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DISAGGREGATE ENERGY SUPPLY AND INDUSTRIAL OUTPUT IN NIGERIA

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Abstract

This paper investigates disaggregate energy supply and industrial output growth in Nigeria using time series data from 1981-2014. Nigeria persistent energy crisis has weakened the industrialisation process despite the country is endowed with various energy resources, gap between the demand and supply of energy still remained a critical challenge. Data were sourced from the Central Bank of Nigeria, Statistical Bulletin and the National Bureau of Statistics. The study employed Ordinary Least Square method, Granger Causality and Johansen Co-integration test to carry out the empirical analysis. The findings show that electricity generated and premium motor spirit have a positive impact on industrial output growth in Nigeria but with high cost of production. Government capital expenditure signed positive, while gas consumption and automated gas oil (diesel) have negative signs from the result. This result implies that the availability of Liquefied Natural Gas in Nigeria has not contributed significantly to the industrial performance while the negative sign of automated gas oil signifies increase in it price which had increase cost of production and consequently reduce the industrial output. The unidirectional causality of Granger Causality test runs from gas consumption, electricity generated to industrial output growth. In view of the findings, it has been observed that, irregular electricity supply has been a major bane to output growth in the manufacturing sector; therefore, it is recommended that the power sector by means of guided private sector initiative should be given more attention for the growth of the nation's economy.

Keywords: Industrial output, Electricity generated, Petroleum consumption, Diesel consumption, Gas consumption.

1.0 Introduction

Energy supply and demand for industrial development have remained critical components of Nigeria's major problem in recent time. Iwayemi (2008) argued that Nigerian energy industry is probably one of the most inefficient in meeting the needs of its customers. This is most evident in the persistent disequilibrium in the markets for electricity and petroleum products, especially kerosene and diesel. The dismal energy service provision has adversely affected living standards of the population and exacerbated income and energy poverty in an economy where the majority of the people live on less than $2 per day. Nigeria's persistent energy crisis has weakened the industrialization process, and significantly undermined the effort to achieve sustained economic growth, increased competitiveness of domestic industries, regional and global markets and employment generation. Nigeria's chronic energy infrastructural gaps which have existed since the large scale inflow of oil income in the mid 1970s has worsened in recent times despite huge amounts of public expenditure invested by government, however, the protracted nature of the energy crises still persists. The billion dollars of pubic investment into capacity expansion in the energy industry contrast sharply with the extremely poor supply outcomes measured by refinery output, rise in imported fuels and frequent power outages and voltage variation.

According to the Nigerian Energy Policy report from 2003, it is estimated that the population connected to the grid system is short of power supply over 60% of the time and less than 40% of the population is even connected to the grid (Okoye, 2007). Also, the Council for Renewable Energy of Nigeria reveals that power outages brought about a loss of 126 billion naira (US$ 984.38 million) annually. Apart from the huge income loss, it has also resulted in health hazards due to the exposure to carbon emissions caused by constant use of ‘backyard generators’ in different households and business enterprises, unemployment and high cost of living leading to a deterioration of living conditions. Nigeria is seen as one of the greatest developing nations in Africa with highly endowed natural resources including potential energy resources. In spite of this, increasing access to energy in Nigeria has proved not only to be a continuous challenge but also a pressing issue with the international community. Hardly, can any enterprise or aspect of human development function productively in any developing economy like Nigeria without electricity or other forms of energy supply. To this end, Energy crisis which has engulfed Nigeria for almost two decades has been enormous and has largely contributed to the incidence of poverty by paralyzing industrial and commercial activities during this period (Oyedepo, 2012).

Nigeria is richly endowed with diverse energy sources; crude oil, natural gas, coal, hydropower, solar energy, fissionable materials for nuclear energy, yet the country consistently suffers from energy shortages, a major impediment to industrial and technological growth. Such indicators as blackouts and persistence reliance on self-generating plants, is a painter to low productivity and underutilization of resources (Udah, 2010). Indeed, as noted by Ekpo (2009), Nigeria is running a generator economy with its adverse effects on cost of production. For over two decades Nigeria has experienced structural challenges in the area of electricity generation, transmission and distribution. The extent of this is underlined by the fact that Nigeria is the largest purchaser of standby electricity generating plants in the world (Braimoh & Okedeyi 2010). Between 1981 and 1985, during the Fourth National Development Plan the oil boom increased power demand growth rate by over 10 Percent. The rapid growth rate makes it difficult for the installed capacity to cope with the requirement of both residential and industrial consumers.

