Journal of Economics and Sustainable Development
ISSN 2222-1700 (Paper) ISSN 2222-2855 (Online)
Vol.4, No.14, 2013

National Electric Energy Supply and Industrial Productivity in Nigeria from 1970 to 2010

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Abstract

This study investigates the impact of electric energy supply on the industrial sector productivity in Nigeria from 1970 to 2010. The specific objectives were; to investigate the extent to which electricity supply impacts on industrial development in Nigeria and examine the existence of a long run relationship between electricity supply and industrial productivity in Nigeria. We obtained secondary data from the CBN Statistical Bulletin, using the multiple regression analysis. The result shows that national energy supply have no significant impact on industrial productivity in Nigeria, the ADF test results shows that all the variables are stationary at first difference and that the convergence of industrial output to equilibrium in Nigeria which is below zero (-.9450) equilibrium line points to the possibility of convergence of industrial output at the nearest future. We therefore recommend sustained sanitization and funding of the power sector and the encouragement of private partnership in the power sector, which we believe will enhance the growth of the economy.

Keywords: industrial output, energy consumption and supply, manufacturing output, price level, co-integration and economic growth.

1. Introduction

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. This sector has attracted special attention several decades ago as it has the potential for improvements in the balance of payment, production of exportable goods and import substitution. Technology is considered as a prime factor in this regard. Industrial development and technological development are interdependent and interrelated. While technological development a prerequisite for industrial development, the industrial sector is the major propelling force for technological development and innovation (Ernst et al, 1994).However in any developing economy like Nigeria, neither can each flourish unless there is adequate technological infrastructure put in place (SutCliffe, 1971, Hodder 1973, Offiong 2001).

Regular and affordable power supply is a catalyst for socio-political, economic development and its sustainability in any society. Hardly, can any enterprise or aspect of human development function productively without electricity or other forms of energy supply. 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. President Obasanjo led government focused on economic reform strategy with a view to ensuring overhaul of the power sector (Asubiojo, 2007). To this end the regime set up a committee to review the National Electric Power Policy, which recommendations were not implemented. On August 26, 2010 President Goodluck Jonathan launched the Roadmap for the Power Sector Reform to fast-track the implementation of the Electric Power Sector Reform (EPSR) Act. The President in his speech identifies the factors affecting reliable electricity service delivery to include the absence of a sustained and deliberately deployed long term power development strategy, under-exploitation of the nation's abundant energy endowments and the absence of adequate implementation of reforms. The low and unstable capacity utilization shows the large gap between installed and actual operational capacity. This gap indicates the level of technical inefficiency in the power sector which weakened the industrialization process, resulting to low productivity and high operational cost, significantly undermined the efforts of the Nigerian government in sustaining its economic performance. We all expect and still expecting government to do more on the state of electricity crisis as a primary factor that enhance industrialization in an economy. Moreso, of all the literature reviewed on energy supply and industrial productivity in Nigeria, the long-run relationship, existing between electricity supply and output growth in Nigeria has not been adequately addressed. It is based on this premise that we decided to carry out this study; to examine the impact of national electric energy supply on industrial productivity and see if there will be a long run relationship between energy and industrial output in the nearest future.

I.1.1 Objectives

The broad objective of this study is to examine the impact of electric energy supply on industrial productivity in Nigeria. The specific objectives are as follows:

- To investigate the extent to which electricity supply impacts on industrial development in Nigeria
- To examine the existence of co-integration between electricity supply and industrial productivity in Nigeria.

I.1.2 Hypotheses

The hypotheses are stated as follows;

- Electric energy supply has not impacted on the industrial productivity in Nigeria
- There is no co-integration between electricity supply and industrial productivity in Nigeria.

2. Literature review

There are a range of competing theories to the study of economic development. Each approach has its strength and weaknesses with different ideological, theoretical and empirical conclusions. This study is anchored on the endogenous growth model. The motivation for the endogenous growth model stems from the failure of the neoclassical theories to explain the sources of long-run economic growth. The neoclassical theory does not explain the intrinsic characteristics of economies that cause them to grow over extended period of time. The neoclassical theory focuses on the dynamic process through which capital labour ratios approach long-run equilibrium. In the absence of external technological change, which is not clearly explained in the neoclassical model, all economies will converge to zero growth. The neoclassical theory see rising GDP as a temporary phenomenon resulting from technological change or a short-term equilibrating process in which an economy approaches its long-run equilibrium. The neoclassical theory credits the bulk of economic growth to a completely independent process of technological progress. Thus in contrast to the neoclassical counterrevolution theories, models of endogenous growth suggest an active role for public policy in promoting economic development through direct and indirect investments in human capital formation and the encouragement of foreign private investment in knowledge-intensive industries such as computer software and telecommunications (Stern, 1991; Sala-i-Martin, 1990; Romer, 1986; Helpman, 1986; Lucas, 1988; Barro, 1990; Todaro & Smith, 2003).

