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Electricity Consumption and Capacity Utilization in Nigeria

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ABSTRACT

The study investigated the effects of electricity consumption on capacity utilization in Nigeria from 1981 to 2017. The study made use of annual time series data which were sourced from Central Bank of Nigeria (CBN) Statistical Bulletin (2018) and World Development Indicators (WDI). Unit root test of Augmented Dickey-fuller (ADF) and Philip Perron (PP) were used for preliminary test with Johansen co-integration test. The study employed Normalized co-integration and vector error correction mechanism in analyzing the data. The unit root results indicated that all variables were stationary at differenced of order I(1), while co-integration established a long run relationship among the variables. The normalized co-integration finding revealed that lnelec, lncabem and lnelecge have positive impact on the lncpu while lncrind and lnecp have negative impact on lncpu, on average. The coefficients of lnelec, lnecp and lnelecge were statistically significant at 5% and 1% levels of significance. Vector error correction mechanism technique showed that a unit rises in inelec, incabem and inelecge decreases incpu by 0.96%, 0.20% and 0.55% respectively on average in the long run while a percentage change in inelec, incabem and inelecge decreases lncpu by 0.186, 0.020 and 0.125% respectively on average, ceteris paribus in the short run. Therefore, the study recommended policies aimed at providing reliable and stable power supply thereby creating avenue for maximum capacity utilization in Nigeria industries.

Keywords: Electricity Consumption, Capacity Utilization, Electricity Generated
JEL Classifications: L94, O14, Q41

1. INTRODUCTION

Nigeria's industrials sector is faced with low level of capacity utilization as a result of increased shortage of power supply. Electricity supply to all sectors of the Nigerian economy has been very unreliable over the years which had attracted the attention of scholars. Nigeria has recorded a great history of unstable and inadequate electric power supply. This problem became more acute in manufacturing sector as the number of manufacturing firms leaving the country and shutting down became more pronounced. Yakubu et al. (2015) established that close to a thousand companied shut down in Nigeria and moved to countries where there is better services electricity services.

The problem of erratic power supply in Nigeria has virtually affected all the major sectors of the economy and particularly devastated the manufacturing sector. It is noticeable that the manufacturing installed capacity in Nigeria not operating at maximum level. However, there is drastic shortfall of electricity consumption which escalated the cost of production in the sector

(Yakubu et al., 2015). According to the Nigerian Association of Chambers of Commerce, Industry, Mines and Agriculture (NACCIMA), the manufacturing sector as a whole operates on more than 70% of energy it generates using generators; and operating these generators greatly increases the cost of manufacturing goods in the country.

The proportion of electricity cost in manufacturing production cost in Nigeria is 30-35% as compared to other countries which is 5-10% (MAN, 2019). This implies that even when the electricity supply is relatively stable, manufacturing production is still relatively costly because of the electricity problem in the country. Manufacturing production cost in Nigeria costs 9 times more the production cost of the same item in China, 4 times in Europe and South Africa, and 2 times in Ghana (Adenikinju and Chete, 2002) as cited by Yakubu et al. (2015). This implies that goods produce in Nigeria cannot compete for market with the same goods produce in these countries. Thus, manufacturing firms in Nigeria can neither gain market domestically nor internationally.

According to Ologundudu (2014), available statistics showed that the percentage utilization of the installed capacity of electricity and index of industrial production lends further credence to the nature of the electricity crisis. The period from 1990 to 2003, saw average installed electricity generating capacity of about 6000 MW, whereas the utilization rate was on the average below 40%. In the 2007, installed electricity generation capacity was about 7,011 MW, while actual utilization rate was 37.4%. The low and unstable capacity utilization, evident in the average capacity utilization of <40% in more than three decades, this showed the large gap between installed and actual operational capacity. This large gap clearly indicates the level of technical inefficiency in the power system.

Ado and Josiah (2015) revealed that power supply in virtually all the states in Nigeria has been worrisome. Some areas have <5 h while it is a total black out in some areas for about 3 days or more. The aforementioned indices confirmed that Nigeria's electricity sector is in crises which require further studies. Many scholars have examined the effects of electricity consumption on industrial/manufacturing output but scanty of studies exist on the link between electricity consumption and capacity utilization which this study intend to fill the gap. Therefore, the study investigated the effect of electricity consumption on capacity utilization in Nigeria. The study is organised into the following sections, section one introduce the study, section two captures theoretical and empirical underpinnings. Section three specified the estimated technique method adopted for the study while section four shows the result output and interpretations. Finally, section five contains the conclusion and recommendations.

