Journal of Economics and Sustainable Development
ISSN 2222-1700 (Paper) ISSN 2222-2855 (Online)
Vol.6, No.13, 2015

The Effects of Electricity Consumption on Industrial Growth in Nigeria

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Abstract
The study analyzed the relationship between electricity consumption and industrial growth in Nigeria. The study make up time series data covering the period between 1980 and 2012 and the data collected were analyzed using co-integration and error correction techniques to estimate the short-run and long-run dynamics of the research models respectively. The result established that in the long-run, there is a significant positive relationship between industrial growth and electricity consumption, electricity generation, labour employment and foreign exchange rate while it showed a negative relationship between industrial growth and capital input (proxied by gross capital formation). The study therefore recommends that government should undertake cogent approach towards reforming the electricity supply in such a way to increase industrial production and to monitor the privatization policy of the electricity sub-sector to provide employment to reduce high rate of unemployment in Nigeria.
Keywords – Industrial growth, economic development, energy, electricity consumption, productions

Introduction

In the historical economic development of the present world super powers, appreciable economic growth began to manifest when those economies embarked on industrialization from the cottage to small scale industries before the dawn of full-fledged industrialization. Industrialization is the process of manufacturing consumer and capital goods which have the tendency of creating the necessary social overhead capital that would stimulate the development of other sectors of the economy. Furthermore, industrial growth or industrialization is a deliberate and sustained application and combination of an appropriate technology, infrastructure, managerial expertise, and other important resources in the production of output.

As a result of the critical role industrialization plays in economic development, the topic has attracted considerable interest in development economics in recent times. Industrialization acts as catalyst that accelerates the pace of structural transformation and diversification of economies, enabling a country to fully utilize its factor endowment and to depend less on foreign supply of finished goods or raw materials for its economic growth, development and sustenance.

In recognition of the importance of industrialization to economic growth and development, Nigeria has adopted various policies, incentives and schemes to promote industrialization. Some of these policies include the import substitution of the 1960s; the indigenization policy that started in 1972; the Structural Adjustment Programme (SAP) of 1986; the establishment of the Bank of Industry and Small and Medium Equity Investment Schemes in 2000 to reduce credit constraints faced by entrepreneurs, the adoption of the National Integrated Industrial Development (NIID) blueprint by the Federal government in 2007 and the current power sector reforms to service the industrial sector effectively.

Most of the policy objectives of government could not be achieved; presently the Industrial sector is nothing to write home about and thus the rising level of unemployment in Nigeria. Nigeria's current Industrial policy thrust is anchored on a guided deregulation and privatization of the economy and government disengagement from some activities of the private sector oriented businesses, leaving government to play the role of facilitator, provision of incentives policy and infrastructure that are necessary to enhance the private sector's role as the engine of growth and development. Government industrial policy is intended to increase export of locally manufactured goods, to increase the local content of industrial output by looking inward for the supply of basic and intermediate inputs, to attract direct foreign investment, to increase private sector participation, to reduce the high level of unemployment and to contribute highly to the Gross Domestic Product (GDP).

Available statistics indicate that the industrial sector seems to be experiencing slow growth and one of the factors responsible to a considerable extent for this slow growth despite the policies and incentives, is poor energy consumption. The survey by Manufacturing Association of Nigeria (MAN) carried out in 2006 and in the first quarter of 2009 painted a dim picture of the Nigerian Industrial sector. According to the survey for instance, only 10 percent of manufacturing concerns in Nigeria could operate at 48.8% of installed capacity, 60% of the company's operations were unable to cover their average variable costs, while 30 percent had to completely shut down. Abundance of energy is a pre-requisite of manufacturing and it is mainly utilized for powering machines for the production of various items. The manufacturing sector has always emphasized the need to improve various infrastructures, particularly, electricity which is in primary form of energy required for production.