Orazulike (2012) opines that owing to the failure of the Power Holding Company of Nigeria (PHCN) and its predecessor, the National Electric Power Authority (NEPA) to meet up with the power demands of both individuals and businesses, they have naturally resorted to self-help through the use of Automated Gas Oil (AGO) known as diesel to power their heavy equipments and plants to generate the much needed electricity. Diesel is therefore in high demand in such sectors as banking, manufacturing, construction, shipping, transportation, tourism etc. Unfortunately, as important as diesel is to economic development, availability and affordability has remained an issue in Nigeria. Likewise, Premium Motor Spirit (PMS), commonly known as petroleum, which is the most controversial of all energy available in the country is faced with inadequate domestic supply and incessant increase in price problems. On Liquefied Natural Gas (LNG) also known as cooking gas, Orazulike(2012) argues that, it has gone beyond the reach of most Nigerians and remains the exclusive preserve of the rich few (the elite), the situation being caused primarily by lack of infrastructure which inhibits the broad distribution of LNG within the Nigerian economy. On Electricity, he describes the Nigerian electricity problem as legendary, which had incapacitated most manufacturing firms in Nigeria.

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. Despite all said and done, there is simply not enough electricity generated to support the entire population and industrialisation in Nigeria. Hence, this study is timing to seek intervention for direction and solutions to the energy sector’s crisis.

This study has attracted considerable interest in development economics in recent times as a result of critical role which Energy plays in industrial sector. Yang (2000) argued that the use of aggregate energy data does not capture the degree or extent to which countries depend on various energy resources. Also, the use of aggregate energy data may not be able to identify the impact of a specific energy type on industrial output. The use of disaggregate data allows for comparisons of the strengths of causal relationships by energy source (Sari et al., 2008). To this end, this study investigates the effects of disaggregated energy supply on industrial output in Nigeria. While the specific objectives are: (i) to examine the main sources of energy in Nigeria and how they contribute to industrial growth. (ii) to establish causal relationship between energy supply and industrial output. The rest of the study is organized as follows: section two contains review of Literature followed by methodology in section three. Section four contains results and discussions accompanied by conclusion and recommendations in the last section.

2.0 Literature Review

Adenikinja (2003) discovered that the cost of electricity failures on the Nigerian manufacturing sector was quite high. Firms incurred huge costs on the provision of expensive back-up to minimize the expected outage costs. The average costs of this back-up were on the average of 3 times the cost of public supplied electricity. This had negative impact on costs competitiveness of the manufacturing sector. The study supported the efforts to privatize and liberalize the electricity sector. This, he hoped would mitigate the burden of poor power supply as well as introduce the needed competition into the electricity market in the country.

In the same vein, Afzal.Yaseen (2012) mentioned fast urbanization and industrialization the major reasons behind the escalating demand of electricity. The shortage of electricity and high interest rate raised the cost of production of textile industry. This shortage decreased the

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production of the textile industry because the factories operate less time due to load-shedding. Less production led to high fixed cost per unit. These worsened situations badly affected the competitiveness of textile industry in international market in Pakistan and ruined the profitability of this sector by increasing the cost of production and expenses. According to Siddique *et al*, (2012), the major causes to increase in the cost of production include instant rise in electricity tariff, shift to alternative source of energy like generators, load-shedding, rising fuel prices, and unavailability of adequate energy resources.

Contrary to others view, Al-Ghandoor *et al* (2008) found that industrial production outputs and capacity utilization were the two most important variables that affected demand for electricity in the industrial sector of Jordan. The study predicted that electricity consumption and associated GHG emission for industrial sector will be 63 percent in the year 2019. While, Wang *et al* (2010) showed that activity effect and shift effect which were caused by the change in the electricity's share of industrial energy use. These are the major factors responsible for the rise in China's industrial electricity consumption between 1998 and 2007. In addition, it was found that street change contributed to the increase in electricity consumption. In contrast, technological effect was responsible for a decrease in electricity consumption during the study period. Furthermore, the results showed that the main contributors to increased electricity consumption among industrial subsectors were manufacturing of raw chemical materials and products, non-metal mineral products, smelting of ferrous and non-ferrous metals, and production and supply of electric power and heat power.