2. LITERATURE REVIEW/THEORETICAL UNDERPINNINGS

This study is based on the theories that relate electricity utilisation to firm capacity utilization propounded by Olayemi (2012) and was cited by Osobase and Bakare (2014). Electricity market theory describes how firms have the options to invest on different power plant size in order to produce electricity at diverse levels of marginal cost since electricity cannot be store at any cost. It is vital for firms to invest in a number of different portfolios of technologies, so as to meet up with fluctuating demand.

The traditional cost theory which is classified into the short-run and long-run periods, in the short run period (SR), some factors such as entrepreneurship and capital equipment are usually considered to be fixed, while in the long-run period (LR); all the factors of production are considered to vary. In this regard, we are taking both terms as a whole, by examining the output level that is obtainable, given a single level of output that rises above the increases in costs.

In this regard, with the aid of the Diagram 1 and consideration of both terms as a whole, the level of output examine is obtainable, given a single level of output that rises above the increases in costs. Hence, the output level of the firms is completely utilised at the point where the Marginal Cost (MC) cuts the curve of the Average Total Cost (ATC) at its minimum point.

It is also assumed that firms in the industry do not build plants with changing productive capacity, but often experienced the phenomenon of excess capacity. Excess capacity is defined as the differences between the maximum amounts of output that a firm can produce and the actual amount produce given the assumption of resources not employed. The excess capacity of firms is depicted in Diagram 2 as illustration. The modern cost theory is constructed on the assumption that firms have right to build their own plants size with certain level of flexibility in their productive level, thereby making it possible for the firms to possess reserve capacity. The theory suggests that reserve capacity of firms implies that some levels of output can be created with a single cost. The above theories discussed will enhance the optimum utilisation of the equipment and tools of the manufacturing industries, thereby increases productivity

Diagram 1: Manufacturing capacity utilization at short run

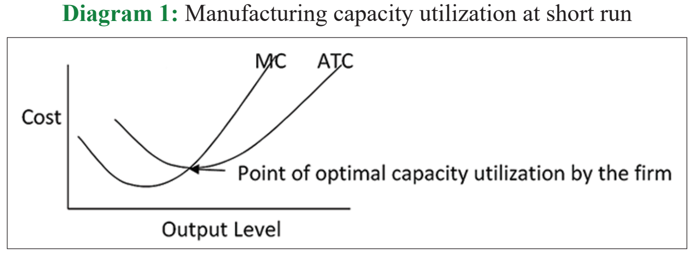
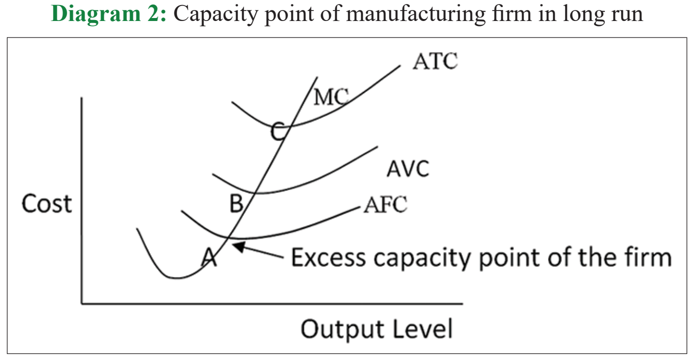


Diagram 2: Capacity point of manufacturing firm in long run



Electricity consumption brings about the concept of capacity utilization in the manufacturing sector of the Nigerian economy. The capacity of an industry is its output that corresponds to its minimum short run average total cost. In the manufacturing sector, the capacity utilization has been largely blamed on frequent power outage among other problems in Nigeria.

Emeka et al. (2016) researched on power supply; average installed manufacturing capacity utilization and unemployment in Nigeria from 1980 to 2013. The study made use of trend analysis and advanced econometrics test. The result analysis showed that there is long run significant relationship that exists among unemployment rate, average manufacturing capacity utilization and power supply in Nigeria but there is no significant causal relationship between average manufacturing capacity utilization and power supply.

