the production function in equation-(1) suggests that their long-run-movements may be related. Allowing for short-run dynamics in factor-input behaviour, in the analysis above, would also suggest that past changes in capital, labor, and energy could contain useful information for predicting the future changes of output, *ceteris paribus*.

Furthermore, both micro and macro-econometric models, have also been used to estimate economies that are highly influenced by their energy sector. For instance, Stern and Cleveland (2004) employed micro-econometric model in the study analysis by specifying production function as a modified version of Ghali and Rl-Sakka (2004):

$$(Qi......Qm) - f(A, XL,.,. X_n, Ei.....Hp) \quad (4)$$

Where:

Qi = are various outputs, such as manufactured goods and services

Xi = are various inputs, such as capital, labor etc.

Ei = are different energy-inputs such as electricity, oil, etc.

A is the state of technology, as defined by the total factor-productivity indicator. The relationship between energy and an aggregate of output, such as gross domestic product, can then be affected by; (a) substitution between energy and other inputs; (b) technological change - a change in A; (c) shirts in the composition of the energy-input; and (d) shifts in the composition of output. Also, shifts in the mix of the other inputs - for example, to a more capital-intensive economy from a more labour intensive economy can affect the relationships between energy and output. It is also possible for the input variable X to affect total factor productivity.

The models are modified to capture the objectives of the study by incorporating the-following-variables (Industrial Performance, Gross Fixed Capital Formation, Gross Domestic Product, Exchange Rate and Capacity Utilization) Industrial output (IND) is utilized in the model to capture the output of industrial sector, as well as the direction of manufacturing sector. Electricity consumption, is, the aggregate amount of power supply by the Power Holding Company of Nigeria (PHON) to industrial sector in megawatts per hours (MW/H). Government Fixed Capital Formation (GFCF) is used to capture expenditure made on infrastructural development by the government to enhance the growth of the manufacturing and other sectors in the economy. Gross Domestic Product (GDP) measures economic growth and increases productivity level.

The exchange rate (EXR) is the rate at which the Naira is exchanged lo the US dollar and other currencies. This affects output of the manufacturing sector, as manufacturers incur high costs importing plants and generators to augment the poor electricity-supply. The Capacity utilization (CPU) in the model measures the extent to which the manufacturers use their production potential. Capacity utilization can be defined as the percentage of total capacity that is actually being achieved in a given period.

3.1 Model Specification

In order to reflect the peculiarities of the Nigeria's electricity supply on industrial performance, this study uses modified version of Ghali and El-Sakka (2004) model by adding the aforementioned variables and the re-specified equation (4) as follows;

$$IND = (IELEC, GFCF, GDP, EXR, CU) \quad (5)$$

Where; IND = Industrial Performance (Proxy Industrial Output); GDP = Gross Domes: Product; EXR - Exchange Rate and CU = Capacity Utilization

Equation 5 is written in linear form.

$$INDt = \beta_0 + \beta_1 IELECt + \beta_2 GFCFt + \beta_3 GDPt + \beta_4 EXRt + \beta_5 CPUt + e1 \quad (6)$$

Where:

t = time period

βo = intercept

$\beta 1$-β_5 are parameter

el = error term also known as the white noise random clement

From the model, the *a priori* expectations are $\beta_1>0$, $\beta_2>0$, $\beta_3>0$, $\beta_4>0$, $\beta_5>0$

3.2 The Model A priori Expectations

In line with economic theory, the study expects a direct relationship between electricity consumption and industrial growth. Adequate electricity supply and distribution constitute a central core to industrial development which cannot be over emphasized. In accordance with this, Industrialization has been a key determinant that fosters high growth indices in emerging economics of the world including China, Indonesia and Taiwan (Nazi ma, 2011). These economies have achieved high growth rates due to high industrial development, which further caused declining poverty trends and high growth statistics (Knivilla, 2008). Development of industrial sectors brings substantial changes in the real sector of the economy and also leads to rise in the national income of the country which in the long-run brings about creation of employment.

