AN ANALYSIS OF THE EFFECT OF POWER SUPPLY ON MANUFACTURING OUTPUT IN NIGERIA (1970-2013)

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Abstract

Manufacturing sector of any economy plays a major role of sustaining such economy's industrialization process. Considering this crucial role, the study was undertaken to examine the impact of power supply on manufacturing output in Nigeria between 1970 and 2013 using the OLS multiple regression and other econometric tests like ADF, Johansen Cointegration and the Vector Autoregression estimates. The result of the study shows that power supply in Nigeria during the period of analysis impacted negatively on manufacturing output. Other variables like capacity utilization and exchange rate also impacted negatively. In view of the findings, the study recommends for efficient and sustained power supply and independent power projects as proposed by some states of the federation.

Keywords: Power Supply, Manufacturing, Output, Nigeria

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1.1 Introduction

Industrialization involves extensive technology-based development of the productive system of an economy. Industrial development therefore, represents a deliberate and sustained application and combination of suitable technology, management techniques and other productive resources to move an economy from the traditional low level of production to a more automated and efficient system of mass production of goods and services (CBN, 2000). According to Anyanwu et al (1997), manufacturing refers to the sector in which there are productions of goods and services through combined utilization of raw materials and other production factors such as labour, land and capital. Manufacturing thus involves the conversion of raw materials into finished consumer, intermediate and capital goods.

The manufacturing sector is a crucial subset of the industrial sector. The wealth and high standard of living enjoyed by the group of Eight Industrialized Nations popularly referred to as the "G-8" is underpinned by the effectiveness of their manufacturing sector which contribute very high to their Gross Domestic Product (GDP). A comparative analysis as at the end of 2011 by Olatundun, (2011) indicates that manufacturing production contributes about 25% to the GDP of most members of the G-8. It contributes 20% to the GDP of Brazil, 28% to the GDP of Indonesia, 34% to the GDP of China, 35% to the GDP of Thailand, 45% to the GDP of Malaysia while it contributes only 2.4% to the GDP of Nigeria.

One of the pre-requisites for increased manufacturing output is adequate supply of electric power which is mainly utilized for driving machines for the production of various items. An efficient power supply according to Olayemi (2008), act as a catalyst that accelerates the pace of structural transformation and diversification of an economy. However, the manufacturing sector of the Nigerian economy has continued to experience massive decline in recent years in terms of employment generation, foreign exchange earnings, output, capacity utilization and contribution to the GDP among others. The poor performance of the sector according to the (Ekpo, 2009) and CBN (2000) has been attributed to a number of factors like high cost of production due to high interest rate, exchange rate and inflation, weak demand for domestic manufactured goods, excessive importation of foreign substitutes, poor power supply, policy inconsistency and political instability.

The power crisis in Nigeria is represented by such indicators like electricity blackouts, power rationing, low shading and persistent reliance on self-generating electricity. Indeed, as noted by Ekpo (2009), Nigeria is running a generator economy with its adverse effects on cost of production. The country's electricity market is dominated on the supply side by a state owned monopoly- Power Holding Company of Nigeria (PHCN) formerly called the National Electric Power Authority (NEPA) that has been incapable of providing minimum acceptable international standards of electricity service that is reliable, accessible and available for consumption in the last few decades. The current power supply of 3000 megawatts is grossly inadequate for meaningful manufacturing production.

In view of these compounding problems of power generation, distribution and consumption especially in the last few decades and its attendant consequences on the Nigerian economic growth and development, the study attempts to examine the relationship between power supply and manufacturing output in Nigeria between 1970 and 2013.

The broad objective of the study is to examine the relationship between power consumption proxied by power supply to the industrial sector and manufacturing output in Nigeria between 1970 and 2013. The study is based on the following specific objectives: (a) to examine the relationship between power supply and manufacturing output in Nigeria. (b) to examine the extent to which power supply has affected manufacturing output in Nigeria and a null hypothesis that; H_o**:** There is no significant relationship between power supply and manufacturing productivity in Nigeria.