Simon-Oke and Awoyeme (2010) examined the effect of manufacturing capacity utilization on industrial development in Nigeria. Manufacturing capacity utilization value and employment were regressed on index of industrial productivity using co-integration and associated error mechanism as analytical tool. The study confirmed that there is a long run positive relationship between manufacturing capacity utilization, value added and index of industrial productivity in Nigeria. Also, Okereke and Onyeabor (2011) assessed capacity utilization of agro-allied industries using regression analysis. Their results showed that the co-efficient of time trend indicated a negative relationship between average capacity utilization and time (years). The study implies that average capacity utilization of industry was decreasing with increasing years at the rate of 1.34%. The study results also showed that a 1% rise in capacity utilization in the energy sector will lead to a 64% rise in capacity utilization in the agro-allied industries.

Edomah (2019) examined the motives and drivers of changes in energy use within the industrial sector. The study makes use of Statistical data from published report and informal interviews of stakeholders in Nigeria's industrial sector. The study showed that outsourcing of industrial services; cost reduction and business realignment motives are key drivers of transitions in Nigeria's industrial sector.

Ohajianya et al., (2014) ascertained the effects of power failure on Nigerian industries in Kano using Cob-Douglas production function and Chi-square. The study established that inadequate power supply affects industrial output by about 30-40%. Also, the use of generators to supplement power from Power Holding Company of Nigeria (PHCN) raised cost of production and reduces profits of industries by 20-50%. The study further found that there were 15 textile industries in Kano out of which only 7 where operational while the rest have closed down. It finding also revealed that more than 1200 number of jobs and about 5500 metric tons of cloth were lost over the period of study.

Akiri et al. (2015) examined the impact of electricity supply (EGI) on the productivity of manufacturing industries in Nigeria between 1980 and 2012. The study employed the ordinary least square multiple regression method. The finding showed that electricity generation/supply in Nigeria under the viewed periods impacted positively on the manufacturing productivity growth, but the coefficient is very low due to inadequate and irregular supply of electricity especially to manufacturing subsector in the economy resulting from government's unnecessary spending on non-economic and unproductive sectors.

Kareem et al. (2014) investigated the econometric analysis of electricity consumption, capacity utilization and economic growth in Nigeria: A disaggregated Analysis. The study adopted regression analysis and causality tests for the empirical analysis. The findings of the study showed a bi-directional relationship between capacity utilization and hydroelectric sources, oil sources; uni-directional relationship existed between capacity utilization and natural gas. No causality was observed between coal and capacity utilization. The study concluded that hydroelectricity and natural gas were factors that contributed mainly to electricity consumption in Nigeria.

Olufemi (2015) attributed the non-competitiveness of Nigeria's export goods to poor infrastructure especially electricity supply, which drives the running cost of firms. Gielen et al. (2019) provided a strong argument to support the importance of energy supply. Ologundudu (2015) established that poor nature of electricity supply in Nigeria imposed significant cost on the industrial sector of the economy. This result corroborates the survey of the Manufacturers Association of Nigeria (MAN) 2005. The survey indicated that the costs of generating power constitute about 36% of production. Olufemi (2015) argued that poor and inefficient electricity supply has adverse implication for industrial development in Nigeria. Ugwoke et al. (2016) added that increase in the electricity production will avoid the paralysation of the industrial production. Increased industrial production will eventually increase output. Thus, this implies that electricity production should become an economic policy high-priority objective which should be urgently responded to. Ultimately, energy efficiency contributes to wealth (Oyedepo, 2012).

Momoh et al. (2018) analyzed several causes of inadequate power supply and argued that this precarious situation has serious negative implications for the operations of industrial sector in the country, as most organization spent fortunes generating their own power and that this situation represents a major setback on the country's quest for industrial development. Uyigue and Archibong (2010) showed that lack of access to electricity inflate production cost and make competition in the global market difficult for developing countries. Ndebbio (2006) cited by Udah (2010) Stated that electricity supply drives industrialization process. The study reported that one important indicator whether a country is industrialized or not is the megawatt of electricity consumed. The researcher opined that a country's electricity consumption per-capita in kilowatt hours (KWH) is proportion to the state of industrialization of that country. Ferguson et al. (2000) in a study of over one hundred countries that represent over 90% of the World economy, revealed strong correlation between the amount of electricity use and GDP per capita at general level.

