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Impact of Power Supply on the Performance Nigerian Manufacturing Sector: 1999-2018

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Abstract
This study examines the impact of power supply on the performance of manufacturing firms in Nigeria. Anchoring on the Production Function Theory (PFT), data from the national statistical bulletin spanning 1999 to 2018 was used to measured the long-run and short-run relationships using the ARDL and VAR analysis. Findings indicate that electricity supply has both long and short term impact on manufacturing sector output, competiveness and capacity utilization. Theoretical and practical implications are discussed.
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1. Introduction

Electricity supply has a remained an area of research interest over the years given its role in economic development across the globe. Its relevance in moving the manufacturing sector forward has also been explored (Osakwe, 2015; Wrigley 2013; Stern, 2004). The manufacturing sector globally has been describe as a catalyst to economic growth and development (Osakwe, 2017, Amarkon, 2012, Gramlic, 1994); given its role in employment generation, poverty reduction, foreign earnings and contribution to Gross Domestic Product- GDP (OECD, 2017; SMEDAN, 2013). For instance, the small and medium scale Enterprises sub-segment of the manufacturing sector accounts for about 70% of jobs creation on average, generating 50- 60% of value added on average globally (OECD, 2017,World Bank, 2018). Besides, the Nigerian Government over the years, having seen the power of manufacturing sector in achieving inclusive economic growth and development, have emphasized the need to diversify the economy and reduce dependence on oil by establishing policies that support the manufacturing sector. Between 1966 and 1986 (Osakwe, 2017), Nigeria promoted industrialization through a policy of import substitution, which involve protecting and supporting domestic industries. There was the National Economic Empowerment and Development Strategy (NEEDS) in 2004, the transformation Agenda of 2011 and the Economic Recovery and Growth plan of 2017 as well as numerous other incentives aimed at fortifying the Nigerian manufacturing sector and empowering it for improved performance.

As rightly observed by Ogwo and Agu (2016), it is practically impossible for any nation to achieve and sustain meaningful growth and development without efficient, reliable and adequate infrastructural facilities. Although scholars have emphasized the pre-eminence of the transport infrastructure in achieving economic growth and development (Ogwo & Agu, 2016; Njoku, 2009; Ikpeaduku & Ureal, 2012), the researcher believes that power infrastructure (energy) remains very critical from the manufacturing sector perspective. This is because, power is a primary need that must be met for productivity to be sustained. Osakwe (2015) observed that the history of industrial development in both advanced and emerging economies indicates that power play a vital role in industrialization process. Wrigley (2013) and Stern (2004) revealed that energy was a major driver of the English Industrial Revolution and no country has been able to initiate and sustain an industrialization programme without access to good, stable and affordable power supply. Corroborating this, Subair and Oke (2015) assert that electricity supply, which is mainly used for driving machines for the production of various items, is a strong factor that will catalyze the productivity of the manufacturing sector and this contributes significantly to the development of the economy. Thus energy or power is indeed an indispensable component of economic growth and development as increase in supply of electricity enhances national productivity and economic development (Obioma, 2016, Omgu, 2008; Aremu & Adeyeme, 2011).

In Nigeria, series of reforms have taken place in the power sector. Obioma (2016) traced these events from 1896 with Nigeria Electricity Supply Company (NESCO) down to the unbundling of the electricity industry exercise that led to the separation of electricity generation from Transmission, Generation and Distribution, as well as the dominance of the private sector. From the Power Holding Company of Nigeria, eleven distribution companies, six generating companies and one transmission company now exist, with on independent regulatory agency - Nigerian Electricity Regulatory Commission (NERC). All these efforts are aimed at improving access to

power and enhancing economic wellbeing and growth in the economy. Yet one of the main challenges facing the manufacturing sector in Nigeria is lack of access to stable and affordable power supply (Osakwe, 2017; Word Bank, 2016), and this has resulted in the untimely collapse of many small and medium scale enterprises (SMEs) in the country (Agu, Onwuka & Aruoma, 2019; MAN, 2015). In 2014, MAN estimated that an average manufacturer experienced power outage 5 times per day and was supplied electricity for just 6 hours per day (Jacobs, 2015), and this is a more serious problem in Nigeria compared to Brazil, Cote divoire, Kenya, Ethiopia, Ghana and South Africa (World Bank, 2016). The plight of the manufacturing sector and the Nigerian economy in the face of the largely erratic, un-accessible and high cost electricity and the enduring desire to improve productively and competitiveness of the sector make this present study imperative. Although previous studies have been carried out in this line (Akiri, Ijuo & Apochi, 2015; Oke, 2008; Udude, Eze & Nweke, 2018; Osakwe, 2017), very patchy information exist for empirical evidences on the relationship between electricity supply and manufacturing sector ‘’performance” from a holistic, national view. Previous studies were only on productivity (Akiri, et al., 2015; Oke, 2008); contribution to GDP (Udude, et al., 2018) and or capacity utilization. By studying the effect of power supply on manufacturing sector performance (output), up to 2018, this study will contribute to the body of literature in this area.