A lot of empirical literatures exist on electricity and its effect on the economic performance. However this study narrows its focus on the relationship it has with Industrial development. Abosedra et al (2009) investigated the direction of causality between electricity consumption and economic growth for Lebanon, using monthly data covering the period 1995 to 2005. The outcome of the study substantiates the absence of a long-term equilibrium relationship between electricity consumption and economic growth but existence of a unidirectional causality without feedback running from electricity consumption to economic growth. They therefore called on the policy makers to place more emphasis on reconstruction and building of additional capacity and infrastructural development in the electricity sector which would drive economic growth of the country. Alper and Atilla (2007) used the wavelet analysis and found that in the short-run, there is feedback relationship between gross national product and energy consumption. However, in the long-run gross national product led to energy consumption. Masih and Masih (2007) studied the causality between energy consumption and GDP in Asian countries using vector error correction model (VECM) and VAR analysis. They used annual data over 1955 to 1999 periods. They drew the conclusion that there was no causal relationship between energy consumption and GDP in Malaysia, Singapore and Philippine. They also found that there was bidirectional causality between energy consumption and GDP in Pakistan, unidirectional causality from energy consumption to GDP in India and unidirectional causality from GDP to energy consumption in Indonesia. Ciarreta, et al (2010) used panel data from 1970 to 2007 to analyze the causality relationship between electricity consumption, real GDP and energy price. They revealed the long-run equilibrium relationship between variables. The causal relationship running from electricity consumption to GDP was revealed. Also they found a bidirectional relationship between electricity consumption and growth in the short-run and long-run. Hondroyiannis et al (2002) studied the link between energy consumption, gross domestic product and the consumer price index (CPI) for Greece. They used annual data over the period 1960 to 1996 and found evidence of long-run bi-directional causality between energy consumption (total and industrial) gross domestic product. On the other hand, there was no causality between residential use of energy and gross domestic product. Another study by Soytas and Sari (2003) obtained mixed results for the countries they studied. While they found bi-directional causality in Argentina, there was causality running from Gross Domestic Product to energy consumption in Italy and Korea and from energy consumption to gross domestic product in Turkey, France, Germany and Japan. Ghosh (2002) carried out a study for India using annual data for the period 1950 to 1997.He found no co-integration but argued that there is unidirectional causality from economic growth to electricity consumption. However, the results contradicted Granger (Granger 1986) postulation that there cannot be causality between non-stationarity variables that are not co-integrated. Sica (2007) of Italy investigated the possibility of energy demand-led growth and growth-driven energy demand hypothesis using the error correction model. The result of the study did not reveal any causality linkage. Though, the standard Granger test found evidence of unidirectional causality running from energy to Gross Domestic Product. Adenikinju (2005)in his study analyzed the cost of power outages to the business sector of the Nigerian economy using both a survey technique and revealed preference approach and the result showed that the poor state of electricity supply in Nigeria has imposed significant costs on the business sector. Lee and Anas (1992)reported that manufacturing sub-sector in Nigeria spend an average 90% of their variable cost on infrastructure, with electric power accounting for half of time share. The duo, having studied 179 manufacturing firms in Nigeria also reported that the impact of electricity deficiency of all types was consistently higher in small firms. Ukpong (1973) also carried out a study on the cost of power outages to the industrial and commercial sector in Nigeria. He used the production function approach to evaluate the power outage cost between 1965 and

1966, with selected firms. From his estimate, he discovered the unsupplied electrical 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 1.8million and 2.75million naira respectively. The unsupplied electrical energy according to Ukpong has a negative implication on the manufacturing productivity growth in Nigeria. A similar framework analysis was also carried out by Uchendu (1993) on the industrial firms in the commercial areas of Logos State Nigeria. The study estimated several types of outage cost such as material and equipment losses and value of unproduced output which was estimated at 1.3million and 2.32million in 1991, 1992 and mid 1993 respectively. The development reduced the value added of major manufacturing firms in Nigeria during these periods.