Most of the empirical literature focused on the link between electricity consumption and industrialization. Also, there were more empirically research studies on the causal and long-run relationship between economic developments, industrialization and electricity supply. Meanwhile, there is a scanty research study on how electricity consumption affects capacity utilization in Nigeria in which this study fills the gap.

3. METHODOLOGY

3.1. Model Specification

The study adopted the model of Emeka et al. (2016) which established causality between average manufacturing capacity and power supply which is stated below as:

$$AMCU = f(PS, EXR, INT) \quad (1)$$

Where: AMCU = Average Manufacturing Capacity Utilization, PS = Power Supply, EXH = Exchange Rate and INT = Interest rate

In order to examine the effect of electricity consumption and capacity utilization the model is re-modified to capture other variables that determine the dependent variable. The model is re-specified thus:

$$CPU = (IELEC, ELECGE, CABEM, ECP, CRIND) \quad (2)$$

Where:
CPU = Capacity Utilization,
IELEC = Industrial Electricity Consumption
ELECGE = Electricity generation
CABEM = Carbon Emission
ECP = Electricity Price Proxied of Consumer Index Price
CRIND = Commercial Bank Credit to Manufacturing Sector

Equation two is written in linear form. By adding the stochastic term;

$$IND_t = \beta_0 + \beta_1 ELECt + \beta_2 ELECGE_t + \beta_3 CABEM_t + \beta_4 ECP_t + \beta_6 CRIND_t + e_1 \quad (3)$$

t = time trend is the time trend, β_0=intercept, $\beta_0 - \beta_6$ are parameter, e_1 = error term also known as the white noise random element

3.2. Data and Measurement

The study made use of annual time series data which were sourced from Central Bank of Nigeria (CBN) Statistical Bulletin 2018 and World Development Indicators (WDI) from 1981 to 2017. The study employed Co-integration and Vector error correction mechanism in analyzing the data. The variables of the model were measured as follows: Capacity utilization rate is measured as an indicator that showed how efficiently factors of production are being used. Industrial electricity consumption (IELEC) is the aggregate amount of power supply by the Power Holding Company of Nigeria (PHCN) to industrial sector in megawatts per hours (MW/H). Electricity generation (ELECGE) is the amount of electricity generated in MW over a specific period of time. Electricity Price (ECP) Proxy of Consumer Index Price, measures the changes in the price of electricity consumed that may be fixed or changed at specified intervals, such as yearly by users over period of time. Carbon emission (CABEM), this indicator is used to measure the emission intensity of manufacturing industries expressed as the amount of pollutant discharged in atmosphere and water per unit of production of the manufacturing industries through the use of backup plant. Credit to industrial sector (CRIND), this measured the credit allocation to the manufacturing sector of industry.

3.3. Unit Root Tests

In order to avoid spurious result, we tested all the variables for stationarity using the conventional ADF (the Dickey–Fuller generalized least square) de-trending test as proposed by Elliot et al. (1996) and the Phillips–Perron (PP) test by Phillips and Perron (1988). Both unit root complement each other, that is, where they agree at a particular order of integration, we accept and in a situation where they disagree, we take the first outcome.

Hence the null hypothesis is H_0 (i.e. β has a unit root) and the alternative hypothesis is H_1: $\beta < 0$.

3.4. Johansen Co-integration

In order to empirically analyze the long-run relationships among the variables of interest (LCPU, LELEC, LELECGE, LCRIND, LCABEM and LECP), the study adopts the Johansen co-integration test. This is possible because all the variables are only stationary at first difference. Johansen (1995) considered the following five cases in Eviews;