2.1 The Structure and Performance of the Nigerian Power Sector

Power system in Nigeria centers around the PHCN as it accounts for about 98% of total electricity generation while generation by other agencies such as Nigerian Electricity Power Company (NESCO) Jos, ASC, NNPC and Shell account for the remaining 2% (CBN, 2000). PHCN owns very large associated and non-associated gas based generating facilities, a number of relatively low cost, developed and underdeveloped hydro sites, as well as coal and solar energy resources. It is also reputed to have ample excess capacity for conversion of installed power generation and transmission facilities to supply power to the domestic markets and neighbouring countries. The Power Authority therefore generates electricity through a mix of

both thermal and hydro systems, with the entire generation nation-wide pooled into the national grid centered at Oshogbo for equal distribution.

Power consumption in Nigeria in the 1970s recorded very significant growth reflecting the generating and distribution capacity, with an all time record high of 76% annual average capacity utilization rate. In the period 1970 to 1980, power consumption increased persistently at an annual average rate of 14.3% with the exception of 1979 when it fell by 8.8%. Also, even though it recorded an annual average increase of 2.4% in the post SAP period, total power consumption declined by 4.1, 1.7 and 2.4% in 1994, 1995 and 1996 respectively (CBN, 2000). During the democratic period of 1999 to date, the situation continued to be worsening as the Newswatch (2008) reported the failure of the federal government to declare a state of emergency in the power sector as elegantly promised by Late President Umaru Musa Yar Adua. The government assured of increasing power generation from the June 2007 capacity of 3,000 megawatts to 10,000 megawatts by December 2007, with the hope of further increasing same to 30,000 megawatts by 2011 and 50,000 megawatts by 2015.

Hitherto in 2014, the generating capacity stands at 3,000 megawatts relative to 48,000 megawatts and 35,000 megawatts generated in South Africa and Egypt respectively (AIT, 2013). This means that most Nigerians are thrown into complete darkness with the skyrocketed cost of business chasing many out of their business endeavours, a position well supported by the CBN and NBS publications.

Notable among the structural and institutional problems of the power sub-sector include poor preventive and routine maintenance of facilities for generation and distribution, frequent use of out-dated and heavily loaded equipments, poor coordination between town planners and PHCN, inefficient billing and collection system, vandalization and pilfering of PHCN equipments by unscrupulous, unpatriotic and selfish groups, poor funding and above all, very endemic corruption in the sector resulting into lack of routine Turn Around Maintenance (TAM) and poor remittances of fund to the government, (CBN, 2000).

2.2 The Structure and Performance of the Manufacturing Sector

There is no consensus on the composition of Nigeria's manufacturing sector. To the CBN (2000), the sub-sector comprises of a wide range of industrial activities which include large,

medium and small scale manufacturing enterprises as well as cottage and hand-craft undertaken in the informal sector using simple technology. This categorization was supported by the Manufacturers Association of Nigeria (MAN) when they categorized the sector into large, medium and small scales in line with the National Council of Industries (NCI) classification.

However, the Bureau of Public Enterprises (BPE) (2006) categorizes the players in the Nigerian industrial and manufacturing sector into four groups: Multinationals, Regional, National and Local operators. The Standard Organization of Nigeria (SON) as cited by Mazi (2010) classified the Nigerian manufacturing sector into the following product sectoral groups: Food, Beverages and Tobacco, Chemical and Pharmaceuticals, Domestic and Industrial Plastic and Rubber, Basic Metal, Iron and Steel and Fabricated Metal Products, Pulp, Paper and paper products, Printing and Publishing, Electrical and Electronics, Textiles, Weaving Apparel, Carpet, Leather and Footwear, Wood and Wood Products including Furniture, Non-Metallic Mineral Products, Motor Vehicle and Miscellaneous Assembly. Whatever is the categorization, the ownership of the manufacturing sector is shared between the public and private sectors of the Nigerian economy with the private sector pre-dominating the entire ownership structure while the public sector dominating only the investment in capital intensive heavy industries (CBN, 2000).