3. Methodology

The secondary data were sourced from the CBN statistical bulletin 2011 from 1970 to 2010. The choice of this period is basically on the availability of the data for the selected variable of interest. Employed a multiple regression analysis to critically examine the impact of energy supply on industrial productivity controlling for manufacturing output, market interest, rate and capital, in line with our stated objectives the Augmented Dickey Fuller (ADF) test and ECM were also employed; testing the order of stationary of the data and the existence of convergence to equilibrium in the long run. Below is the detail of the data:

Years	INDST Y	MAN Y	ENRGY	CAPITAL	CPI	INT
1970	819.1	317.6	20	358.45	0.23	4.5
1971	1012	307.7	25.3	540.35	0.23	4.5
1972	1215.5	381.1	30.7	651.73	0.24	4.5
1973	1416.5	472.7	34.5	749.85	0.28	4.5
1974	4927.4	1182.02	60.37	899.12	0.31	4.5
1975	7463.01	1186.53	85.95	1339.22	0.45	4
1976	9159.86	1463.59	85.2	2064.43	0.5	3.5
1977	9600.54	1695.58	98.66	2872.32	0.66	4
1978	9041.71	2168.99	110.77	4059.86	0.7	5
1979	10863.66	2599.15	137.32	4902.1	0.75	5
1980	10922.91	3485.86	143.72	6234.23	0.88	6
1981	89072.78	13837.92	801.93	8570.05	1.03	6
1982	82206.51	15633.54	887.71	10668.34	1.1	8
1983	71967.76	10797.42	853.63	11668.04	1.53	8
1984	77888.8	9532.75	902.35	12462.93	1.87	10
1985	85097.43	12032.4	1019.22	13070.34	1.89	10
1986	82860.89	11582.62	665.93	15247.45	2.15	10
1987	81596.46	12041.61	696.57	21082.99	2.36	12.75
1988	85146.6	13713.89	702.13	27326.42	3.8	12.75
1989	93971.61	14011.49	759.42	30403.22	5.5	18.5
1990	115591.4	14702.4	827.96	33547.7	5.7	18.5
1991	108081	16078.45	827.96	41352.46	7	14.5
1992	109682.6	15357.18	923.46	58122.95	10.42	17.5
1993	109344.2	14788.13	937.41	127177.7	16.8	26
1994	106747.6	14591.36	1006.79	143424.2	29.7	13.5
1995	108162.7	13836.14	990.68	180004.8	45.03	13.5
1996	114992.2	13953.42	1012.47	238596.6	51.47	13.5
1997	116576.9	14009.95	1006.37	316207.1	56.73	13.5
1998	117870.3	13046.3	940.94	351956.2	63.49	14.31
1999	110558.6	13494.64	953.17	431168.4	63.63	18
2000	121756.6	13958.82	972.24	530373.3	72.87	13.5
2001	128418.6	14935.1	11684.85	764961.5	84.9	14.31
2002	123553.5	16439.36	13318.07	930493.9	95.2	19
2003	149878.7	17369.63	15598.81	1096536	117.9	15.75
2004	156486.8	19436.78	18252.54	1421664	129.7	15
2005	159161.4	21305.05	19439.86	1838390	144.7	13
2006	155165.5	23305.87	20344.44	2290618	157.1	12.25
2007	151699.1	25535.5	21301.04	3680090	167.4	8.75
2008	146519.6	27806.76	22035.93	6941383	192.6	11.85
2009	149486.5	29990.92	22682.77	9147417	216	10.84
2010	157905	32281.31	23364.38	10157021	223	5.43

Source: CBN Statistical Bulletin 2011

3.1.1 Model Specification

The essence of regression is to reveal the causal relationship that exist between variables, in this regard the functional relationship between industrial productivity and energy supply taking control for market interest rate, capital and manufacturing output is given as;

INDST = f (ENERGY, CAP, INTEREST, CPI, MANY) …….. 1

Where INDST is industrial productivity

ENERGY is energy/electricity supply

CAP is capital generated from the capital market and loan from government

INTEREST is the market lending rate

CPI is price level in the economy and

MANY is manufacturing output

The econometric model for equation 1 is

$INDST = \rho + \pi ENERGY + \beta_1 CAP + \beta_2 INTEREST + \beta_3 CPI + \beta_4 MANY + \mu$……. 2

Where ρ is the intercept of the regression which assume the level of productivity at zero supply of energy ceteris paribus

π and βi are parameters of estimates, π is the slope of the regression line, other things being equal and

μ is the random term which measure the effect of other factors on industrial productivity other than the ones identified and is independently and identically distributed (iid).

In line with objective two, we therefore state the ECM which measures the co-integration (existence of long run relationship) between energy supply and industrial productivity in Nigeria.