1. The level data yt have no deterministic trends and the co-integrating equations do not have intercepts:
$$H(r): \Pi\, yt\text{-}1 + Bxt = \alpha\, \beta' yt\text{-}1 \quad (1)$$
2. The level data yt have no deterministic trends and the co-integrating equations have intercepts:
$$H(r): \Pi\, yt\text{-}1 + Bxt = \alpha(\beta' yt\text{-}1 + \rho\, 0) \quad (2)$$
3. The level data yt have linear trends but the co-integrating equations have only intercepts:
$$H(r): \Pi\, yt\text{-}1 + Bxt = \alpha(\beta' yt\text{-}1 + \rho\, 0) + \alpha^{\perp} \quad (3)$$
4. The level data yt and the cointegrating equations have linear trends:
$$H(r): \Pi\, yt\text{-}1 + Bxt = \alpha(\beta' yt\text{-}1 + \rho\, 0 + \rho 1t) + \alpha^{\perp} \gamma\, 0 \quad (4)$$
5. The level data yt have quadratic trends and the co-integrating equations have linear trends: H(r):
$$\Pi\, yt\text{-}1 + Bxt = \alpha(\beta' yt\text{-}1 + \rho\, 0 + \rho 1t) + \alpha^{\perp}(\gamma\, 0 + \gamma 1t) \quad (5)$$

where $\alpha^{\perp}$ are the deterministic terms "outside" the co-integrating relations. When a deterministic term appears both inside and outside the co-integrating relation, the decomposition is not uniquely identified. Johansen (1995) identifies the part that belongs inside the error correction term by orthogonally projecting the exogenous terms on to the α space so that $\alpha^{\perp}$ is the null space of α such that $\alpha' \alpha^{\perp} = 0$. EViews uses a different identification method so that the error correction term has a sample mean of zero. More specifically, we made use of case 3 which has been the standard practice (i.e. an unrestricted constant that has no trend). The hypothesis is stated as;

H_0: No co-integrating equation
H_1: H_0 is not true (there are co-integrating equations)

Decision criteria: Rejection at the 5% level

Reject the null hypothesis if the Trace and Max statistics >5% critical values, otherwise, fail to reject the null hypothesis.

3.5. Vector Error Correction Model

The VECM restricts the long-run behavior of the endogenous variables to converge to their co-integrating relationships while allowing for a short run adjustment. It is a restricted VAR designed for use with non-stationary series that are known to be co-integrated. The co-integrating term is called the error correction term since the deviation from long run equilibrium is corrected gradually through a series of partial short run adjustments. In our six-variable case, the VECM is specified as;

$$\Delta \ln y_t = \alpha_0 + \sum_{i=1}^{k} \alpha 1 \Delta \ln yt - i + \sum_{i=1}^{k} \alpha 2 \Delta \ln X1t - i + \sum_{i=1}^{k} \alpha 3 \Delta \ln X2t - i \sum_{i=1}^{k} \alpha 4 \Delta \ln X3t - 1 + \sum_{i=1}^{k} \alpha 5 \Delta \ln X4t - i + \sum_{i=1}^{k} \alpha 6 \Delta \ln X5t - i + ECT_{t-1} + \varepsilon_t \quad (1)$$

Equation 1 is a general long run model in VECM for a six- variable case. So plugging in our variables into the equation, we have;

$$\Delta \ln CPU_t = \alpha_0 + \sum_{i=1}^{k} \alpha 1 \Delta \ln CPUt - i + \sum_{i=1}^{k} \alpha 2 \Delta \ln ELECt - i + \sum_{i=1}^{k} \alpha 3 \Delta CABEMt - i + \sum_{i=1}^{k} \alpha 4 \Delta \ln CRINDt - i + \sum_{i=1}^{k} \alpha 5 \Delta \ln ECPt - i + \sum_{i=1}^{k} \alpha 6 \Delta \ln ELECGEt - i + ECTt - 1 + \varepsilon_t \quad (2)$$

While the short run model is specified as;

$$\Delta y_t = \sigma + \sum_{i=1}^{k-1} \gamma i \Delta yt - i + \sum_{i=1}^{k-1} \cdot i \Delta X1t - i + \sum_{i=1}^{k-1} \cdot i \Delta X2t - i + \sum_{i=1}^{k-1} \cdot i \Delta X3t - i + \sum_{i=1}^{k-1} \cdot i \Delta X4t - i + \sum_{i=1}^{k-1} \cdot i \Delta X5t - i + \lambda ECTt - 1 + \mu_t \quad (3)$$

Where ΔlnCPU= log of cpu,
$\Delta lnCPU_{t-1}$ = difference log of cpu
$\Delta lnELEC_{t-1}$ = differenced log of ELEC,
$\Delta lnCABEM_{t-1}$ = differenced log of CABEM,
$\Delta lnCRIND_{t-1}$ = differenced log of CRIND,
$\Delta lnECP_{t-1}$ = differenced log of ECP,
$\Delta lnELECGE_{t-1}$ = differenced log of ELECGE, b
ECT_{t-1}= error term which signifies the long run equation, and
ε_t= the stochastic term or white noise assumption.