Gross fixed capital formation will have a positive relationship on industrial output, gross fixed capital formation captured expenditure made on infrastructural development by the government to enhance the growth of the manufacturing and other sectors in the economy. With adequate provision for capital expenditure in energy sector, this will spring up small-scale enterprise which is central and critical in every human society. It is through entrepreneurship that societies can attain any level of development. Small scale and medium industries are said to be the secret behind rapid development of countries like Japan, China and Malaysia etc. Low entrepreneurship is also said to be the major causes of under development of most countries in Africa, Asia, Latin America and the rest.

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A direct relationship is expected between industrial output and gross domestic product. Un-interrupted electricity supply contributes to industrial performance which in turn cause rise in the economic growth, it is expected that positive relationship exists between exchange rate and industrial production. Favourable exchange rate policies enhance access to foreign exchange for production thereby increasing manufacturing output and employment while reducing inflation. In the vein, capacity utilization is assumed to have direct relationship with industrial performance. The industrial production and capacity utilization figures usually reflect similar changes in overall economic activity. A high level of industrial production refers to the extent to optimal utilization of installed productive capacity of such industry.

Given the nature of the models it became expedient for this study to make use of time-series data which are basically secondary data. The data for electricity consumption in industrial sector of Nigeria were obtained from Central Bank of Nigeria (CBN) Statistical Bulletin for industrial electricity consumption. While, the other variables were sourced from CBN's Annual Reports, Statistical Bulletins, as well as the publications of IMF and the National Bureau for Statistics (NBS). The variables are; Industrial output. Gross Fixed Capital Formation, Gross Domestic Product, Exchange Rate and Capacity Utilization.

The study employs four method of data analysis; First, descriptive statistics is used to examine the trend and magnitude of the selected variables. Second, the Augmented Dickey Fuller (ADF) test was used to test, if the data series used for the selected variables were stationary or not. The Augmented Dickey Fuller (ADF) Unit Roof Test is used because of its superiority over the Dickey-Fuller (DF) Lest, In the ADF test, the more negative it is, the stronger the rejection of the Hypothesis that there is a unit root at some level of confidence Third, the Johansen Co-integration test is to check whether the regression residuals are co-integrated, that is, to test whether there is a long-run relationship between dependent and independent variables in the model, Lastly, fully modified least squares method (FMQLS) is use to account for serial correlation effects and for the endogeneity in the regressors that results from the existence of a co-integrating relationship.

4. Results and Discussion

4.1 Descriptive Statistics

The measures that were used to describe the data set are central tendency and measures of dispersion. Measures of central tendency include the mean and median while measures of dispersion or variability include the standard deviation, the minimum and maximum values of the variables, kurtosis, skewness and Jargue-bera.

Table 1. Descriptive Statistics

	IND	1ELEC	GFCF	GDP	EXR	CPU
Mean	116.7038	307.1547	12.87135	3.563243	81.24541	45.16486
Median	116.9000	257.9000	12.09000	4.210000	92.70000	43.00000
Maximum	170.9000	594.4800	35.22000	15.33000	169.9000	73.30000
Minimum	10.00000	121.0000	5.460000	-10.93000	0.610000	29.30000
Std. Dcv.	44.90864	115.8002	6.267641	4.934220	63.20549	9.903709
Skewness	-0.798953	0.655999	1,962755	-0.480644	-0.124503	0.543262
Kurtosis	3.121123	2.420512	7.496087	4,160173	1.446994	3.168076
Jarque-Bera	3.958962	3.171430	54,92100	3.499703	3.813823	1.863543
Probability	0.138141	0.204801	0.000000	0.173800	0.148538	0.393855
Sum	4318.040	11364.72	476,2400	131.8400	3006.080	1671.100
Sum Sq. Dev.	72604.30	482748.9	1414.200	876.4750	143817.6	3531.004
Observation	38	38	38	38	38	38

Source: Author's Regression output (2021).

Table 1 above shows the descriptive statistics of the variables involved in the analysis. The mean for industrial output, industrial electricity consumption, gross fixed capital formation, gross domestic product., exchange rate and capacity utilization arc 116.7038, 307.1547, 12.87135, 3.563243, 81.24541 and 45.16486 respectively. The range of industrial electricity consumption mean is substantial in magnitude as gross domestic product appears to be lesser. The result shows that industrial electricity consumption has the mean 307.1547, while gross domestic product has the lowest 3,563243. This result implies that industrial electricity consumption is quite high due to the provision and maintenance of expensive energy back-up to minimize the expected outage from the national grid. The persistent reliance on self-generating plants are pointers to low productivity and underutilization of resources in Nigeria's industrial sector, this has no impact on economic growth of Nigeria. Also, the result reveals underutilization of installed capacity level of industrial production and inadequate infrastructural development in Nigeria.