Energy is the capacity of a system to do work. In carrying out any activity by any system (animate or inanimate) energy is utilized. This energy is obtained from various sources with photosynthesis while inorganic systems depend on a wide range of fuel sources. Energy plays a fundamental role in shaping the human condition. People's need for energy is essential for survival, so, it is not surprising that energy production and consumption are some of the most important activities of human life. According to elementary physics, energy is of various forms, each form being transferrable or convertible to another. The major forms of energy are: mechanical energy, solar energy, thermal energy, electrical energy, electromagnetic energy and mass or nuclear energy. Industrial-use energy like all other uses preys on the convertibility of forms of energy, such that a factory could generate electricity from solar panels (star or electrical conversion) or from mechanical generation (chemical to mechanical to electrical conversion) and so on. Electrical energy is used in industries to power heavy machinery and smaller appliances (electrical to mechanical conversion). The electrical sector is a subset of the energy sector and access to electricity serves as the basic form of energy supply to the masses that play a vital role in the growth of a nation's economy. Odell,(1965) in his study on the role of electricity in a rapidly developing economy, he observed that electricity is very important for industrialization which leads to economic growth and development.

This paper aims at ascertaining the impact of electricity consumption in industrial growth.

Literature Review

Electric energy is an important factor of production and crucial for industrialization and economic growth. The quest for rapid and firmly economic growth is a function among other variables, an adequate supply and distribution of energy particularly electricity.

Classical economists did not recognize energy as a factor of production in the production process neither did the Neoclassical, today, economists like Alam (2006) in his work on economic growth with energy was of the opinion that not only does energy serve as a factor of production; it also acts as a booster to the growth of a nation.

Okonkwo (1998), submitted that regular supply of all forms of energy in an economy is regarded as essential "oil" for propelling the wheels of economic activities, aimed at increasing growth of aggregate output.

Energy, apart from serving as a pillar of wealth creation in developing economies, it serves as an engine of growth for all sectors of the economy; electricity development and utilization therefore has pervasive impact on industrial development.

Asatu-Adjaye (2000), in his research on Singapore and Indonesia industrial development, found out the causality of energy consumption and economic growth. According to him, energy efficiency is an indispensable component of industrial productivity.

Alam (2006) agreed that there is a departure from neo-classical economics which recognizes only capital, labour and technology as to a factor of production to include energy, according to him; energy drives the work that converts raw materials into finished products in the manufacturing process.

Sanchins (2007) argued that electricity as industries is responsible for a great deal of output and it had effects not only on factors of production but also on the impacts of capital accumulation. She added that increase in the electricity will avoid the privatization of the industrial production.

Iwayemi (1988) argued for the importance of energy sector in the socio-economic development of Nigeria, submitting that strong demand and increased supply would stimulate the increased income and high living standard.

According to Archibong (1977), the positive side of the Structural Adjustment Programme (SAP) could not be fully established due basically to poor infrastructures especially electricity consumption. This undermined the effectiveness of fiscal and other incentives designed to stimulate the growth and diversification of the economy. In support of Arhibong, Okafor (2008), argued that poor and inefficient electricity consumption has had adverse implication for industrial development in Nigeria.

Also, Oke (2006) attributed the non-competitiveness of Nigeria's export goods to infrastructure, especially electricity supply, which drives the running cost of firms. In his contribution, Lee and Anas (2007), industrial establishments in Nigeria spend an average of 32% of their variable costs on infrastructure with electric power accounting for more than half of this share.

In 2005, Adenikinju examined the cost of electricity shortages on the Nigerian manufacturing sector using the data obtained from a nationwide survey. The study confirms that the cost of electricity failures to the Nigerian manufacturing sector is quite high. Nigerian firms were found to incur costs on the provision and maintenance of expensive back-up to minimize the expected outage costs. This includes high cost diesel and gas with the average costs as huge as three times the cost of publicity supplied electricity. The marginal cost estimates also indicates that the cost of Kwh of unserved electricity is very high. A lot of multinational corporations have closed their firms and relocated to the nearby countries that enjoy uninterrupted electricity supply.

Methodology

The study made use of secondary data obtained from the various publications of the Central Bank of Nigeria (CBN) and the National Bureau of Statistics (NBS). The data covered 1980-2012 and the econometric approach is based on time series data regression.

The model specification used in this research followed the model of Romer (1986), which was established due to the weakness of the Solow growth model. The production function under the Solow growth model implies that $Y = f(K, L)$, where technology is exogenously determined. The Romer model is different as technology which is seen as energy, is an endogenous variable.