In the investigation of Meyers and Sathaye (1998) on changes in electricity consumption of the largest developing countries between 1970 and 1986. The results showed that average annual growth in electricity consumption ranged from 4.4 percent in Argentina to 13 percent in South Korea. Combined electricity consumption for the 13 countries under study had an average growth of 10 percent per annum in the 1970s and 7.1 percent in the 1980 – 1986 periods. The industrial sector continued to dominate electricity consumption but its share of total consumption declined in the face of faster growth in the residential and commercial sectors. Industrial sector consumption rose significantly in Latin America during the 1970 – 1986 periods, but did not increase greatly in most of the Asian countries. Increases in residential electricity use per capita and the number of homes that have electricity had been most rapid in Asia. However, most Latin American countries still had higher use per capita than most Asian countries. (Ibid)

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

Furthermore, Chebbi and Boujelbene (2008) observed that the various sectors (agriculture, manufacturing and service) and overall gross domestic product are co- integrated with energy consumption. This implies that there exists a long run relationship between the various output and energy consumption. The VECM estimate observed that there exists unidirectional causality, running from the different sectors to energy consumption, as well as from overall GDP growth to energy consumption. The study concluded that causality estimate signified a less energy dependent economy and suggested that it is sectoral growth that drives the energy consumption in Tunisia and not vice versa.

Also, quite a number of studies have been carried out on the impact of electricity generation on manufacturing and industrial growth. For instance, Ukpong (1993) applied production function approach to investigate the impact of erratic power supply on selected firms in commercial and industrial sectors in Nigeria from 1965-1966. His finding shows that about 130 KW/H and 172KW/H were not supplied to the firms in the two periods. The estimated cost of this is N1.68 million in 1965 and N2.75 in 1966. By implication, he noted that erratic power supply has adverse impact on productivity growth of manufacturing sector in Nigeria. In contrary, Meadows, Riley, Rao, and Harris (2003) and Tarun, Uddin, and Ambarish (2013) studies, confirmed electrification to have a positive significant impact on the growth of SMEs as well improves the performance of new commercial establishments (as cited in Maleko, 2005). Also, earlier studies on energy supply shocks have focused primarily on the electricity sector (Lee and Anas 1991, 1992; Uchendu 1994, World Bank 1993, and Adenikinju 2000). These studies used primary data sources and revealed preference approach to examined the cost of electricity failure on the economy, while publicly supplied electricity has been a major militant factor against private sector growth in Nigeria, the private response to the electricity failure has also been hampered by fuel scarcity

Issues on energy consumption and economic growth nexus have figured prominently in the energy literature since the seminal study by Kraft and Kraft (1978). Subsequently, studies in both developed and developing countries have been conducted on aggregate energy consumption-economic growth nexus but their findings have been inconsistent. While some reported unidirectional causations: from aggregate energy consumption to economic growth (Akinlo, 2009; Narayan and Singh, 2007; Altinay and Karagoal, 2005); or from economic growth to aggregate energy consumption (Binh, 2011; Yoo and Kim, 2006; Kraft and Kraft, 1978), others have observed bidirectional causality between the variables (Kaplan et al, 2011; Chen et al, 2007). Yet, a few have equally reported the absence of causality between the variables (Ghaderi et al, 2006; Zou and Chau, 2006). Beyond focusing on the nexus between aggregate energy consumption and economic growth, studies have also examined the nexus between disaggregate energy consumption and economic growth (see Ogunleye and Ayeni, 2012; Aliero and Ibrahim, 2012; Omisakin, 2008). Apart from the above, a few studies (such as Liew et al, 2012; Chebbi and Boujelbere, 2008) have examined the nexus between aggregate energy consumption and sectoral output. Liew et al (2012) noted that there exist different directions of causality between aggregate energy consumption and the output of different sectors. According to Liew et al (2012), the worth of this research is that energy-dependent sectors of the economy can be recognized for appropriate energy policy implementation and to avoid energy conservation policies that may retard the growth of these sectors.

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However, with respect to the Nigerian economy, there exists a paucity of knowledge on the nexus between disaggregate energy supply and industrial output performances. This issue has been utterly neglected by previous endogenous studies which have mainly focused on aggregate energy consumption-economic growth nexus (see Aliero and Ibrahim, 2012; Omisakin, 2008) and on disaggregate energy consumption-economic growth nexus (see Ogunleye and Ayeni, 2012; Akinlo, 2009). This neglect has strong policy implications for the Nigerian economy. For instance, the Nigerian economy has witnessed a sustained growth of about 6.5 percent since 2001, which in no doubt is a consequence of growth in some sectors of the economy. The increase in sustained growth over this period may also imply increased energy consumption in these sectors.