The maximum and minimum values of all the variables ranging from 10.00000 to 170.9000; 121.0000 to 594.4800; 5.460000 to 35.22000; -10.93000 to 15.33000; 0.610000 to 169.9000; and 29.30000 to 73.30000 are for industrial output, industrial electricity consumption, gross fixed capital formation, gross domestic product, exchange rate and capacity utilization respectively. This result shows that, industrial electricity consumption has the highest maximum value of 594.4800 caused by the huge running cost on diesel and gas by industries to maintain constant electricity supply while the minimum value is -10,93000 of gross domestic product which indicates non-performance of industrial sector to economic growth. This finding affirmed the study of Lee and Anas (1992) that industrial establishments in Nigeria spend an average of 32% of their variable costs on infrastructure with electric power accounting for more than half of this share.

Skewness and kurtosis provide summary information about the shape of distribution. The skewness indicator is used in the distribution analysis as a sign of asymmetry and deviation from a normal distribution while the kurtosis indicator is also used as a sign of flattering or peakedness of a distribution. The result from Table 1 shows that only three variables are less than zero-skewness < 0 which are industrial output -0.798953, gross-domestic product -0.480644 and exchange rate -0.124503. This implies that the values concentrated on the right of the mean with extreme values to the left; however, industrial electricity consumption, gross fixed capital formation and capacity utilization are normally distributed.

Also, the Kurtosis result implies that gross fixed capital formation 7.496087 and gross domestic product 4.160173 are leptokurtic distribution sharper than a normal distribution with values concentrated around the mean and thicker tails. This means high probability for extreme values kurtosis > 3. For industrial output 3.121123 and capacity utilization 3.168076 are mesokurtic distribution, which is normal distribution with kurtosis equal to 3 while industrial electricity, consumption 2.420512 and exchange rate 1.446994 are platykurtic distribution, flatter than a normal distribution with a wider peak. The probability for extreme values is lesser than a normal distribution and the values are spread around the mean.

4.1 Stationarity Test

In order to test for the Stationarity of the time series data used in this research. The conventional stipulation of the ADF test shows that, the calculated ADF test statistics must be to a greater extent negative. In which case, it must be greater than or equal to any of the critical values in absolute term before a variable is regarded to be stationary. The result is presented in the Table 2 below:

Table 2. Test for Unit Root at Level

Variables	Test Statistics	5% Critical Value	P –value	Level	Stationary /Non-Stationary
IND	-5.749590	-2.981038	0.0001	1(1)	S
IBLHC	-6.891954	-2.951125	0.0000	1(1)	S
GFCF	-4.674462	-2.945842	0.0006	1(0)	S
GDP	-3.368738	-2.945842	0,0189	1(0)	S
F.XR	-6.360290	-2,948404	0.0000	1(0)	S
CPU	-3.174402	-2.945842	0.0299	1(0)	S

Source: Author’s Regression output (2021).

The results from the Table 2 show that gross fixed capital formation, gross domestic product, exchange rate and capacity utilization arc stationary at level while industrial output and industrial electricity consumption are stationary at first difference. This can be seen by comparing the test statistics (in absolute terms) of both the ADF test statistic with the critical values (also in absolute terms) at the 5% level of significance. This finding established a short run relationship among the selected variables for the study.

4.2 Johansen Co-integration Test

This study employed Johansen Co-integration Test to check whether the regression residuals are co-integrated, that is, to test whether there is a long-run relationship between dependent and independent variables in the model. This test makes use of Trace Statistics by comparing their values with the critical values at 5% level. If the values of the Trace Statistics are greater than the Critical values, the study conclude that there will be long run relationship. Otherwise, the regression residual is not co-integrated.