Romer takes investment in research technology as endogenous factor in terms of the acquisition of new knowledge by rational profit maximization firms. His aggregate production function of the endogenous theory is as follows:

$$Y = f(A, K, L)$$

Where:

Y= aggregate real output.

K= stock of capital

L= stock of labour

A= Technology (or technology advancement)

Adopting this model, Y or the aggregate real output is used as a proxy for Industrial output growth is expressed as a function of capital, labour employed, energy disaggregated into electricity generation and consumption.

Therefore, the model is modified to take the form: ……..

$IDG_t = f(K_t, LE_t, EC_t, EG_t, FER)$…….. (1)

For the purpose of estimation, equation (1) can be expressed as:

$$IDG_t = \beta_0 + \beta_1 KI_t + \beta_2 LE_t + \beta_3 EC_t + \beta_4 EG_t + \beta_5 FER + \mu_t \text{ ……. (2)}$$

Where:

$IDG_t =$ Industrial output growth at time t.

KI_t =Capital input at time t – Proxy by gross capital formation

LE_t = Labour employed at time t

$EC_t =$ Electricity consumption at time t.

$EG_t =$ Electricity generated at time t.

FER= Foreign Exchange Rate

$U_t =$ Stochastic error term at time t.

$\beta_0 =$ Intercept term.

$\beta_0 - \beta_4 =$ Co-efficient.

As stated in the model above, the variables used in the analysis of the effect of electricity consumption on industrial growth are explained: Capital input refers to the amount used in financing production process. It is a good measure of industrial growth, as there is positive relationship amongst due to the fact that an increase in capital input will lead to an increase in the level of industry production, leading to industrial growth. Labour employed is another measure for industrial growth, an increase in labour employed will lead to increase in production level which leads to industrial growth. Electricity generation is the total electricity generation. It is measured in megawatt per hour by converting million kilowatts per hour. Electricity Consumption refers to aggregate electricity consumption. It is measured in mega watt per hour by converting million kilowatts per hour.

Foreign Exchange Rate: This explained the cost of importation of raw materials used in the production exercise as well as the cost of production respectively.

A prior expectation

The study examines the effect of electricity consumption on industrial growth. It is important to note the expected signs of the parameters. The Apriori expectation for the parameters in use includes:

$$\frac{\delta DG}{\delta KIT} > 0, \frac{\delta DG}{\delta LET} > 0, \frac{\delta DG}{\delta ECT} > 0 \; and \; \frac{\delta DG}{\delta FER} > 0$$

They are all expected to have positive relationship.

Technique of Analysis

Data analysis is the way by which raw data's are made meaningful, understandable and interpreted. The purpose of analysis is to reduce data to an interpretable form so that the relationship of the research problems can be studied and tested.

The method of data analysis adopted for this study includes : multiple regression i.e. Unit Root Stest, which is to test the level of stationarity and hence the order of integration, co-integration analysis and vector error correction.

Co-integration was used to capture long-run analysis. Also, the study used Granger causality test for the direction of causality test to test for the direction of causality among the variables. Co-integration technique used was the Johansen Trace and Maximal Eigen value test.

Empirical results

The objective of this study is to examine the effect of electricity consumption on industrial growth in Nigeria. The variables used to estimate our model are the annual data from 1980-2012 on industrial output growth, capital inputs (proxy by gross capital formation), labour employed, electricity consumption, electricity generation and foreign exchange rate.

The stationarity was carried out to test and establish the long run relationship of each variable. Augmented Dickey Fuller Unit root test was used to test for the stationarity of each variable. The result of the co-integration test is reported next. The Johansen co integration test was used and followed by the error correction model.