By apriori, α2>0, α3>0, α4>0α5>0and α6>0.

4. RESULTS

4.1. Result of the Unit Root Test

Both tests of unit root employed in this study Augmented Dickey-fuller (ADF) and Philip Perron (PP) indicate that the variables are non-stationary. But when they are differenced, they become stationary, that is, they are all integrated of order one I(1). Hence the series are integrated of same orders. This requires a further test of long run relationship which requires co-integration with Johansen approach (Table 1).

4.2. Results of Johansen Co-integration Test

The result of the Johansen co-integration test indicates that there is a co-integration among the variables. This is revealed by the existence of two co-integrating equations of the Trace test and one co-integrating equation of the maximum Eigenvalue value test at 5% levels of significance. Hence both tests agreed on the existence of co-integration among the variables. This simply means that there is a long run relationship (Table 2A and B).

The normalization equation is based on max-eigen value result of one co-integrating equation. So normalizing around lncpu where lncpu is the dependent variable, our result can be interpreted as follows;

In the long run, lnelec, lncabem and lnelecge have positive impact on the lncpu while lncrind and lnecp have negative impact on lncpu, on average, ceteris paribus. The coefficients of lnelec, lnecp and lnelecge are statistically significant at the 5% and 1% levels of significance. Thus, the null hypothesis of no co-integration is rejected against the alternative of a co-integrating relationship in the model (Table 2C).

Table 1: Unit root test (ADF and PP)

Level I(0)			Difference I(1)		Decision
Variables	ADF	PP	ADF	PP	
lcpu	−2.43285	−2.55751	−3.6680***	−3.6680***	
	(0.1407)	(0.1116)	(0.0095)	(0.0095)	I(1)
lelec	−0.88569	1.833596	−9.21004***	−8.86173***	
	(0.7809)	(0.9821)	(0.0000)	(0.0000)	I(1)
lelecge	−1.37358	−1.35754	−6.66215***	−6.66215***	
	(0.5842)	(0.5919)	(0.0000)	(0.0000)	I(1)
lcrind	−0.66846	−0.63768	−4.76362***	−4.73822***	
	(0.8421)	(0.8495)	(0.0005)	(0.0005)	I(1)
lcabem	−0.71511	−1.005	−6.51677***	−10.5006***	
	(0.3999)	(0.2768)	(0.0000)	(0.0000)	I(1)
lecp	−0.80488	−0.56515	−5.99475***	−10.2684***	
	(0.4263)	(0.4654)	(0.0000)	(0.0000)	I(1)

*Significant at 10%, **Significant at 5%, and ***Significant at 1%. The asterisks indicate the rejection of null hypothesis of unit root. Source: Authors Computations using ADF and PP unit root test

4.3. Results of VECM

The long run co-integrating equation can be written as;

$$ECT_{t-1} = [1.00000lcpu_{t-1} - 0.961902lelec_{t-1} - 0.206726lncabem_{t-1} + 0.066114lncrind_{t-1} + 0.578132lnecp_{t-1} - 0.551309lnelecge_{t-1} + 3.521707$$

While the short run equation is;

$$\Delta lncpu_t = -0.112ECT_{t-1} + 0.307lncpu_{t-1} - 0.186lnelec_{t-1} - 0.020lncabem_{t-1} + 0.065crind_{t-1} + 0.031lnecp_{t-1} - 0.126lnelecge_{t-1} - 0.012$$

Table 2A: Johansen co-integration test

Unrestricted cointegration rank test (trace)				
Hypothesized Number of CE(s)	Eigenvalue	Trace Statistic	0.05 Critical value	Prob.**
None*	0.708776	112.0456	95.75366	0.0024
At most 1*	0.552163	71.33473	69.81889	0.0377
At most 2	0.461468	44.82498	47.85613	0.0937
At most 3	0.405502	24.40098	29.79707	0.1840
At most 4	0.164118	7.239734	15.49471	0.5499
At most 5	0.039323	1.323878	3.841466	0.2499