$INDST_t = \rho + \pi ENERGY_t + \beta_1 CAP_t + \beta_2 INTEREST_t + \beta_3 CPI + \beta_4 MANY_t + \theta\mu_t + \varepsilon$ …….. 3

Where θ is the adjustment coefficient which measure the degree of convergence of the explanatory variable to equilibrium, μ_t is the long run equilibrium output variable ε is the stochastic term, other variables remain as earlier defined. In analyzing the data we use the STATA 10.0.

3.3 ***Results and Discussion***

We then present the result in tabular format, following econometric approach in respect to the stated objectives:

Model 1 (objective 1): parametric estimate on the impact of energy consumption on industrial output having a control for interest rate, manufacturing output, capital and price level (CPI)

Industrial output	Coefficients	't'statistics	P>|t|
Man	6.0410	16.44	.000
Energy	-1.241	-2.49	.017
Capital	-0.0116	-9.19	.000
CPI	449.555	6.08	.000
Interest	1106.314	2.99	.005
Constant	-5553.573	-1.92	.062
R^2 = .9825	F (5, 35) = 392.88	R^2adjusted = .9800	No. of Obs. = 40

Software used: STATA 10.0

From the above estimated parameters of the model

INDST = -5553.573 + 6.0410Man – 1.241Energy - .0116Cap + 449.555CPI + 1106.314Interest.

We observed that the manufacturing input/output has a positive impact on industrial output in Nigeria as well as interest and price level in the economy. Energy consumption has a negative effect on industrial output as well as capital from the capital market and government. Hereto, at every effort of increasing energy consumption, industrial output falls by 1.241 at a unit increment, all things being equal. All the observed variables predict industrial output variability of about 98.25 per cent. Energy consumption is significant at 5 per cent with p-value of .017 which is less than 0.05, disproving the hypothesis that energy consumption has no impact on industrial output in Nigeria; hence energy consumption has a significant impact on industrial output in Nigeria. All the observed variables are statistically significant at 5 per cent level, the coefficient of determination (R^2 = .9825) shows that the estimated regression line is very sound, that is have a good fit. This is also support the F-statistics (F = 392.88) that the regression line significant, different from zero.

Unit root test at first difference

Variables	ADF Statistics	1%	5%	10%	Lags
Industrial	-4.207	-3.668	-2.966	-2.616	2
Man	-3.048	-3.668	-2.966	-2.616	2
Energy	-3.228	-3.662	-2.964	-2.614	1
Interest	-3.931	-3.668	-2.966	-2.616	2
Capital	-3.061	-3.662	-2.964	-2.614	1
Stationary at ordinary level					
CPI	2.272	-3.662	-2.964	-2.614	2

In order to agree with econometric principles of data stationarity (that the data are stationary) and the estimated regression is not spurious in nature, we then carry out the unit root test (ADF test), which we observed that only price level (CPI) is stationary at ordinary level i.e. has no unit root, while the rest variables have unit root at their ordinary level i.e. are not stationary. We then carryout an ADF test again at their first differences, which are given above and we discovered the data to be stationary at their first difference. This agrees with macroeconomic data which always assume to be stationary at their first difference. Industrial output, manufacturing output, capital interest rate, and energy consumption are all stationary at 5% level, wherein their calculated ADF statistics -(4.207, 3.048, 3.061, 3.931, 3.228) greater than the 5% critical values –(2.966, 2.966, 2.964, 2.966, 2.964) respectively. At this juncture we conclude that the data has no unit root. On this premise we agreed that our earlier regression is spurious; therefore we have to rerun our regression again at their first difference of industrial output, manufacturing output, energy consumption, capital interest rate variables and price level.

A parametric estimate of the impact of energy consumption on industrial output taking control of manufacturing output, capital, interest rate and price level (CPI)

d.Industrial output	Coefficients	't'statistics	P>|t|
d.energy	.4184	.45	.658
d.man	5.3417	6.88	.000
d.capital	-.0048	-1.25	.219
d.interest	-157.5287	-.32	.748
CPI	-21.9592	-.56	.582
Const	1723.817	.87	.389
R2 = .5961	R2 adjusted = .5367	F(5, 34) = 10.03	No. of Obs. = 40

Indust = 1723.817 + .4184energy + 5.3417man - .0048capital – 157.5287interest + 21.9592CPI

From the above estimate we observed that only manufacturing output has a significant impact on industrial output with p-value of .000 while the rest variables are not including energy consumption in the economy. Though the overall regression line has a good fit and different from zero, yet coefficient of determination has fall drastically from .9892 to .5961, showing the predictability of industrial output in the economy to be just 60 per cent instead of the 98.92 per cent of the earlier prediction by the selected variables. Secondly in this regression we also observed that the impact of energy consumption has changed from negative to positive after differencing the variables of interest. Hence with p-value of .658 for energy consumption is an indication that energy consumption has no significant impact on industrial output in Nigeria ceteris paribus. This automatically agrees with the null hypothesis that energy consumption has no impact on industrial output in Nigerian economy.