Hence, none of the cited works studied in Nigeria have analyzed the impact of the disaggregate forms of energy on output; previous work examined either aggregate energy or a single energy source in isolation. Therefore, this study use disaggregate forms of energy supply following Yang (2000), who argued that the use of aggregate energy data does not capture the degree or extent to which countries depend on various energy resources. Furthermore, the use of aggregate energy data may not be able to identify the impact of a specific energy type on industrial output. The use of disaggregate data allows for comparisons of the strengths of causal relationships by energy source (Sari et al., 2008).

3.0 Methodology

3.1 Research Design and Strategy

Research design is the structure and strategy for examining the relationship between the variables of the study. The research design adopted for this study is the experimental research design. The main reason is that experimental research design combines the theoretical consideration with empirical observation. It enables us therefore to examine the effects of independent variables on the response variable.

3.2 Identification of Variables

The need for variable identification is important so as to know what method would be put in place to source for such variable. Index of manufacturing production in percentage proxy for Industrial output (IND), this is utilised in this model to capture the volume of production, as well as the direction of manufacturing sector. The indicator measures the amount of output from the manufacturing industries annually. Oil price (OILP) measured price fluctuations resulting from changes in either the demand or supply side of the international oil market which arises as a result Organization of Petroleum Exporting Countries (OPEC) supply quotas, political upheavals and militant group’s activities in the Niger Delta region of Nigeria. Electricity generation in megawatts per hours in MW/H (EGI), Electricity generated and supplied is the aggregate amount of power generated and supply by the Power Hold Company of Nigeria (PHCN) to the industrial sector in megawatts per hours (MW/H). In the Nigeria context, electricity generated is also used to capture supply to the end users. Government Capital Expenditure (GCE) is used to capture expenditure made on infrastructural development by the government to enhance the growth of the manufacturing and other sectors in the economy. Labour wage rate (WR) included in the model represents the welfare of the labour force. When welfare of workers is appropriately taken care of it increases their productivity level.

3.3 Types and Source of Data Collection

The data to be used for the study are entirely time series secondary data. The time series covered the periods between 1981-2014. The 1981 was chosen as a based year because between 1981 and 1985, during the Fourth National Development Plan the oil boom increased power demand growth rate by over 10 Percent. The rapid growth rate makes it difficult for the installed capacity to cope with the requirement of both residential and industrial consumers. While 2014 as a current year; this is used to provide better in-depth understanding on disaggregated energy supply up till date. The data were sourced from the Central Bank of Nigeria (CBN), Statistical Bulletin and the National Bureau of Statistics.

3.4 Method of Data Analysis

This study employed ordinary least square and Granger Causality approach to examine relationship between disaggregated energy supply and industrial output in Nigeria. The selected variables in correlation to the industrial output are used to investigate the proportion of energy supply on industrial productivity in Nigeria for the period of 1981-2014. This will enable us to induce flexibility and the nature of directional relationship that exists between the variables. Finally, the econometric techniques (ordinary least square and Granger Causality test) were employed for in depth understanding of the relationship and also to provide empirical evidence for further research.

3.5 Model Specification

The model specification adopted in this paper 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).. (i)

Where: technology is exogenously determined.

However, 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) ....(ii)

Where: Y= aggregate real output.

K= stock of capital

L= stock of labour

A= Technology (or technology advancement)

In Nigeria context, 4 main energy types are considered and they include petroleum, diesel, gas and electricity. Therefore, A is restated as follows:

A = PMS, AGO, GAS, ELECT ....(iii)

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Where; A represents the state of technology as defined by the total factor productivity indicator. It also stands for different energy inputs in production process; Petroleum consumption, Diesel Consumption, Gas consumption and Electricity supplied.

This study modified the Romar model by adding disaggregate energy forms in substitution of A and re-specified equation (ii) as follows:

INDt = Ct, PMSt, AGOt, GASt, ELECTt, GCEt, WRt………………………………...... (iv)

Where:

C_t = constant

INDt = Industrial output at t time

PMSt = Premium Motor Spirit (Petroleum Consumption) at t time

AGOt = Automated Gas Oil (Diesel Consumption) at t time

GASt = Gas consumption at t time

ELECTt = Electricity Supplied at t time

GCEt = Government capital expenditure at t time

WRt = Wage rate of labour at t time

To estimate equation (iv) we take the natural logs of both sides and add the error term (μ_t) which result in the following equation (iii):

$InIND_t = C_t + \alpha InPMS_t + \beta InAGO_t + \phi lnGAS_t + \delta InELECT_t + \psi InGCE_t + \delta InWR_t + \mu_t \ldots$ (v)

Where α, β, ϕ, ʒ, ψ and δ are constant elasticity coefficients of output with respect to the PMSt, AGOt, GASt, ELECTt, GCEt, WRt. Also μ_t is a constant parameter and represent the white noise error term.