Trace test indicates 2 cointegratingeqn(s) at the 0.05 level. *Denotes rejection of the hypothesis at the 0.05 level. **MacKinnon-Haug-Michelis (1999) P-values.
Source: Authors computations

Table 2B: Unrestricted cointegration rank test

Unrestricted cointegration rank test (Maximum Eigenvalue)				
Hypothesized Number of CE(s)	Eigenvalue	Max-Eigen Statistic	0.05 Critical value	Prob.**
None*	0.708776	40.71089	40.07757	0.0424
At most 1	0.552163	26.50976	33.87687	0.2905
At most 2	0.461468	20.42400	27.58434	0.3125
At most 3	0.405502	17.16125	21.13162	0.1645
At most 4	0.164118	5.915856	14.26460	0.6240
At most 5	0.039323	1.323878	3.841466	0.2499

Max-eigenvalue test indicates 1 cointegratingeqn(s) at the 0.05 level. *Denotes rejection of the hypothesis at the 0.05 level. **MacKinnon-Haug-Michelis (1999) P-values.
Source: Authors computations

The results in the short run equation indicates that the adjustment coefficient is −0.112 with t-statistics of 2.321 which implies that the previous period's deviation from long run equilibrium is corrected in the current period as an adjustment speed of 11.2%. In other words, the previous year's deviation from long run equilibrium is corrected at a speed of 11.2%. A percentage change in lncrind and lnecp are associated with 0.066 and 0.578% increase in lncpu respectively. However, a unit rises in inelec, incabem and inelecge decreases incpu by 0.96%, 0.20% and 0.55% respectively on average, ceteris paribus in the long run. Also, a percentage rise in lncrind and Inecp are associated with 0.065 and 0.031% increase in lncpu, while a percentage change in inelec, incabem and inelecge decreases lncpu by 0.186, 0.020 and 0.125% respectively on average, ceteris paribus in the short run (Table 3).

4.4. Diagnostics Tests

4.4.1. Results of the autocorrelation test

Since the probability values are 0.5356 and 0.6361 which are higher than the 5% level of significance and we cannot reject the null hypothesis. We therefore conclude that there is no serial correlation the model (Table 4).

4.4.2. Results of the normality test (Jarque-Bera)

The Jarque-Bera always factors both Kurtosis and Skewness in his computation so we interpretenormalilty based on J-Bera test. So, for the six components representing our six variables, their residuals are normally distributed since their probability values are >5% level of significance. Also the overall for the entire model, the residuals are normally distributed (Table 5).

4.4.3. Results of the heteroskedasticity tests

The probability value is 0.4361 which is above 5% level of significance, we cannot reject the null hypothesis, but we accept it and conclude that the model is homoskecdastic (Table 6).

4.5. Stability Test

The cumulative sum of recursive residuals (CUSUM) test was applied to assess parameter stability (Pesaran and Pesaran, 1997). The result indicates the absence of any instability of the coefficients

Table 2C: Normalized cointegrating coefficients

1 Cointegrating Equation(s)	Log likelihood		119.3163		
Normalized cointegrating coefficients (standard error in parentheses)					
LNCPU	LNELEC	LNCABEM	LNCRIND	LNECP	LNELECGE
1.0000	−0.961902	−0.206726	0.066114	0.578132	−0.55131
	(0.40952)	(0.28335)	(0.08097)	(0.07624)	(0.27517)
Adjustment coefficients (standard error in parentheses)					
D(LNCPU)	−0.111638				
	(0.0481)				
D(LNELEC)	0.001199				
	(0.0497)				
D(LNCABEM)	0.325761				
	(0.14796)				
D(LNCRIND)	−0.098267				
	(0.09468)				
D(LNECP)	−1.382797				
	(0.32152)				
D(LNELECGE)	−0.000557				
	(0.05504)				