The Problem

The manufacturing sector ordinarily is expected to play leading role in the economic growth and development agenda of any nation. However, a lot of factors militate against the ability of the sector to actualize this goal, especially in developing and emerging economies, Nigeria inclusive. Among these factors is lack of access to stable and affordable power supply (Osakwe, 2018;World Bank, 2016) and this leads to increase in spending cost, which has sent many manufacturing firms out of business and eventually reduces the productivity of the sector in the economy (Olayemi, 2012). According to Lee and Anas (1992), the manufacturing sub-sector in Nigeria spend on average 90% of their variable cost on infrastructure, with electric power accounting for half of the amount. Osakwe, (2018) observed that the power problem is a challenge and an important factor militating the ability of the producers and consumers to effectively participate in the growth and development process. He outlined three principle channels through which the poor access, unstable supply and high cost of electricity in Nigeria has had a deleterious impact on industrialization – low capacity utilization rate, low competitiveness, and lack of firm growth particularly for SMEs. A 2016 survey by the World Bank indicates that 71% of Nigerian firms use generators, and generator fuel alone accounted for about 23% of the total cost of the intermediate inputs used in manufacturing between 2010 and 2012 (NBS, 2014). Besides, an average manufacturing firm in Nigeria loses about 17% of its sales due to power outages compared with less than 1%, 1% and 5% for China, South Africa and Ethiopia respectively (Word Bank, 2016, Osakwe, 2018).

It is also clear that in Nigeria, electricity generated and transmitted are far above the quantity supplied by the Distribution Companies (DISCOS) and that consumed by the consumers. The power sector also accesses less than 50% of its installed generation capacity of about 7,228MW as less than 5,000MW is generated and transmitted (Obioma, 2016). Today we have the capacity to generate and transmit over 7,000MW but we cannot distribute more than 5,200MW now (Fashola, 2018). In 2018 for instance, between January and May, there was 37731 available megawatts of electricity given the installed capacity, but only 19654 representing 52% was generated and transmitted.

In sum, this paper argues that lack of access to stable and affordable power supply to the manufacturing sector increases cost, lowers capacity utilization and competitiveness which are indicators of poor performance measured in terms of manufacturing output. This scenario hampers the efforts of the manufacturing sector to make meaningful economic contribution to the economy as productivity is reduced and low employment is experienced. To show the magnitude of the negative effects of the poor electricity supply to the manufacturing sector, and the economy, measured in terms of its manufacturing national output, this study was conceived.

Objectives of the Study

The major objective of the study is to examine the impact of electricity supply on the performance of the Nigerian manufacturing sector between 1999 and 2018. The specific objectives are as follows:

i. Know whether significant relationship exists between electricity supply and manufacturing output in Nigeria.
ii. Measure the relationship between manufacturing output, electricity supply and manufacturing employment by means of Vector Autoregressio (VAR) model.
iii. Know whether significant relationship exists between electricity supply and capacity utilization of the manufacturing industry.
iv. Measure the relationship between electricity supply and manufacturing sector competitiveness.

Review of Related Literature

2.1 Electricity Generation, Distribution and Consumption in Nigeria

The Electricity sector in Nigeria generates, transmits and distributes megawatts of electric power that is significantly less than what is needed to meet basic household and industrial needs (Adedeji, 2016). In 2012, Adedeji (2016) noted that the industry labored to distribute 5,000 megawatts, very much less than the 40,000 megawatts needed to sustain the basic needs of the population. This deficit is also exacerbated by load shedding, partial and total system collapse and power failure. To meet demand, many households and businesses resort to purchasing generating sets to power their properties, this source of energy provided 6,000 megawatts in 2008 (Adedeji, 2016).

Oyewo, Aghahosseini, Bogdanov and Breyer (2018) observed that electricity in Nigeria is generated through thermal and hydropower sources. The main source of electricity generation comes from fossil fuels especially gas, which accounts for 86% of the capacity in Nigeria with the remainder generated from hydro power sources. Before the beginning of the Fourth Nigerian republic, power generation was largely the responsibility of the Federal Government through NEPA. But reforms started in 2005 with the signing of the Electric Power Sector Reform Act opened up the industry to private investors. In 2014, the sector was privatized with three groups having the responsibility of providing power (Oyewo et al., 2018). Yet, energy generation still lags behind installed capacity as shown in table 2.1.

Table 2.1: Available Capacity and Average Daily Generation

Month/Yr	***Available capacity* (MW)**	***Average daily generation***
January 2018	7,457	3,744
February 2018	7,515	4,005
March 2018	7,475	4,079
April 2018	7,250	3,999
May 2018	8,034	3,827
Total	**37,731**	**19,654**

Source: *"NERC Quarterly Reports"*. www.nercng.org. 2018. *Retrieved 01/09/2019.*

The Guide to the Nigerian Power Sector (2016) identified that Nigeria has 23 power generating plants connected to the national grid with the capacity to generate 11,165.4 MW of electricity. These plants are managed by generating companies (Gencos), independent power providers and Niger Delta Holding Company (NIPP). The major independent power plants prior to the power sector reforms are Shell owned Afam VI (642MW), Agip built Okpai plant (480MW) and AES (270MW).The third sector is the NIPP, a project that was initiated in 2004 to fast track the development of new power plants in the country. Majority of the new proposed plants are gas powered plants. In 2014, the proposed capacity of NIPP plants was 5,455MW.