On attainment of independence in 1960, the Nigerian government embarked upon the transformation of the country into an industrial-based economy as reflected in the various development plans from 1962 to 1985. The import substitution and export-driven industrialization strategy encouraged industrial development while the oil boom lasted.

Data from the CBN (2000) showed that manufacturing production rose to an annual average rate of 15.6% between 1974 and 1977 while its share of GDP increased from 5.4% in 1977 to 13% in 1982 with overall manufacturing capacity utilization rate fluctuating between 70 and 75% during the period of 1975 to 1980. However, manufacturing activities dropped sharply from 1982, following the fall in foreign exchange inflows which weakened the ability of manufacturers to import the needed inputs. Output thus fell by an annual average of about 3% between 1981 and 1986.

In spite of the spirited efforts made by the government to boost manufacturing exports under the SAP, the sector did not make any significant contribution to the growth of the economy. The introduction of SAP and the subsequent depreciation of the naira exchange rate, the performance of the sub-sector as reflected in output levels deteriorated persistently. From 1999 to date, output from the manufacturing sector has continued to decline. The obvious reasons have been the non-implementation of the policy documents of successive governments in Nigeria. The National Economic Empowerment and Development Strategy (NEEDS) and the 7-Point Agenda were not, in any way, implemented due to corruption, insecurity, insincerity and religious sentiments exhibited by the leaders. Presently, the sector is like a disaster waiting to happen with a minimal contribution of 2.4% to the GDP of Nigeria (NBS, 2011).

The CBN (2000) reported that low investment owing to low savings in the domestic economy and poor inflow of foreign investment, low overall manufacturing capacity utilization rate, poor technical base to support growth activities, inadequate and high-priced imported inputs and communication services, frequent disruptions in electric power and water supply, poor roads and other transportation problems, massive importation and even smuggling of finished goods resulting to unfair competition, weak demand for local manufactured goods and corruption are the major problems of manufacturing sub-sector in Nigeria.

2.3 Theoretical Framework

This study has attracted some basic theoretical discussions, reflecting issues bordering on power and manufacturing output growth. Some of these theoretical expositions include the traditional and modern theory of costs. The traditional theory of cost admits that optimal level of output is attainable at a single level of output where cost begins to rise. Therefore, the output capacity is fully utilized at a point where the marginal cost curve cuts the average cost curve from below or at the minimum while the former start rising. Under the traditional theory of cost, firms do not build plants with varying productive capacity, thus the excess capacity is often a phenomenon experienced by firms.

Excess capacity according to Bannock et al (1998) is the difference between the amount produced by a firm or group of firms and the higher amount that could have been most

efficiently produced. Bannock (1998) asserts that sustained excess capacity is also a feature of firms in monopolistic competition, while it will only exist in the short run under the perfect competition. Excess capacity could also mean the difference between the actual output and maximum possible output of a firm, industry, or economy at large, when there are unemployed resources. However, the modern theory of cost, in its own description assumes that firms build their plants with some flexibility in their productive capacity and making it possible for such firms to have reserve capacity. In furtherance to that, the theory also asserts that firms which utilize two-third and three quarters of their adequate supply of power are considered to be efficient. The reserve capacity under the modern theory of cost implies some outputs can be produced at a single cost.

Whichever positions or arguments put forward by each of the theories considered in this study, they are not permanently meant to bridge the gap between the power supply and manufacturing productivity especially in the developing countries of Africa. The permanent solutions should be sought in the total revolution and overhauling of the power sector, to allow the optimal use of equipment in the manufacturing sectors across developing countries especially Nigeria.