Table 3. Unrestricted Cointegration Rank Test (Trace)

Hypothesized No. of CE(s)	Eigenvalue	Trace -Statistics	0.05 Critical value	Prob.**
None *	0,670260	101,7082	95.75366	0.0183
At most 1	0.520608	62.87743	69.81889	0,1578
At most 2	0.386154	37.14415	47.85613	0.3408
At most 3	0.285814	20.06378	29.79707	0.41.86
At most 4	0.209576	8.282374	15.49471	0.4357
At most *5*	. 0.001452	0.050871 .	3.841466	0,8215

Trace lest indicates 1 cointcgrating eqn(s) at the 0.05 level

* denotes rejection of the hypothesis at the 0.05 level

**MacKinnon-Haug-Miehelis (1999) p-values

Source: Author's Regression output (2021)

The results from Table 3; show that, Trace test indicates at least one co-integrating equations at the 0.05 level. This denotes the rejection of the Null Hypothesis at the -0.05 level. The statistical significance is evidenced from the p-values. Based on the finding from the results, there is a long run equilibrium relationship between the dependent and independent variables since Trace statistics is more than the critical value at 5% level of significance.

4.3 Fully Modified Least Square Regression Result

Table 4. Fully Modified Least Squares Result

Dependent Variable: IND				
JWethod; Fully Modified Least Squares (FMOLS)				
Date: 11/30/20 Time: 11:38				
Sample (adjusted): 1982 2019				
Included observations; 38 after adjustments				
Cointegrating equation deterministic: C				
Long-run covariance estimate (Battlett kernel, Newey-West fixed bandwidth =4.0000)				
Variable	Coefficient	Sid. Error	t-Statistics	Prob.
IELEC	0.094738	0.053636	1.766325	0.0875
GFCF	-1.854379	1.398072	-1.326383	0.1947
GDP	-2.010557	1.196036	-1.681016	0.1031
EXR	0.449801	0.103279	4.355187	0.0001
CPU	0.760634	0.626376	1.214342	0.2341
C	45.03214	21.61444	2.083428	0.0458
R-squared	0.649125	Mean dependent var		1 17.4517
Adjusted R-squared	0.590646	S.D. dependent var		45.31139
S.L. of regression	28.99058	Sum squared resid		- 25213.60
Long-run variance	572:2824			

Source: Author's Regression output (2021).

Table 4 reported the fully modified least square multiple regression results, according to the result, industrial electricity consumption has a positive relationship with industrial output in Nigeria. The findings revealed that a unit rise in industrial electricity consumption increased industrial output by 9.4%.and is significant at 8 percent level. This result is consistent with the study *a priori* expectation. This indicator only reflects a meagre impact of industrial output growth in Nigeria compare to other countries. This finding established that electricity supply is one of the major, determinants, of industrial output growth in Nigeria. This result corroborates the study of Ogunjobi (2015) which established positive relationship between industrial output and, electricity consumption in Nigeria. In the same vein, Ziramba (2009) affirmed that only electricity consumption has a significant long-run impact on real output in South Africa.

However, the coefficient of gross fixed capital formation signed negative with industrial output against the study *a priori* expectation within the period investigated. The result means that, a percentage change in gross fixed capital formation will bring about a reduction in industrial performance by 0.01-8 units in Nigeria. This signifies that gross fixed capital formation impacted negatively on industrial performance in Nigeria. This result connotes deficiency of capital infrastructural development in Nigeria especially in industrial development. This finding, agreed with the study of Okonkwo (2010) that low capital accumulation is the main obstacle faced in achieving the goal of sustained economic growth in Nigeria. This finding shows that, there is still a lot to be done by government to effect the industrial growth in power sector of the Nigeria economy in order to compete favourably with developed countries. Also, World Bank (2004) reports that the nation’s difficult business, environment largely been caused by inadequate power supply which served as most severe constraint for industrial development in Nigeria.

Also, gross domestic product has a negative relationship with industrial output over the examined period, hence, not statistically significant. This result suggests an inverse relationship between economic growth rate and industrial performance in Nigeria. The indicator revealed 1 percent rise in gross domestic product reduces industrial performance by 0.020 percent. This result is in line with the research work of Obioma, Uchenria-tand Alexanda (2015) that, the influence of industrial output on economic growth is no statistically significant. This implies that inefficiency in the power sector has weakened: industrial performance, resulting into low productivity and retarded economic growth of Nigeria with high operational costs, which have significantly undermined the efforts of the Nigerian government in sustaining its economic performance.