From the above regression wee then predict and test the stationary of the residual

Unit root test for the residual (U) at ordinary level

Variable	ADF Statistics	1%	5%	10%	Lag
Residual(U)	-3.929	-3.662	-2.964	-2.614	2

From the ADF test we observed that the ADF statistics (-3.929) is greater than the 5% critical value (-2.964) which implies that the residual is stationary and independently and identically distributed in nature, no existence of unit root. And the stationarity of the residual implies that there exist a long run relationship between energy consumption and industrial output in Nigeria. We then conclude that the error term has no unit root.

Cointegration test (objective two): testing the existence of a long run relationship between energy consumption and industrial output taking control of manufacturing output, capital, interest rate and price level.

d.industrial output	Coefficient	't'statistics	P>|t|
d.man	5.5575	9.34	.000
d.energy	.5196	.73	.473
d.capital	-.0123	-3.73	.001
d.interest	421.8726	1.08	.287
CPI	2562.95	.81	.424
L.U(residual)	-.9450	-5.02	.000
Constant	793.06	.52	.606
R2 = .7709	R2 adjusted = .7292	F(6, 33) = 18.50	No. of Obs. = 40

From the estimate we observed that policy adjustment coefficient lie below the equilibrium by .9450 and all things being equal, as policy gears toward enhances energy supply increases and consumption follow suit that industrial output will converges to equilibrium, which will promote productivity and efficiency in Nigeria. The statistical significant of the adjustment coefficient is an indication that improving energy supply will enhance industrial productivity in the economy.

Since variable CPI and interest rate significant we then drop them and see if the adjustment coefficient will change.

d.industrial output	Coefficient	't'statistics	P>|t|
d.man	5.522	9.42	.000
d.energy	.7015	1.05	.301
d.capital	-.0100	-5.11	.000
L.U (residual)	-.8687	-4.99	.000
Constant	1446.893	1.11	.275
R^2 = .7615	R^2 = .7342	F(4, 35) = 27.94	Observation = 40

As we remove those two variables we can now see that all the variables are significant except the energy consumption which calls for policy implication to foster industrial output productivity. The convergence of the adjustment coefficient has also reduced; hence the convergence of industrials output to equilibrium in line with energy supply and consumption is a thing of power policy readjustment and change in policy making towards policy enhancement.

5. Conclusion

The study reveals that other things being equal energy/electricity supply has no significant impact on industrial productivity in Nigeria, though at ordinary status it seems to be significant but negative, after differencing the data to stationary it reveals its true impact of not being significant but having a positive impact. Other variables control seems to have a significant impact on industrial productivity in the economy. The ADF test reveals that all the variables are stationary only at first difference except CPI. The regression is none zero type and the selected variables are good predictors of industrial output variability in Nigeria. We believe that industrial output will converge to equilibrium in the nearest future if sanity returns to the power sector; hence we propose a full sanitization of the power sector with evaluation, monitoring and appraisal of the generating transmitting and distributing units quarterly. Policies should gears toward a private power driving to avoid corruption and existence of social desperadoes in the said sector, restriction generators importation, and revitalization of consumption pattern.

Suggested area for future study include economic growth and manufacturing output, critical evaluation of the Nigerian industrial sector, electric energy implication on economic productivity, and power supply and it implication on national development of vision 202020 in Nigeria.

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5.2 Acknowledgement

Researchers acknowledge the President of the Federal Republic of Nigeria Dr. Good luck Jonathan and his Special Adviser on Research and Strategy; Bar. Oronto Douglas, for their unalloyed support in course of our educational pursuit. Researchers also acknowledge the Departments of Economics of the University of Port Harcourt, Niger Delta University and University of Nigeria Nsukka for creating the enabling environment for the research. Researchers finally wholeheartedly appreciate the support and encouragements of their immediate family members, Dr. Edoumiekumo Samuel, Dr. Ajie H.A Prof. G.S. Angaye

Dr. Michael Baghebo Mr. Nwajinka Charles Chibundu and other colleagues in the department of the prestigious Niger Delta University, in Bayelsa State of Nigeria.

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