Table 2.2: Gencos and their Installed Capacity

GenCo	**Installed Capacity (MW)**	Type	Privatisation Status
Afam Power Plc	**776MW**	Gas	100% Sold
Sapele Power Plc	414MW	Gas	51% Sold
Egbin Power Plc	1,020MW	Gas	100% Sold
Ughelli Power Plc	900MW	Gas	100% Sold
Kainji Power Plant	760MW	Hydro	Long Term Concession
Jebba Power Plant	578MW	Hydro	Long Term Concession
Shiroro Power Plc	600MW	Hydro	Long Term Concession

Source: *"NERC Quarterly Reports"*. www.nercng.org.2018. *Retrieved 01/09/2019.*

Distribution

Nigeria has eleven distribution companies that are charged with the responsibility of collecting energy from the transmission company and to supply to households and the industrial outfits. The DISCOS are:

Distribution Company	Districts
Kaduna Electricity Distribution Company	Kaduna including the districts of Makera, Doka, BirninKebbi, Gusau, Sokoto and Zaria
Yola Electricity Distribution Company Plc	Yola, Maiduguri, Taraba and Damaturu districts
Enugu Electricity Distribution Company Plc	Aba, Abakaliki, Abakpa, Awka, Ogui, Onitsha, Owerri, Nnewi, and Umuahia
Abuja Electricity Distribution Company Plc	Abuja, Minna, Suleja, Lokoja and Lafia Districts
Ibadan Electricity Distribution Company Plc	Abeokuta, Dugbe, Molete, Ijebu-Ode, Osogbo, Ilorin, Sango-ota and Oyo
Jos Electricity Distribution Company Plc	Jos, Makurdi, Bauchi and Gombe districts
Eko Electricity Distribution Company Plc	Festac, Ijora, Lagos Island, Ajah, and Badagry
Ikeja Electricity Distribution Company Plc	Lagos, Shomolu, Alimosho, Ojodu, Ikorodu, Oshodi and Abule-Egba
Port Harcourt Electricity Distribution Company Plc	Calabar, Diobu, Ikom/Ogoja, Borikiri, Uyo and Yenegoa
Benin Electricity Distribution Company Plc	Ado-Ekiti, Afenonesan, Akure, Asaba, Akpakpava, ‘ Ugbowo and Warri
Kano Electricity Distribution Company Plc	Nassarawa, Dala, Katsina, Dutse, Kumbotso, Funtua and Dakata districts

Source: Oseni (2011). "An analysis of the power sector performance in Nigeria".Renewable and Sustainable Energy Reviews.**15** (9): 4765–4774. *doi:10.1016/j.rser.2011.07.075. ISSN 1364-0321*

2.1.2 Electricity Supply and Manufacturing Sector Productivity

The Manufacturing sector is comprised of thirteen activities: Oil Refining; Cement; Food, Beverages and Tobacco; Textile, Apparel, and Footwear; Wood and Wood products; Pulp Paper and Paper products; Chemical and Pharmaceutical products; Non-metallic Products, Plastic and Rubber products; Electrical and Electronic, Basic Metal and Iron and Steel; Motor Vehicles and Assembly; and Other Manufacturing (National Bureau of Statistics, 2019).

Manufacturing is seen as the life force for sustainable economic growth and a catalyst to the transformation of an economy from a raw material base into a more active and productive economy (Okonjo-Iweala & Osafo-kwaako, 2007). There is a consensus among researchers that for any meaningful improvement in the productivity of manufacturing sector to take place in any economy, electricity supply and demand must remain uncompromising elements of the process (Iwayemi, 1998; and Odell, 1995, as cited in Olayemi, 2012; Akiri, Ijuo, Abraham & Apochi, 2015). Thus, Yakubu, Manu and Bala (2015) noted that 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.

Ndebbio (2006) agreed with this contention, noting that electricity supply drives the growth of manufacturing sector. He argued that one important indicator to show whether a country’s manufacturing sector is growing or not is the megawatt of electricity (supplied and) consumed. According to him, a country’s electricity consumption per capita in kilowatts per hour (Kw/H) is proportional to the state of the growth of the industrial sector of the country. Adenikinju (2005) provided a strong argument to further support the overwhelming importance of energy supply to the Nigerian economy. The poor nature of electricity supply in Nigeria, according to him, has imposed significant cost in the manufacturing sector of the economy. This argument is also in line with the survey of the Manufacturers Association of Nigeria (MAN) in 2005, where it was indicated that the cost of generating power constituted about 36 percent of the production. Accordingly Ekpo (2009), in his own opinion, elaborated on the cost of running a generator economy and its adverse effects on investment. He strongly opined that for Nigeria as a nation to accelerate the pace of the growth of manufacturing sector, the country should consider fixing power supply problem.

Historically speaking, Yakubu et al. (2015) noted that the Nigerian manufacturing sector formally came into existence as a sub-sector of the economy in 1960. Okere and Fidelis (2012) observe that in the 1960s and 1970s, after the country’s independence, the manufacturing sector developed positively as a result of Foreign Direct Investment (FDI). This continued hitherto 1980, and thereafter, the sector recorded low growth and development. Adenikinju and Chete (2002) reveal the same observation. The study revealed that the performance of the manufacturing sector from 1970 to 1980 was satisfactory, afterward, declining trend was observed. Dipak and Ata

(2003) revealed 25% decline in the real output of manufacturing sector from 1982 to 1986 (Yakubu et al., 2015).

Yakubu et al. (2015) identified that this waning trend persisted and became worsen as the power sector deteriorates by each day in the country, as depicted in table 2.1 where manufacturing sector's contribution to the Gross Domestic Products (GDP) kept declining from 1980 to 2009. The situation became more noticeable in the1990s and 2000s with more than 800 firms shut down and about one million workers rendered unemployed (Adenikinju, 2002; Ogwo & Agu, 2017). This has great psychological effects on the workers (Oyalakin & Agu, 2017). One of the major factors responsible for this trend is the inadequate and poor power supply which makes cost of production unbearable to remain in business. This is notable from the Word Bank's Ease of Doing Business survey (2012) where Nigeria ranks 176th in getting electricity as shown in figure 2.1.