2.4 Empirical Review

Most of the empirical works reviewed in this study have indicated the poor state of power supply in developing African countries. Ukpong (1973) carried out a study on the cost of power outages to the industrial and commercial sector in Nigeria using the production function approach to evaluate power outage cost between 1965 and 1966, with selected firms. From his estimation, he discovered unsupplied electricity energy to be 130Kwh and 172Kwh between the periods. The corresponding costs of the power outage to the industrial sector in the two years were estimated at N1.68 million and N2.75 million respectively. The unsupplied electricity energy according to Ukpong, has negative implication on the manufacturing productivity growth in Nigeria.

A similar framework of analysis was carried out by Uchendu (1993) on industrial firms in the commercial areas of Lagos State, Nigeria. He established several types of outage costs such as material and equipment losses and value of unproduced output, which was estimated to be

N1.3 million, N2.01 million and N2.32 milllion in 1991, 1992 and mid 1993 respectively. This development reduced the value added of major manufacturing firms in Nigeria during the period of analysis.

World Bank (1993) conducted a study and estimated the adaptive cost of power failure in Nigeria which amounted to $380 million. Also, the estimate of NEPA now PHCN revenue lost to unsupplied consumers was stated by the World Bank as $140 million. However, the short term losses incurred by consumers such as raw materials and equipment losses was known to be less than 50%. Also, that only 34% of Nigeria's population has access to the public power supply, which is always in short supply for the household sector not to consider supply to the manufacturing sub-sector.

Olayemi (2008) employed an OLS multiple regression to analyze the time series data between 1980 and 2006 about electricity crisis and productivity of manufacturing sector in Nigeria. The study showed negative impact of electric supply on growth of manufacturing sector. The study recommended independent power projects by some states of the federation.

We cannot conclude that the literature on this subject matter is replete, but most of the literature found has no concrete empirical evidence. The work of Olayemi (2008) is really good and empirical in nature. The work is however obsolete because, from 2008 to date and particularly with the advent of the 7-point agenda and now the transformation agenda where power and manufacturing sector reform were emphasized by the government, it is long enough for one to expect some changes in the principal variables hence the importance of this study.

3.1 Methodology

Secondary data relevant to this study was sourced from the CBN, NBS, National Electricity Regulatory Commission (NERC) and the internet. The study employed a multiple regression model using Ordinary Least Squares (OLS) for estimation complimented by the ADF unit root test, Johansen Cointegration test and the Vector Autoregression (VAR) estimates.

The work of Olayemi (2008) expresses manufacturing productivity index as a function of megawatt of electricity generated and supplied explicitly as follows:

$$MPI = \beta_0 + \beta_1 EGI + \beta_2 CPU + \beta_3 GCE + \beta_4 EXR + \mu \text{---------- (1)}$$

Where;

MPI = Manufacturing Productivity Index

EGI = Electricity Generation

CPU = Capacity Utilization

GCE = Government Capital Expenditure

EXR = Exchange Rate,

μ = Stochastic Error Term.

Olayemi's (2008) model was adopted and slightly adjusted to include manufacturing output as a percentage of the GDP (MOD) as the dependent variable following the assertion by the CBN (2000) that manufacturing sector is assessed by employing criteria such as its share in the GDP. The model was further adjusted with the inclusion of inflation rate proxied by the consumer price index (CPI) following the submissions of Ekpo (2009) that high inflation was also responsible for the weak demand for domestic manufactured goods in Nigeria. It was also more appropriate to use power consumption by the industrial sector as an index of measurement for manufacturing. The necessary model for estimation was explicitly stated as follows:

$$MOD = \beta_0 + \beta_1 IPC + \beta_2 CPI + \beta_3 CPU + \beta_4 EXR + \mu \text{---------- (2)}$$

Where;

MOD = Manufacturing Output as percentage of GDP

ICP = Industrial Power Consumption

CPI = Consumer Price Index

CPU = Capacity Utilization in the Manufacturing Sector

EXR = Official Real Exchange Rate

μ = Stochastic Error Term

ICP and CPU are expected to have positive relationship with manufacturing output while CPI and EXR are expected to have negative relationship with manufacturing output on *a priori* expectation.