The *apriori* expectations are:

$\frac{\delta OILP}{\delta IND} \gtrless 0$; $\frac{\delta EGI}{\delta IND} > 0$; $\frac{\delta GAS}{\delta IND} > 0$; $\frac{\delta GCE}{\delta IND} > 0$; $\frac{\delta WR}{\delta IND} > 0$

3.6 The Theoretical Proposition of the Model

In line with economic theory, an increase in economic growth causes an increase in energy consumption. Energy demand motivate economic growth through increase in the aggregate productivity of various sectors that uses energy in the economy and this have a multiplier effect on the aggregate output of the economy which later result to proportional changes in the productive capacity of the economy. The relationship between oil price and industrial output can either be positive or negative. The oil legacy has imposed significant costs to the national economy in Nigeria through petroleum and energy price distortions. Oil price volatility put upward pressure on energy consumption and the continuous upwards movement in oil prices lead to an increase in cost of production in manufacturing sector which caused rise in the price level of industrial products and consequently reduce the industrial output.

We expect a direct significant relationship between electricity supply and industrial growth. Adequate electricity supply and distribution constitute a central core to industrial development which cannot be over emphasized. In accordance with this, Industrialization has been a key determinant that fosters high growth indices in emerging economies of the world including China, Indonesia and Taiwan (Nazima, 2011). These economies have achieved high growth rates due to high industrial development, which further caused declining poverty trends and high growth statistics (knivilla, 2005). Development of industrial sectors brings substantial changes in the real sector of the economy and also leads to rise in the national income of the country which in the long-run brings about creation of employment.

Natural gas being a clean, efficient source of energy, we expect a direct relationship between gas consumption and industrial output. Nigeria has enormous resources of natural gas, but gas development has not been a priority until recently. Industry in United States accounts for a great deal of natural gas consumption. Industrial usage of gas allows the users to regulate more closely the amount of moisture in the air, leading to a more consistent and high quality product. Moreso, it is expected that government capital expenditure will have a positive relationship with industrial output, Government capital expenditure captured expenditure made on infrastructural development by the government to enhance the growth of the manufacturing and other sectors in the economy. With adequate provision for capital expenditure in energy sector, this will spring up Small-scale enterprise is central and critical in every human society. It is through entrepreneurship that societies can attain any level of development. Small scale and medium industries is said to be the secret behind rapid development of countries like Japan, China and Malaysia etc. low entrepreneurship is also said to be the major causes of under development of most countries in Africa, Asia, Latin America and the rest. Finally, we expect positive significant between industrial output and labour wage rate. It is assumed that, when welfare of *workers* is appropriately taken care of it increase their productivity level.

4.0 Data Analysis, Results and Discussions

This section presents and analyses the results of the time series data test. The data used in the study is to determine the effects of disaggregated energy supply on industrial output in Nigeria for the period of 33years (i.e 1981-2014). The paper test for stationarity of the variables, co-integration test, ordinary least square regression analysis and pairwise granger causality tests to examine a one to one causal nexus between energy consumption and industrial output in Nigeria.

Table 4.1: Test for Stationarity

To determine the order of integration of the variables, the Augmented Dickey-Fuller test is used to test for stationarity of the time series and the results is as follow:

Variables	Test Statistics	Critical Values 1%	Critical Values 5%	Critical Values 10%	Level S/NS
IND	-3.691903	-3.670170	-2.963972	-2.621007	1(0)S
PMS	-9.214475	-3.711457	-2.981038	-2.629906	1(2)S
AGO	-6.197023	-3.653730	-2.957110	-2.617434	1(1)S
GAS	-7.351406	-3.653730	-2.957110	-2.617434	1(1)S
ELECT	-4.899265	-3.653730	-2.957110	-2.617434	1(1)S
GCE	-7.982532	-3.699871	-2.976263	-2.627420	1(0)S

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WR	-5.459850	-3.653730	-2.957110	-2.617434	1(1)S

Source: Reseacher's Computation

The reports from Table 4.1 above reveal that test statistics values are greater than the critical values at all level of significance for the entire variables. Industrial output and government capital were significant at fist level while automated gas oil, gas consumed, electricity generated and wage rate were significant at first differenced level, however, only premium motor spirit is significant at second differenced level. The implication of this is that six of the variables are integrated together in the same order, as this is the first sign of a long-run relationship among the variables in absolute term.