Table 2.3: Percentage Contributions of Different Sectors to GDP in Nigeria

Sectors	**1960-1970**	**1971-1980**	**1981-1990**	**1991-2000**	**2001-2009**
Agriculture	55.8%	28.4%	32.3%	34.2%	40.3%
Industry	11.3%	29.1%	41.0%	38.6%	28.4%
Manufacturing	6.6%	7.3%	6.1%	4.9%	3.9%
Building & Construction	4.8%	8.3%	2.3%	1.8%	1.8%
Wholesale & Retail Trade	12.8%	17.6%	14.5%	13.8%	14.0%
Services	15.3%	16.5%	9.8%	11.5%	15.5%
Total value Added	100%	100%	100%	100%	100%
Diversification Index	0.2	0.4	0.4	0.4	0.3

Source: *Adopted from National Bureau of Statistics (NBS) in Yakubu, Y., Manu, S. B. &Bala, U. (2015). Electricity supply and manufacturing output in Nigeria: Autoregressive distributed lag (ARDL) bound testing approach, Journal of economics and sustainable development, 6(17), 7 – 19.*

2.2 Theoretical Framework

This study is anchored on the production function theory. A production function generally expresses the technical relationships between physical quantities of inputs (e.g., electricity supply) and outputs (e.g., manufacturing output), and represents a useful and powerful tool for the macroeconomic analysis and evaluation of governmental structural policies (Hossain & Al-Amri, 2010). Hossain et al. (2004) reviewed some production models that are recently used in the literature and found Cobb-Douglas production model as the most suitable one for measuring the production process of the manufacturing industries in a developing countries such as Nigeria.

Capital and labour were found to be the key determinants of production output in the model. Production was measured as the total monetary value of all goods produced in a year, labour as the total number of people per hours worked in a year and capital as the monetary value of all machinery, equipment and buildings.

The function used by Cobb and Douglas (1928) was modeled as follows:

$$Y = AK^{a} L^{b} u \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots(3.1).$$

Where Y represented total production (output), K was capital and L was labour. A represented the level of technology (constant) while a & b are positive parameters, and u is the disturbance (error) term (Hossain & Al-Amri, 2010). Taking the log on both sides of equation (3.1), the function transforms to a log-linear form as:

$$\ln Y = \ln A + a\ln K + b\ln L + \ln u \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (3.2).$$

Cobb-Douglas production function was made under the following assumptions: Mpatane (2015):

(a). Y_1 represent actual production Y.
(b). Y_1 approaches zero as either labour or capital approaches zero.
(c). the marginal productivity of labour is proportional to the amount of production per unit of labour.
(d). the marginal productivity of capital is proportional to the amount of production per unit of capital.

In line with the above, the neoclassical production function, particularly (Cobb & Douglas, 1928) expresses the technical relationship between given level of output and a given quantity of physical inputs. A change in output (in this study, manufacturing output) is as a result of variation in the physical inputs (here, electricity supply). The production function has only two factor inputs in production, but with the emergence of empirical evidence identifying energy or electricity as an independent and primary factor input in production process, there is departure from the neoclassical thinking of production function to that which includes energy as an independent factor of production (Alam, 2006). To this respect, our model for manufacturing sector's output constitutes an explicit inclusion of electricity supply as primary and independent factor of production.

Some critics argue that estimations of production functions merely capture an underlying accounting identity, yet research upholds the relevance of the Cobb-Douglass theory (Felipe & McCombie, 2014). Despite several stringent criticisms, the Cobb-Douglas function has not been abandoned and, recently, a number of growth models have been presented that make use of it (Labini, 1995). Specifically, the strength of the model has been emphasized. According to (Ezeh & Nnadi), the key advantages are:

i. It can handle multiple inputs in its generalized form.

ii. Even in the face of imperfections in the market, it does not introduce distortions of its own.
iii. Unconstrained CD-function further increases its potentialities to handle different scales of production.
iv. Various econometric estimation problems, such as serial correlation, heteroscidasticity and multicolinearity can be handled adequately and easily.
v. It is argued that most of its criticism is focused on its inflexibility and admits that except for one obvious assumption all other assumptions can be relaxed.
vi. It is further argued that it facilitates computations and has the properties of explicit represent ability, uniformity, parsimony and flexibility. Even the problem of simultaneity can be overcome.

2.3 Empirical Framework

Nwankwo and Njogo (2013) employed a multiple regression model to examine the effect of electricity supply on economic development and likewise the effect of electricity supply on industrial development. The result of the regression shows that, the electricity (ELEC), Gross fixed capital formation (GFCF), industrial production (INDU) variables and population have the positive sign. That is, they are positively related to RGDP Per capita. Turning to the Industrial production expenditure model, the electricity generation expenditure, gross fixed capital formation and population variables are positively related to GDP Percapita. As a way of facilitating the economic development, it was recommended that issues relating to electricity production and industrial development should be given priorities particularly in the budget scheme and because of this, substantial amount should be allocated to the electricity sector to be able to fix the state of electricity permanently in a good shape.

Yakubu, Manu and Bala (2019) explored the relationship between electricity supply and manufacturing sector's output in Nigeria using time series data from 1971 to 2010. They adopted Autoregressive Distributed Lag (ARDL) bounds testing approach to cointegration, and found long run relationship between the variables, and shows significant and negative error correction term. Manufacturing output is found to be positively dependent on electricity in both short run and long run, but only significant in the long run. The policy implication of these findings is that electricity supply must be increased if the productive capacity of the manufacturing sector is to be improved.