4.1 Analysis and Interpretation of Results

Table 4.1 ADF Unit Root Test

Variables	ADF Value at 1st Difference	Mackinnon Critical Value @ 5%	Order of Integration
DMOD	-11.24329	-2.936942	1(0)
DICP	-5.217128	-2.943427	1(0)
DCPI	-6.415894	-2.938987	1(1)
DCPU	-3.423263	-2.936942	1(0)
DEXR	-6.040804	-2.936942	1(0)

Source: Computed by the Authors, 2014 from Eviews 7.0

The result in Table 4.1 shows that the log of Manufacturing Output (MOD), Industrial Power Consumption (ICP), Capacity Utilization (CPU) and Exchange Rate (EXR) are stationary at 1st difference. The log of Consumer Price Index (CPI) has however shown evidence that it is integrated of order one (1). This implies that all the variables have violated the stochastic assumptions of the OLS hence an OLS model cannot be relied upon in estimating the result. Since the ADF test has shown that one of the series is integrated of order (1), there is the need to check for long run convergence to a unique equilibrium by all the integrated series. The result of the Johansen Cointegration test is presented in table 4.2.

Table 4.2 Johansen Cointegration Test (Trace Statistics)

Variable	Eigen Value	Trace statistics	5% critical value	Hypothesised no. of CE(s)	Prob**
DMOD	0.529694	73.38806	69.81889	None*	0.0252
DICP	0.479161	43.21322	47.85613	At most 1	0.1275
DCPI	0.232069	17.12064	29.79707	At most 2	0.6311
DCPU	0.127802	6.558436	15.49471	At most 3	0.6295
DEXR	0.026855	1.088879	3.841466	At most 4	0.2967

Trace test indicates 1 cointegrating equation(s) at the 0.05 level

** denotes rejection of the hypothesis at the 0.05 level*

*** Mackinnon-Hang-Michelis (1999) P-values*

Source: Computed by the Authors, 2014 from Eviews 7.0

Looking at the trace statistics as compared to the critical value at 5% level of significance, the hypothesis of no cointegrating or the existence of at most one cointegrating vector was accepted. The result shows that there is only one (1) cointegrating equation (vector) in the set of normalized cointegrating vectors.

Table 4.3 Johansen Cointegration Test (Maximum Eigen Statistics)

Variable	Eigen Value	Max Eigen statistics	5% critical value	Hypothesised no. of CE(s)	Prob**
DMOD	0.529694	30.17484	33.87687	None	0.1299
DICP	0.479161	26.09258	27.58484	At most 1	0.0766
DCPI	0.232069	10.56220	21.13162	At most 2	0.6907
DCPU	0.127802	5.469557	14.26460	At most 3	0.6818
DEXR	0.026855	1.088879	3.841466	At most 4	0.2967

Trace test indicates 1 cointegrating equation(s) at the 0.05 level

*** Mackinnon-Hang-Michelis (1999) P-values*

Source: Computed by the Authors, 2014 from Eviews 7.0

The result of table 4.3 shows that the Maximum Eigen test as compared to the critical value at 5% level of significance shows one cointegrating equation and the values is at par with the trace test. A normalization of the model has produced the results presented in table 4.4. This can be interpreted as the long run relationship between power supply and manufacturing productivity in Nigeria.

Table 4.4 Normalizing the Model (*standard errors in parentheses***)**

MOD	ICP	CPI	CPU	EXR
1.0000	0.014751 *(0.002126)*	-0.071162 *(-0.04356)*	0.172683 *(0-05845)*	0.001670 *(0.01643)*

Source: Computed by the Authors, 2014 from Eviews 7.0.

These are set of elements in an inverse matrix hence opposite signs are expected when interpreting the normalization result. Thus, in the long run, there is negative relationship between ICP, CPU and EXR and manufacturing output in Nigeria. There is however a positive relationship between CPI and manufacturing output in Nigeria. This finding is very consistent with Olayemi (2006) who found out negative impact of electricity supply on growth of manufacturing sector.