Table 4.2 Co-integration Test Result

To test that the regression residuals are co integrated, that is to test whether long run relationship exist between the dependent and independent variables in the model, Johansen(1988) and Juselius (1990) is adopted in this study. This is done by comparing the Trace statistic with the critical value, if the former is greater than the later then we conclude that there is a long run equilibrium relationship otherwise the regression is not co-integrated.

Hypothesized No. of CE(s)	Trace Statistics	0.05 Critical Value	Prob.**
None*	584.4416	125.6154	0.0001
At most 1*	201.0723	95.75366	0.0000
At most 2*	105.1878	69.81889	0.0000
At most 3*	62.46844	47.85613	0.0012
At most 4*	34.74350	29.79707	0.0124
At most 5	14.69727	15.49471	0.0657
At most 6	1.734238	3.841466	0.1879

Source: Reseacher's Computation

The table 4.2 represents the co-integration test as it shown that there are four co-integrated equations in the model at 5% critical values. Based on the fact that the trace statistics is greater than the critical value at 5%, this confirm the unit root test in order of integration that industrial output, premium motor spirit, automated gas oil, gas consumption, electricity generated, government capital expenditure and wage rate co-integrated in the long-run at the same speed. Therefore, there is a long-run equilibrium relationship among the variables.

Table 4.3: Empirical Result of OLS Method

Dependent Variable: IND
Method: Least Squares
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Sample (adjusted): 1983 2014
Included observations: 28 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	4957.187	1155.990	4.288259	0.0004
PMS	34.22602	23.21188	1.474504	0.1567
PMS(-1)	85.15445	17.59013	4.841036	0.0001
AGO	-64.02002	25.68184	-2.492813	0.0221
GAS	-0.038305	0.043699	-0.876578	0.3917
ELECT	10.17434	1.388024	7.330090	0.0000
GCE	0.001306	0.000313	4.166793	0.0005
WR	-53.99388	37.94007	-1.423136	0.1709
ECM(-1)	-0.463232	0.219633	-2.109124	0.0484

R-squared	0.977509	Mean dependent var	16530.60
Adjusted R-squared	0.968040	S.D. dependent var	5475.514
S.E. of regression	978.8837	Akaike info criterion	16.86579
Sum squared resid	18206053	Schwarz criterion	17.29400
Log likelihood	-227.1211	Hannan-Quinn criter.	16.99670
F-statistic	103.2244	Durbin-Watson stat	2.012674
Prob(F-statistic)	0.000000		

Source: Reseacher’s computation, 2015.

The result from Table 4.3 showed the regression result for the variables selected from disaggregated energy supply and industrial performance in Nigeria. The result reveals that a positive relationship between coefficient of Premium Motor Spirit (Petroleum Consumption) and industrial output in Nigeria. The finding shows that a unit percent increase in Premium Motor Spirit will bring about 851% rise in manufacturing output. This result is in line with our theoretical proposition and statistically significant.

However, Automated Gas Oil popularly known as diesel has a negative relationship with the industrial output in Nigeria. This finding corroborate the study of Adenikinja (2003) who discovered that firms incurred huge costs on the provision of expensive back-up to minimise the expected outage costs, which had a negative impact on costs competitiveness of the manufacturing sector. In addition, Orazulike (2012) discovered that failure of the Power Holding Company of Nigeria to meet up with the power demands; industries have naturally resorted to self help through the use of diesel to power their heavy equipments and plants to generate the much needed electricity. Unfortunately, availability and affordability has remained the issue in Nigeria which has increased the cost of production in Nigeria. This is also in tandem with Ekpo(2009) findings that, Nigeria is running a generator economy with its adverse effects on cost of production.

Also, Gas consumption coefficient signed negative from the result and not statistically significant. This result implies that the availability of Liquefied Natural Gas (LNG) in Nigeria has not contributed significantly to the industrial performance. According to Orazulike (2012) revealed that the situation is caused primarily by lack of infrastructure which inhibits the broad distribution of Liquefied Natural Gas within the Nigerian Economy. Meanwhile, the usage of Liquefied Natural Gas by industrial sector will minimise the high demand placed on diesel and petroleum usage which could serve as an alternative energy source for industrial sector if properly harnessed.