Cobb-Douglas production function (Cobb & Douglas, 1928) cited in Mpatane (2015) and the neoclassical traditional production function have been applied by previous studies (Beaudreau, 2005; Beaudreau, 1995; Enang, 2011 & Enang, 2010) in Ezeh and Nnadi (2016). Cobb-Douglas production function is one of the widely used production functions in presenting how two or more inputs (capital and labour) can be used to produce a certain amount of output. The function was introduced by Wicksteed (1894) and was put to test by Cobb and Douglas (1928) when modeling the growth of the American economy for the period 1899 to 1922. Cobb and Douglass (1928) wanted to find out the amount of labour and capital that are used to produce the volumes of goods and to determine the relationship between labour capital and production. The authors were of a view that production output can best be measured by the amount of labour used and the capital investment.

Ugwoke, Dike and Elekwa (2019) examined the impact of electricity supply on industrial output in Nigeria. Data for the period 1980 to 2014 were obtained from CBN and WDI and analyzed using a double-log linear formulation. The results show that electricity supply and trade openness impact industrial production negatively in Nigeria. They were also not statistically significant. It was recommended that, having failed to provide electricity even for the present level of industrial production, government should immediately provide tax relief for all privately generated power for industrial output.

Allcott, Allan and Stephen (2020) estimated the effects of electricity shortages on Indian manufacturers, instrumenting with supply shifts from hydroelectric power availability. They found that India y s average reported level of shortages reduces the average plant's revenues and producer surplus by 5 to 10 percent, but average productivity losses are significantly smaller because most inputs can be stored during outages using production function. Shortages distort the plant size distribution, as there are significant economies of scale in generator costs and shortages more severely affect plants without generators. Simulations show that offering interruptible retail electricity contracts could substantially reduce the impacts of shortages. Sabo and Lekan (2019) examined the effect of controlling firm characteristics in the energy-business growth relationships. Data were collected through a self-administered survey questionnaire. The target population consisted of SMEs operating in the city of Kano, Katsina and Jigawa state, Nigeria. Multi-stage sampling was applied to collected data from three stratums i.e manufacturing, hotel & restaurant and wholesale & retail sector SMEs. The study found that, relationship exists between SMEs growth, electricity supply and firm characteristics (firm age, size and leverage). Specifically, the relationship is positively strong between SMEs growth, electricity supply and firm age whereas both firm size and leverage had a similar less relationships. On the basis of these empirical findings, the paper recommends that there is an an urgent need to improve electricity supply to SMEs in order to accelerate

In their study, Adoghe, Odigwe and Igbinovia (2009) examined the power sector reforms, effects on electric power supply reliability and stability in Nigeria. The methodology adopted was to review the power sector before and after the reform, effects of the reform on electricity supply, reliability and the expected impact of the proposed

models on the Nation's economy. The major problems affecting the model been pursued especially in a developing country like Nigeria were also examined. The Electric Power Sector has over the past 25 years witnessed a slow and steady decline leading to near complete failure of the system in 1999 at the beginning of the immediate past civilian government. The federal government of Nigeria using National Council on Privatization (NCP) in 1998 had therefore, embarked on an electric power sector reform program, which gave birth to 18 companies under the auspices of Power Holding Company of Nigeria (PHCN). These companies unbundled from the defunct vertically integrated Nigeria Power Authority (NEPA) monopolistic utility are characterized with horizontal structure. In February 2007 government of Nigeria awarded contracts of about $875 million across the country in actualizing some of the goals in the power sector reforms. The study opined that if all identified problems militating against NEPA meeting the energy demand of the country is met by the reformed energy sector, in no distant time Nigeria can boost of an Electric Power Industry (EPI) that can meet the needs of its citizen in the 21st century and place the nation as one of the industrialized country in the world.

Idris, Kura, Ahmed and Abba (2013) assessed the power sector reforms from the Obasanjo Administration (1999) to date with a view to bringing out the problems and prospects, challenges and defects associated with the reforms. The paper also sets to explore better ways of ensuring the success of the reforms by identifying certain key issues that must be addressed by government. The work uses documentary analysis method in sorting out relevant information. The paper concludes that, the government needs to aim at overhand rather than severing with existing situations in the energy and power sector respectively as well as the overall national socio-economic and political order.

The work of Ogundipe (2013) examined the relationship between electricity consumption and economic growth in Nigeria using the Johansen and Juselius Co-integration technique based on the Cobb-Douglas growth model covering the period 1980-2008. The study adopted also conducted the Vector Error Correction Modelling and the Pairwise Granger Causality test in order to empirically ascertain the error correction adjustment and direction of causality between electricity consumption and economic growth. The study found the existence of a unique co-integrating relationship among the variables in the model with the indicator of electricity consumption impacting significantly on growth. Also, the study shows an evidence of bi-directional causal relationship between electricity consumption and economic growth. Prominent among the policy recommendation, is the need to strengthen the effectiveness of energy generating agencies by ensuring periodic replacement of worn-out equipment in order to drastically curtail transmission power losses.

The paper of Akiri, Ijuo and Apochi (2015) set out to examine the impact of electricity supply (EGI) on the productivity of manufacturing industries in Nigeria between 1980 and 2012. The variables in the model include, manufacturing productivity index (as dependent variable) while electricity generation, capacity utilization rate, government capital expenditure on infrastructures and exchange rate (represent the explanatory variables). The study employed the ordinary least square multiple regression to analyze the time series data between 1980 and 2012. The result of the study shows that electricity generation and 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. In view of the findings, the study suggests among others, a reverse of the ugly trend of poor electricity supply by ensuring that funds allocated for the development of the electricity subsector are prudently utilized, and to ensure that the ongoing deregulation of the power subsector be sustained to allow for competitiveness of the industry as that would bring about adequate and regular electricity supply in the country.