Table 4.5 Vector Autoregression Estimates

Variable	Coefficient	Std. Errors	t-statistics
MOD (-1)	0.303650	0.19063	1.59292
MOD (-2)	0.658676	0.19431	3.38983
ICP (-1)	-0.000565	0.00096	-0.59098
ICP (-2)	-5.41E-05	0.00094	-0.05749
CPI (-1)	0.005496	0.01591	0.34533
CPI (-2)	0.011563	0.01594	0.72543
CPU (-1)	0.178481	0.07026	-2.54040
CPU (-2)	-0.133287	0.06551	-2.03469
EXR (-1)	-0.006445	0.01924	-0.33505
EXR (-2)	-0.009131	0.01841	-0.49589
ECM	-2.932354	2.90869	-1.00814

R-squared 0.778306 Adj R-Squared 0.701859

F-statistic 10.18108

Source: Computed by the Authors, 2014 from Eviews 7.0

From Table 4.5, the extent to which any previous disequilibrium in the model is adjusted for in the current year is captured by the coefficient of the error correction. The coefficient of error correction carries the correct sign, with the speed of equilibrium of 29%. The coefficient of multiple determination (R^2) stood at 0.778306 (78%). This means that the explanatory variables in the model accounted for 78% of the variations in the dependent variable (MOD). The high R^2 value was supported by the value of adjusted R^2 of 0.701859 (70%). This is no doubt a very good fit. The Durbin-Watson can be computed using (N-K) and (K-1) degrees of freedom. From the sample size of 42 observations and 4 independent variables, the tabulated value of D-W shows positive autocorrelation but is within the normal bound of 1.66.

The result of the vector Autoregression estimates also confirms the normalization result. The coefficient of a one-year and two year lagged value of ICP is negatively related to manufacturing output. It means that even in the long run, ICP would continue to negatively impact on manufacturing output. A 1% reduction in ICP would result to more than 5% reduction in manufacturing output hence the impact ratio is 1:5. This however, contradicts our *a priori* expectation of a positive relationship between the two since power was treated as an input for manufacturing output. It implies that epileptic power supply has been one of the greatest problems of manufacturing output in Nigeria.

A one year and two year-lagged values of CPU and EXR are both negatively related to the MOD and are statistically significant at 10% and 5% respectively. The current low capacity utilization in most manufacturing outfits in Nigeria and outrageous importation of close substitutes has completely distorted domestic economic activities in the manufacturing sector.

One year and even two year-lagged value of CPI has a positive relationship with manufacturing output and is statistically significant at 1% confidence level. This implies that when prices are moderately high, it is in the first place a good signal for the producers to strive for increased output. But excessive inflation becomes detrimental to production.

4.2 Test of Hypothesis: The following hypothesis was formulated;

Ho: *There is no significant relationship between power supply and manufacturing productivity in Nigeria.*

Using the popular F-statistics for large sample size with (N-K) and (K-1) degrees of freedom, (42-4) (4-1) = (38)(3), the tabulated F-value is 4.51. Thus, F_c is 10.20 and F_t is 4.51. Thus, $F_c > F_t$

It falls in the critical rejection hence we reject the Ho of no significance relationship between power supply and manufacturing productivity in Nigeria. It makes no economic meaning to conclude that power supply does not contribute anything at all to manufacturing productivity in Nigeria, except that the contribution is abysmally low and far below expectation hence the need to improve significantly on the current power supply situation in Nigeria.

5.1 Recommendations

i. The PHCN must be made to supply efficient and sustained power, not only to the industrial sector but also to the entire Nigerian economic society for improved production and distribution.

ii. The Federal government must support the initiative of independent power projects, as proposed by some states in Nigeria.

iii. Subsidy should be given to local producers especially those that required foreign capital inputs and expertise for efficient production.

1v. The use of relevant productive technology must be encouraged to enhance capacity utilization in manufacturing sector.

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