Moreso, exchange rate has a positive relationship with industrial output growth and statistically significant. The result revealed that a unit rise in exchange rate bring about 44% rise in industrial output. This finding affirmed the study of Ehinomen and Oladipo (2012) that exchange appreciation has a significant relationship with domestic output which promotes industrial output growth. Finally, capacity utilization has a direct relationship with industrial output as expected but not significant. The finding, showed that, low capacity utilization is due to shortages in electricity supply as well as other energy supply to industrial sector in Nigeria.

The value of the R-Square (R^2) for the model is pegged at 0.649125 or 64% which implies that industrial electricity consumption, gross fixed capital formation, gross domestic product, exchange rate and capacity utilization explained about 64% systematic variation in the industrial output in Nigeria over the observed years while the remaining 36% variation is explained by other variables outside the model.

The t-test statistics confirms the standard error test. Testing at 5% level, the variables fall within the acceptance region to confirm the alternative hypothesis that industrial electricity consumption and exchange rate are statistically significant. In other words, they do contribute significantly to industrial output in Nigeria. However, the t-statistics for gross fixed capital formation, gross domestic product and capacity utilization were not significant. The result implies that gross fixed capital formation, gross domestic product and capacity utilization are not statistically significant in explaining industrial output over the study period.

The standard error test revealed that industrial electricity consumption and exchange rate are significant when compared half of each coefficient with its standard error, it was found that the values of the standard errors were less than half of the coefficients. In other way round, gross fixed capital formation, gross domestic product and capacity utilization were not significant in the estimated model. Lastly, the long run variance for the model stood at 572.2824. The implication of this result connotes that the recommended Bartlet Kernel bandwidth of 4.0 which implies that the model is free from the problem of heteroskedasticity.

5. Conclusion

The study investigated the effects of electricity consumption on industrial performance in Nigeria from 1981 to 2019. Descriptive statistics, unit root and co-integration tests were conducted on the time series data selected for the study. The results of the descriptive statistics revealed-that industrial electricity consumption is high due to the provision and maintenance of expensive energy back-up to minimize the expected outage from the national grid. Also, the finding revealed underutilization of installed capacity level of industrial production and inadequate infrastructural development in Nigeria. The unit root test confirmed that gross fixed capital formation, gross domestic product, exchange rate and capacity utilization were stationary at level while industrial output and industrial electricity consumption become stationary at first difference. Johansen co-integration test established a formation, gross domestic product, exchange rate and capacity utilization.

The empirical result, of the fully modified least square method showed that industrial electricity consumption and exchange rate have a-direct and significant positive relationship with industrial output in Nigeria. The finding confirmed that electricity consumption is one of the major determinants of industrial output growth in Nigeria. However, gross fixed capital formation and gross domestic product have a negative relationship with industrial, output and were not significant in the model over the study period. Capacity utilization has a dire relationship with industrial output as expected but not significant. The non-significant capacity utilization is due to shortages in electricity consumption from national grid as well as other energy supply to industrial sector in Nigeria.

One key finding is that, inadequate energy supply accounts for adverse and decline in productivity of the industrial sector. The gap between energy supply and demand has brought about the acquisition of expensive power backup in the forms of plants diesel generators, inverters and others alternative backup which hike the cost of product. To this end, there is need for a comprehensive energy mix option through government policies to complement the existing energy sources available in Nigeria, as well as others renewable energy resources for industrial sector and domestic use. Past, expenditures on electricity sub-sector infrastructure should be investigated to know if the huge funds invested were actually used or diverted. There is need for more commitment by government to monitor. The use of allocated funds in the sector for effective and efficient utilization.

Economic growth rises when productivity increases, government should encourage and accelerate other factors that affect productivity in the country especially manpower and skills to improve the economic performance. Sound economic policies that will stabilize the exchange rate, encourage optimal utilization of installed productive capacity should he prioritized to make industrial goods competitive in the global market.

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