While studying "Electricity consumption and manufacturing sector productivity in Nigeria: An autoregressive distributed lag-bounds testing approach", Danmaraya and Hassan (2016) employed the autoregressive distributed lag technique to provide evidence of long run and short run relationship, as well as the causality between manufacturing productivity and electricity consumption in Nigeria for the period 1980-2013. When electricity consumption, capital formation and manufacturing productivity are applied as the dependent variable(s), the bounds test provides a proof of cointegration among electricity consumption, manufacturing productivity, and capital. Similarly, the findings demonstrated bidirectional causality between manufacturing productivity and energy consumption. Nigeria is along this line an electricity reliant nation. It is likewise a nation in which electricity consumption is rising with the manufacturing productivity. This demonstrates that electricity is a powerful determinant of manufacturing performance in Nigeria; accordingly, policy on energy should guarantee that electricity creates less negative effects on manufacturing productivity.

Mensah (2018) presented evidence on how the provision of unreliable electricity constrains expansion in the productive sectors of the economy and consequently leading to a reduction in the number of employment opportunities in Africa. Using GIS data on electricity transmission network in the continent, he compute an index that explores variations in technical losses in the electricity network as an instrument for electricity shortages. He combine this instrument with geo-referenced data from the Afrobarometer and Enterprise Surveys from over 20 African countries to causally estimate the impact of electricity shortages on employment and the mechanisms

driving the impact. Results from the paper reveal that electricity shortages exert a substantial negative impact on employment rates in Africa. The evidence also shows three channels by which electricity shortages affect labor market participation. First, on the extensive margin, electricity shortages constrain the creation of new businesses through its negative effect on entrepreneurship. Second, in the intensive margin, electricity shortages reduce output and productivity of existing firms, thereby causing them to reduce labor demand. Third, electricity shortages act as a distortion in the business climate thereby reducing the trade and export competitiveness of African firms.

Ugwoke, Dike and Elekwa (2016) examined the impact of electricity supply on industrial output in Nigeria. Data for the period 1980 to 2014 were obtained from CBN and WDI and analyzed using a double-log linear formulation. The results show that electricity supply and trade openness impact industrial production negatively in Nigeria. They were also not statistically significant. It was recommended that, having failed to provide electricity even for the present level of industrial production, government should immediately provide tax relief for all privately generated power for industrial output. Doing so will not erode the gains of petroleum products subsidy removal but will improve the macroeconomy by effectively checking the excessive production cost which hinders industrial progress in Nigeria. It was also recommended that future trade treaties should take into account the actual state of Nigeria's industrial sector, in order to obviate the increasing platform for products of other economies which our economy is fast becoming while we ourselves produce and export little.

The sustainable development of a country depends on rates of economic growth. Economic growth, in its turn, is related to use of energy in terms its intensity and price. It was on this basis that the paper of Korsakienė, Tvaronavičienė and Smaliukienė (2013) aimed to reveal if increasing prices of gas and electricity retard development of industrial sector of Lithuanian economy. A question, if international competitiveness of industry, measured by industrial export, remains unaffected in result of increase of energy resource prices is being raised. Energy intensity issues are not being tackled; during considered period energy intensity did not changed significantly. The object of research is industrial sector of Lithuanian economy. The method used is a correlation analysis, and the time span of data is 2000–2011. An economic interpretation of obtained results would lead to the conclusion that an increase of energy prices has not had significant malign impact on industrial sector development and export.

Yahaya, Salisu and Uma (2015) found that there exists long run relationship between electricity and manufacturing output in Nigeria. The study identifies electricity supply as a significant factor in the growth of the manufacturing sector in Nigeria. Nwankwo & Njogo (2013) concluded in their study that electricity generation and industrial production can promote economic development since both variables showed some positive impact on economic development while electricity variable too can impact positively on the industrial sector through adequate flow. This will definitely improve the performance of the industrial sector. Ogunjobi (2015) studied the effects of electricity consumption on industrial growth in Nigeria. It was found that there exist co-integration relationship between electricity consumption and industrial growth in Nigeria. The study further established positive relationship between industrial growth and labour employment, electricity generation, electricity consumption and foreign exchange rate in the long-run while it had a negative relationship with capital input.

In Pakistan, Tang and Shahbaz (2013) conducted a study to assess the causal relationship between electricity consumption and real output at the aggregate and sectoral levels. The study focused mainly on agriculture sector, manufacturing sector and service sector. Johansen and Juselius cointegration test as well as Granger causality test were used to determine the order of integration. The study used annual time series data from 1972 to 2010. Cointegration was observed both at aggregate and sectoral level. A unidirectional causality running from electricity consumption to real output was found at aggregate level while at sectoral level electricity consumption granger causes real output in the manufacturing sector. In agricultural sector, there was no evidence of causality between electricity consumption and real output.

Qazi, Ahmed and Mudassar (2012) used Johansen cointegration approach based on VAR to conduct a study on the relationship between disaggregate energy consumption and industrial output. The study covered the period 1972 to 2010. There were three results obtained from the analysis. The results showed a positive long run relationship between disaggregate energy consumption and industrial output. Bidirectional causality was observed running from oil consumption to industrial output. On the other hand, evidence of a unidirectional causality was observed running from electricity consumption to industrial output. Unidirectional causality was also found from industrial output to coal consumption. However no causality was observed between gas consumption and industrial output. In the short run, bidirectional causality was found between industrial output and oil. Still in the short run, there was evidence of unidirectional causality from electricity consumption to industrial output.