Source: Authors computations

Table 3: Vector error correction mechanism output

The long run model							
Cointegrating Eq:	**LNCPU(−1)**	**LELEC(−1)**	**LNCABEM(−1)**	**LNCRIND(−1)**	**LNECP(−1)**	**LNELECGE(−1)**	**C**
CointEq1	1.000000	−0.961902	−0.206726	0.066114	0.578132	−0.551309	3.521707
Std. Errors		(0.40952)	(0.28335)	(0.08097)	(0.07624)	(0.27517)	
t-statistics		[−2.34886]	[−0.72957]	[0.81652]	[7.58273]	[−2.00352]	
The short run model and ECT							
Cointeq	0.307289	−0.186396	−0.020112	0.065015	0.031420	−0.125633	−0.012318
Std. errors	(0.16198)	(0.10367)	(0.05090)	(0.10139)	(0.02625)	(0.14372)	(0.02589)
t-statistics	[1.89707]	[−1.79799]	[−0.39510]	[0.64123]	[1.19679]	[−0.87415]	[−0.47571]
Error correction	−0.111638						
Std. errors	(−0.0481)						
t-statistics	[−2.32101]						

Table 4: Vector error correction residual serial correlation LM tests

Null hypothesis: No serial correlation at lag h						
Lag	**LRE* Stat**	**Df**	**Prob.**	**Rao F-stat**	**df**	**Prob.**
1	35.14577	36	0.5090	0.965893	(36, 64.2)	0.5356
2	33.00014	36	0.6120	0.894204	(36, 64.2)	0.6361

Source: Authors computations

Table 5: Normality test result output

Component	Jarque-Bera	df	Prob.
1	0.322207	2	0.8512
2	5.476794	2	0.0647
3	0.760574	2	0.6837
4	4.839980	2	0.0889
5	1.660658	2	0.4359
6	0.959029	2	0.6191
Joint	14.01924	12	0.2995

*Approximate P-values do not account for coefficient. Estimation.
Source: Authors computations

Table 6: Heteroskedasticity test result

VEC residual heteroskedasticity tests (levels and squares		
Joint test		
Chi-square	**Df**	**Prob.**
297.2467	294	0.4361

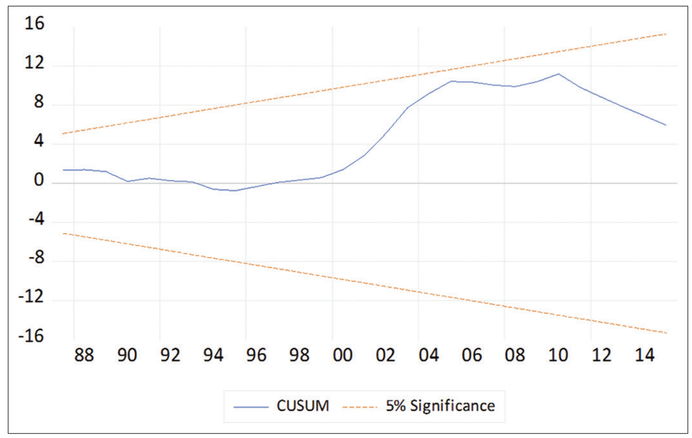
Source: Authors computations

because the plot of the CUSUM statistic falls inside the critical bands of the 5% confidence interval of parameter stability (Figure 1).

4.6. Empirical Results and Discussion of Findings

The study found that commercial bank credit to industries has direct relationship with capacity utilization in the model estimated. This implies that a unit rise in commercial bank credit to industries increases capacity utilization by 6% which suggests that credit to industries has not contributed enough to enhance capacity utilization in Nigeria. The finding is in tandem with study of Ebi and Nathan (2014). Equally, a unit rise in electricity price increases capacity utilization by 3% in the short-run of the model estimated. The findings corroborate the study of Emery and Chang (1997). In the long-run, the coefficient of commercial bank credit and electricity price caused an increase of 6% and 5% of capacity utilization respectively. The finding agrees with the study of Akujuobi and Chima, (2013) that revealed the existence of a long run relationship between credits to the production sector in Nigeria.

Figure 1: Cumulative Sum Residual Test (Stability Test)



Source: Authors Computations

5. CONCLUSION AND RECOMMENDATIONS

The study concluded that industrial electricity consumption, carbon emission and electricity generated have direct impact on capacity utilization while commercial bank credits to industries and electricity price have inverse relationship on capacity utilization in Nigeria on average in the long run. However, industrial electricity consumption, carbon emission and electricity generated inversely impacted capacity utilization in the short run.

Based on the findings, the study therefore recommended policies aimed at providing reliable and stable power supply thereby creating avenue for maximum capacity utilization in Nigeria industries. There is also need to ensuring that funds allocated for the development of the electricity subsector are prudently utilized.

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