Unit Root Test

The Augmented Dickey Fuller Unit Root Test was conducted for the variables in the model, the result of the test as they were found to be stationary are presented in the Table I:

Table 1: Unit Root Test

VARIABLES	ADF STATISTIC VALUE	CRITICAL VALUE	ORDER OF INTEGRATION
IDG	-4.999452	-3.661661(***)	I(1)
KI	-4.151496	-3.699871(***)	I(1)
LE	-63.68634	-3.661661(***)	I(1)
EG	-6.776124	-3.661661(***)	I(1)
EC	-6.681144	-3.661661(***)	I(1)
FER	-5.320973	-3.661661(***)	I(1)

Source: Author's Computation

Note: (***) Denotes Rejection of hypothesis at 1% level of significance

The result of the Unit root test above showed that all the variables are integrated of order one. This is because their Augmented Dickey Fuller statistics values are greater than the critical values at 1% level of significance. This fulfils the condition for Co-integration test to be carried out to detect the long run relationship between the variables.

Co-integration Test

The Result of the Johansen Co integration Procedure between the variables is presented in the table below:

Table 2: Johansen Co-Integration Rank Test Result

RANK	TRACE STATISTIC	5% CRITICAL VALUE
0	118.9130(**)	95.75366
1	84.83172(**)	69.81889
2	54.08623(**)	47.85613
3	26.96199	29.79707
4	11.51548	15.49471
5	1.454627	3.841466

Source: Author's Computation

Note :(**) denotes rejection of hypothesis at 5% level of significance

The result of the co integration rank test presented in the table above indicates three co-integration equations. This is because their trace statistic values are greater than the critical values at 5% level of significance. The results therefore confirm the existence of Co-integration among the variables. Thus we can conclude that there exists a long run relationship between electricity consumption and industrial growth in Nigeria.

Vector Error Correction Model

To estimate the effect of electricity Consumption on industrial growth in Nigeria on the long run, the result is given below:

Table 3: Vector Error Correction Model

S/N	COEFFICIENT	STANDARD ERROR	T-STATISTICS
C	-13527.58	(6333.57)	[-2.13585]
D(IDG(-1))	0.604965	(0.24573)	[2.46194]
D(KI(-1))	-0.001389	(0.00040)	[-3.49804]
D(LE(-1))	0.004285	(0.00395)	[1.08495]
D(EG(-1))	827.7271	(1373.47)	[0.60266]
D(EC(-1))	2528.745	(1485.61)	[1.70216]
D(FER(-1))	85.18232	(63.3554)	[1.34452]
ECT	-0.727759	(0.27748)	[-2.62271]

Source: Authors Computation

Long Run Relationship

IDG = -13527.58-0.001389 (KI(-1))+0.004285 (LE(-1))+827.7271 (EG(-1))+2528.745 (EC(-1))+85.18232 (FER(-1))
(6333.57) (0.00040) (0.004285) (1373.47) (1485.61) (63.3554)

R^2 = 0.77 ADJ R^2= 0.57

The above equation indicates the long-run relationship among the independent and dependent variables. The result from this analysis shows that there is a long-run relationship between the industrial growth and other variables. There is a positive relationship between the industrial growth and labour employment (LE), electricity consumption (EC), electricity generation (EG) and Foreign Exchange Rate (FER) while there is negative long-run relationship between industrial growth and capital input - KI(proxied by capital formation). A unit increase of IDG will lead to 0.4 increase in LE, 1373 in EG, 1485.6 in EC and 63.3 in FER and 0.04 decrease in KI. The positive relative in LE, EG, EC and FER are in line with the apriori expectation while KI showed a negative relationship with IDG in the long-run and this is not in line with the apriori.

The R^2 is equal to 0.77 which implies that 77% of the adjustment in the dependent variable is determined by the independent variables in the model while 23% is unexplained. It shows that 77% of the variation in industrial growth is brought about by the independent variables.

Conclusion and Recommendation

The result of the study reveals that there was co-integration relationship between electricity consumption and industrial growth in Nigeria. The study established the 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.

Recommendation

Since it has been established through the study that electricity consumption play a positive role in industrial growth in Nigeria, therefore government should undertake cogent approach towards refining the electricity supply in such a way that it will lead to increased industrial production and economic growth respectively.

Government privatization policy of the electricity sub-sector should be highly monitored to provide enough electricity generation and consumption to encourage mass employment of a skilled and unskilled labour in the economy.

Government and the host communities of electricity companies should cooperate with these electricity providers against vandals of electric equipment and the disruption of electricity supply to the industrial set-ups.

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