Gap in Literature

Following the review of extant empirical studies, most previous studies measured only electricity supply and manufacturing output. None is known that introduced variables such as capacity utilization, employment generation, and competitiveness as indicators of the manufacturing sector performance. This study adds to the literature by extending the existing models with these variables. Although a lot of studies have been done on the

link between electricity and manufacturing performance, most studies concentrated on few industries, while others considered an aspect of manufacturing sector performance. In this study, the entire manufacturing sector was considered to provide more holistic results on this relationship. Again, very few studies measured the long-run and short-run relationships using the ARDL and VAR analysis. Besides, most of the study used pre-current democratic dispensation data; that is before 1999. We expect a difference in attention to electricity in the present democratic dispensation and thus concentrated on data from 1999-2018. Most extant studies ended in 2013. This study brings newness to existing literature by covering the period of 1999 to 2018. These gaps are closed by basing on the production and neoclassical traditional production function (theories) to expand the literature using a holistic current national figure.

3. Methodology

This study adopted econometric method of analysis in determining the impact of electricity supply on Nigeria's manufacturing sector using an annual data for the period 1999 to 2018. This study is a time series analysis because it involves timing effect, and that data are in a series of particular time periods or intervals.

This study was based on pure secondary data from the Central Bank of Nigeria statistical Bulletin, the National Bureau of Statistic, Central Bank of Nigeria web-site (www.cenbank.org), CIA World fact Book, IMF World Economic Outlook, Debt Management Office (DMO), and the World Bank Economic Outlook (www.tradingeconomics.com). The data set used for analysis is shown as Appendix 1.

Model Specification

Hypothesis one aims at finding the impact of electricity supply on the manufacturing sector output between the periods of 1999 to 2018, including their long-term and short-term impacts respectively.

Thus: $MSP = F(ES)$ …….(3.1).

The linear model for this hypothesis is:

$Y_1 = a_0 + a_1ES_1 + a_2MSO + a_3MSE + a_4MSCM + a_5MSCU + U_t$---------- (3.1a).

Where:

Y_1 = Manufacturing sector performance.
ES_1 = Electricity supply.
MSO = Manufacturing sector output
MSE = Manufacturing sector employment
MSCM = Manufacturing sector competitiveness
MSCU = Manufacturing sector capacity utilization

a_0, a_1, are regression parameters to compute, U_t is the error term.

Y_1 is the dependent variable while ES_1 is the independent variable, implying that manufacturing sector performance overtime depends on the quantity of electricity supplied. U_t is the disturbance term or the unobservable/unobserved exogenous factors. The above equation was analyzed using linear specification. Based on the theoretical underpinning of the model, it is economically expected that there should be a positive relationship between electricity supply and the manufacturing sector performance in Nigeria, hence ($a_1 > 0$).

In hypothesis two, the relationship between manufacturing output, electricity supply and manufacturing employment is measured using the VAR model.

In hypotheses three and four, the relationship between electricity supply, capacity utilization, and competitiveness which are also predictors of manufacturing sector performance is tested. Thus,

$MSCM = f(ES)$ …… (3.2)

$MSCU = f(ES)$ …. … (3.3)

Also, the Unit Root test, Cointegration test, Autocorrelation, and heterosecdasticity tests were carried out to verify the model.

Methods of Data Analysis

Generated data for this study were subjected to series of tests to ensure that informed decisions are made. First, some pre-estimation diagnostic tests, including descriptive and stationarity, AIC (Akaike information criterion), SIC (Schwarz information criterion), and HQ (Hannan-Quinn information criterion would be conducted. This would be followed by main analysis with unit root tests of all the variables to ensure that the variables are stationary and equally to determine the level at which stationarity would be achieved. The analysis will continue with the diagnostic test with the Bounds Test of ARDL for cointegration (Test for Long-run Relationship), and then the VAR analysis.

Generally, the following steps describe the methodology adopted:

Step 1: Description of data – sources, coverage (scope), frequency, and units of measurement.

Step 2: Pre-tests, such as descriptive statistics, Lag selection order test using the maximum order based on the various information criteria including AIC (Akaike information criterion), SIC (Schwarz information criterion),

and HQ (Hannan-Quinn information criterion.
Step 3: Estimation technique – model building. Here, four models are involved as specified above. Two estimation techniques would be applied – ARDL and VAR.
Step 4: Analysis and discussion, including cointegration tests, discussion of the ARDL and VAR results, post estimation tests – serial correlation (BreuschGeofrey test), normality, ARCH (heteroscedasticity test), Ramsy RESET (Specification test), and stability test.

4. Findings

Following the analysis of data, the following major findings relating to the specific objectives of the study were made:

1. That there is a positive and significant relationship between electricity supply and manufacturing output. Specifically, at 10% significance level, a 1% increase in electricity supply leads to about 12% increase in manufacturing output.
2. There is a long-run positive and significant relationship between electricity supply and manufacturing output. Specifically, at 5% significance level, a 1% increase in electricity supply leads to about 20% increase in manufacturing output at lag one.
3. That there is a significant relationship between manufacturing output, electricity supply and manufacturing employment by means of Vector Autoregressive (VAR) model.
4. That electricity supply positively and significantly influences manufacturing output in the short-run. Thus, there a positive and significant short-run relationship between electricity supply and manufacturing output. At 5% level of significance, a 1% change in electricity supply leads to an increase of about 12% in manufacturing output.
5. That there is a positive and significant relationship between electricity supply and manufacturing competitiveness. Specifically, at 10% significance level, a 1% increase in electricity supply leads to about 11% increase in manufacturing sector competitiveness.
6. That there is a positive and significant relationship between electricity supply and manufacturing capacity utilization. Specifically, at 10% significance level, a 1% increase in electricity supply leads to about 10% increase in manufacturing capacity utilization in Nigeria.