Electricity generated shows a positive sign on industrial output in the estimated model. The findings showed that a unit percent rise in electricity generated/ supply will bring about 101 percent improvements in industrial productivity in Nigeria. This is contrary to the findings of Olayemi, (2012), Lee and Anas (1992) who observed an inverse nexus between electricity generation and index of manufacturing production. Hence, this result affirmed the study of Ogunjobi (2015) that established a long-run positive relationship between industrial growth and electricity consumption. The implications of this findings is that, an increase in electricity generated/supply will bring about rise in index of manufacturing production, on the contrary, erratic electricity supply will translate to decline of the latter. In Nigeria, the epileptic electricity supply explains the reasons why manufacturers opt for alternative power supply, this scenario upsurge the cost of production and doing business. Also, Aderibigbe (2010) opines that the situation is so appalling that, the nation has an aggregate installed generating capacity of 8,227 MW in 2009 and the maximum available generating capacity is estimated to be 5482MW, while the actual demand is projected to be above 30,000MW.

The nexus between government capital expenditure and index of manufacturing production meet up with the positive sign, which implies that, if more funds are being allocated for infrastructural development, this will enhance the growth of the manufacturing industries vice versa. The Nigeria experiences have shown that, budgetary allocations that have been channelled for various capital projects from each successive government (General Ibrahim Babangida since 1984 to President Goodluck Jonathan, 2014) have gone down the lane to other government official private projects and this has not contributed to the development of the power sector, as well as the growth of output of manufacturing sector in the society.

According to our theoretical proposition, labour wage rate is expected to have a positive relation with industrial output, but the reverse is the case in the model estimated. This can be attributed to the huge cost incurred to generate electricity while the welfare of workers has negatively affected the efficiency of production. Intuitively, it is clear that if two firms have the same factors of production and still produce different quantities of output, the difference could be due to the welfare of workers appropriately taken care of which might increase their productivity level.

The lagged error correction term ECM (-1) included in this model to capture the long run dynamics between the integrating series is correctly signed (negative) and statistically significant. The coefficient indicates adjustment of 46% from actual changes in the previous year. This adjustment implies that errors are corrected in less than two years.

Furthermore, the value of the adjusted R^2 is pegged at 0.968040 or 96.0%. The value of the R^2 implies that premium motor spirit, automated gas oil, gas consumption, electricity generated government capital expenditure and labour wage rate explained about 96.0%

systematic variation in the private domestic saving in Nigeria over the observed years while the remaining 4% variation is explained by other variables outside the model. The standard error test revealed that premium motor spirit, automated gas oil, electricity generated and government capital expenditure on infrastructural development statistically significant. When compared half of each coefficient with its standard error, it was found that the values of the standard errors were less than half of the values of the coefficients. The gas consumption and labour wage rate were not statistically significant in the estimated model.

The t-test statistics confirms the standard error test. Testing at 5% level, the variables fall within the acceptance region to confirm the alternative hypothesis that premium motor spirit, automated gas oil, electricity generated and government capital expenditure statistically significant. In other words they do contribute significantly to industrial output growth in Nigeria.

The F-statistics is used to test for stability in the regression parameter coefficient when sample size increases, as well as the overall significance of the estimated regression models. Thus, we compare the calculated (F*), with the critical value at 5% level. From the statistical table, The F-statistics is 2.512255, while estimated F* is 103.2244. Obviously, the estimated F* is greater than the F value obtained from the table (that is, 103.2244> 2.53). This implies that, there exist significant relationship among the identified independent variables and the dependent variables and that the regression coefficients are stable.

In conclusion, the Durbin-Watson statistics is used to test for the presence of serial or autocorrelation, which indicate the relationship between the successive values of the same variable from period to period. The value of Durbin Watson statistics is 2.012 for this model. This falls within the determinant region (i.e. 1.5 < d < 2.5) and implies that there is a negative first order serial autocorrelation among the explanatory variables in the model

Table 4.4: Pair-Wise Granger Causality Test

Null Hypothesis	**Lag**	**F-Statistic**	**Prob.**	**Granger Causality**
PMS does not Granger Cause IND	2	9.11463	0.0009	PMS ⟷ IND
IND does not Granger Cause PMS		4.23161	0.0252	Bi-directional Causality
AGO does not Granger Cause IND	2	0.53443	0.5921	No Causality
IND does not Granger Cause AGO		2.47768	0.1028	
GAS does not Granger Cause IND	2	4.27089	0.0245	GAS ⟶ IND