5. Conclusion

The problem of electricity supply to households and industries has remained for many decades in Nigeria. Globally, even among the developing countries, Nigeria is among the countries with the least electricity supply per day (see for instance, WEF, 2018). With the findings of this study which align with extant studies (see Nwankwo & Njogo, 2013; Adoghe et al., 2009; Idris et al., 2013; Ogundipe, 2013; Akiri et al., 2015; Menseh, 2018), that a positive and significant short-run and long-run relationship exists between electricity supply and manufacturing sector output. Specifically, the long-run effect is found in this study to be more impactful – 1% increase in electricity supply leads to 20% increase in manufacturing output.

This evidence is enough to spur actions towards encouraging regular and more hours of electricity supply to the manufacturing sector. Its indirect implications include enhanced contribution to GDP, improved employment opportunities, better capacity utilization and competitiveness, and reduced cost of production and inflation.

Recommendations

Based on the findings of the study, the following recommendations are made:

1. Given the important role of electricity supply in enhancing manufacturing output, employment generation, competitiveness and capacity utilization, there is need for implementation of stringent policies by the government on the number of hours of electricity supplied to the industries per day. Regulating this in a corrupt-free manner will improve supply of electricity and enhance manufacturing output.
2. Government is expected to sincerely upgrade electricity infrastructure and encourage the GENCOS and DISCOS to live up to their contract agreement. This will ensure that megawatt of electricity generated is fully transmitted and supplied to the consumers, especially industrial users.
3. With the growing level of corruption in the management of electricity supply, electricity consumers, community leaders, and the labour organization are expected to rise up and challenge the GENCOS and the DISCOS to agree on specific level of power supply per day to justify the bills. For example, the Egbu community in Imo State, Alaoji in Abia State, Afam in Rivers State among others where the power transmission branches are located challenged the DISCOS to a contract of number of hours per day of electricity. This has enhanced productive capacity of informal small firms in the areas. Nigerian consumers of electricity can emulate this.
4. There is need for a corrupt-free competitive power industry. The present industry has used

government-enabled corruption to stifle the normal interaction of demand and supply in the industry. Today, even without supply, consumers are expected to pay. But when the prepaid metre is made affordable and accessible to consumers, genuine competition wil be restored in the industry.

5. Nigeria is encouraged to emulate global best practice on electricity supply to the industrial sector. Full utilization of installed power generation capacity, full transmission of generated megawatts, and full distribution of transmitted megawatts must be legally enforced. This will ensure improved electricity consumption with its numerous benefits.

Limitations of the Study

The researcher encountered various limitations such as data from various sources on the same variable contradicting each other. There was also financial difficulty especially given the current economic reality in the world occasioned by the Covid-19 pandemic. The problem of time required to strike a balance between family, work, and academic pursuit was also experienced. However, in spite of these limitations, the researcher made frantic efforts to manage the situation for a reliable quality research. First, with the guide of the supervisor and other research expects, data comparison and evaluations were made before adopting the ones used in the study. We obtained reliable data from authentic sources such as CBN, Debt Management Office etc. the researcher also managed to beat the challenge of family, worklife, and academic pursuit imbalance.

Areas for Further Study

Since this study is not holistic, the researcher recommends a detailed study of the various yardsticks of manufacturing sector performance such as capacity utilization, employment generation, and net export and how they are affected by electricity supply.

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Appendix 1:

Table 3: **Nigeria's Manufacturing Sector and Electricity Supply**

Year	Electricity Supply (Mg)	Manufacturing Output ($)	Manufacturing Employment %	Capacity utilization %	Manufacturing Competitiveness index
1999	84.30	9,652,425,000	11.82	34.6	61.8
2000	83.92	9,676,574,000	11.99	36.1	55.7
2001	83.91	10,308,990,000	11.84	42.7	47.9
2002	83.90	11,266,790,000	12.03	54.9	52.8
2003	84.90	12,653,020,000	12.01	55.7	56.3
2004	83.90	14,813,660,000	11.79	54.8	45.5
2005	83.92	17,721,000,000	11.72	53.3	45.7
2006	83.95	20,901,980,000	11.57	53.30	58.2
2007	86.16	23,156,360,000	11.51	53.38	51.25
2008	84.80	27,532,140,000	11.53	53.84	52.78
2009	84.13	22,878,770,000	11.39	58.92	54.47
2010	79.80	23,810,310,000	11.65	52.12	52.13
2011	87.10	29,425,440,000	11.74	56.20	48.22
2012	84.42	35,484,720,000	11.76	27.88	49.22
2013	83.60	45,980,980,000	11.81	35.99	52.45
2014	84.66	54,779,490,000	11.79	43.80	51.05
2015	81.50	46,631,460,000	11.68	40.10	49.11
2016	86.00	35,122,360,000	11.58	60.50	49.43
2017	86.80	32,847,650,000	11.56	55.04	47.14
2018	84.30	38,324,700,000	11.55	55.04	47.13

Source: CBN Statistical Bulletin, (2019) and National Bureau of Statistics (2019), the World Bank Economic Outlook (www.tradingeconomics.com).

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