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IND does not Granger Cause GAS		0.77471	0.4708	Unidirectional Causality
ELECT does not Granger Cause IND	2	6.67792	0.0044	ELECT → IND
IND does not Granger Cause ELECT		1.39054	0.2662	Unidirectional Causality
GCE does not Granger Cause IND	2	19.9499	1.E-05	No Causality
IND does not Granger Cause GCE		0.39744	0.6768	
WR does not Granger Cause IND	2	0.28221	0.7563	Unidirectional Causality
IND does not Granger Cause WR		11.0628	0.0003	IND → WR
ELECT does not Granger Cause PMS	2	6.37791	0.0054	ELECT → PMS
PMS does not Granger Cause ELECT		0.09193	0.9124	Unidirectional Causality
GCE does not Granger Cause PMS	2	8.83692	0.0015	GCE → PMS
PMS does not Granger Cause GCE		0.19976	0.8204	Unidirectional Causality
ELECT does not Granger Cause AGO	2	3.70548	0.0378	ELECT → AGO
AGO does not Granger Cause ELECT		0.22228	0.8021	Unidirectional Causality
GCE does not Granger Cause AGO	2	5.74035	0.0099	GCE → AGO
AGO does not Granger Cause GCE		0.05527	0.9464	Unidirectional Causality

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GCE does not Granger Cause ELECT	2	0.13448	0.8749	No Causality
ELECT does not Granger Cause GCE		0.01348	0.9866	

Source: Researcher's Computation, 2015.

Finally, we also employed Pair-wise Granger Causality between the PMS, AGO, ELECT, GCE, WR and industrial output in the estimated model. The results showed that some of the variables exhibited uni-directional causality at lag length 2. This implied that unidirectional causality run from GAS-IND, ELECT-IND, IND-WR, ELECT-PMS, GCE-PMS, ELECT-AGO and GCE-AGO from Table 4.3 above. The result of the Granger causality tests conform with the work of Enang (2010), who found a unidirectional causality that runs from electricity generation to industrial production, without feedback effect. This is in line with Ajanaku (2007) statement, that unstable electricity supply and other key factors have hindered the performance of the industrial sector in Nigeria. Whereas, bi-directional relationship existed between PMS-IND, this result relatively conform with the work of Canning & Pedroni, (2004), who observed that resultant effect of electricity outrage, is sourcing for alternative power supply by manufacturers, this process increases the cost of production, making our goods more expensive in the domestic and international market, by implications discourage export in favour of import in Nigeria. Furthermore, the result reveals that government capital expenditure on infrastructural development has not caused improvements in power sector despite huge amount invested as result of corruption and mismanagement of resources. Hence, this has not contributed significantly to the industrial productivity performance in Nigeria.

5.0 Summary, Conclusion and Recommendation

This study examine disaggregated energy supply and industrial output in Nigeria using time series data from 1981-2014. The study employed Ordinary Least Square method (OLS), Augmented Dickey Fuller Test Equation, Granger Causality and Johansen Co-integration test to carry out the empirical analysis. One key finding is that, the pitiable state of the power sector in the country accounts for adverse and decline in productivity of the manufacturing sector. The unstable electricity supply bane has brought about the acquisition of expensive power backup in the forms of plants, generators, inverters, etc. However, the inefficiency to boost electricity supply causes the gap between the demand and supply of diesel and petroleum as the major alternative source for industrial sector to power their heavy equipment in Nigeria. The aftermath effect is on cost competitiveness in the manufacturing industries. Therefore, there is need for the government to invest on infrastructural development not only on facilities that will set the paste for the new power sector investors to functions, but also on other keys sectors, such as inter state and city railways, roads, etc. These in no small way will help trigger the growth of the manufacturing sector, as well as other subsectors. Also, this study suggests the establishment of a world class research and development centre, taking example from the developed nations (Canada, USA, Germany, Switzerland, etc) where new ideas, techniques and innovations for local manufacturers can spring forth.

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Moreso, if the country is to unleash the enormous potential of its renewable energy resources on its drive to match electricity demand and achieving the MDG's and Vision 2020, the constraints to rapid development and exploitation of renewable energy resources such as lack of appropriate policy, absence of regulatory and institutional framework to stimulate demand and attract investors must be review. Finally, the tariff charged by this investors (electricity supply companies) must be affordable by an average Nigerian, and the government must put in mind that the goals of an investor is profit making at the expense of peoples' welfare. Likewise, the government should encourage the manufacturing sector by giving tax holiday to indigenous infant industries and subsidising tariff plan (high electricity bills) for investors in the manufacturing sector to produce at a low cost.

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