RELATIONSHIP BETWEEN ELECTRICITY CONSUMPTION, MANUFACTURING OUTPUT AND FINANCIAL DEVELOPMENT: A NEW EVIDENCE FROM NIGERIA

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ABSTRACT

Electricity is regarded as *sine quo non* for any meaningful social, economic and modern scientific advancement of any country in the world. It is regarded as a force and engine room of the industrial sector. However, in Nigeria, instability in power supply is negatively affecting manufacturing efficiency. Time series data for 1981 until 2015 was used to examine the symmetric relationship between the electric consumption, manufacturing output and financial development in Nigeria. The result indicates the co-movement in the variable over long time horizon, meaning that any inefficiency in electricity supply would impedes industrial output. Moreover, the Granger causality test based on vector error correction framework shows the presence of causality between power utilization of manufacturing firms and economic growth without feedback. In this sense it can be stress that stable electricity consumption is important factor for Nigeria's manufacturing sector. The result of variance decomposition further indicates that the variation in the industrial output responds more to shocks in the electricity supply than its own shock. This finding suggests that energy is the engine of manufacturing sector in Nigeria.

Contribution/ Originality: This study contributes to the existing literature of energy economics by examining the symmetric relationship of factors that inhibits energy sustainability in Nigeria. The study uncovers the major impediments to the Nigeria's manufacturing revolution. Sustainable development is only possible, if and only, these rigidities were systematically tackled.

1. INTRODUCTION

Electricity is the bedrock on which socio-economic activities thrive. Nigerians like other inhabitants of Sub-Saharan African needs consistence energy for sustaining their daily economic activities. Efficiency in power distribution network (transmission and distribution linkages) consistent to propel and support the dynamism of consumer demands, as well as, to deliver regular, authentic and low-cost power has been integral part of development agenda for more than three decades (Aliero *et al.*, 2013; Ibrahim and Muhammad, 2014). However,

Nigeria is presently facing perennial challenges for dependable and efficient power supply to domestic, private and industrial consumers. This situation is adversely affecting all efforts aimed at industrialising the economy.

Adequate electricity supply is essentially required for the strength in the industrial sector. The energy sector controls electricity supply, which in turn, muscle the machines and equipments for the creation of different kinds of commodities (Olayemi, 2012). Therefore, the function of the industrial sector cannot be overlooked, since studies have shown the crucial responsibility it plays in winding he engine of growth in emerging economies (Kniivila, 2008). Due to the vitality of industrial sector for nation building, Nigeria government since independence has implemented several policies, schemes and incentive (for instance, tariff protection, approved user scheme, import duty relief, complete veto on some oversee commodities and export incentives) to promote the subsector. Equally, some small-scale and medium-scale Nigerian enterprises have committed a huge amount of their aggregate capital to provide 50 percent of their electricity requirements, while majority of the sizeable enterprises relied fully on self-generated electricity to ensure uninterrupted power supply for efficient performance (Iloeje *et al.*, 2004). This and some other limitations have caused uninspiring contribution of the industrial sector to the Nigeria economy. Regular and low-price and sustainable electricity supply is the basis for any meaningful socio-political, economic advancements of any society. Electricity has substantially dominates and controls virtually every production aspect of human life. In this 21st century, hardly any enterprise can survive without robust electricity.

The major symptoms for the failure of Nigerian policy implementation are its inability to harness abundant natural gas and renewable energy sources optimally. Nigeria is still known for its epileptic power supply. Yet some communities have no ingress to power supply, and those that are connected are experiencing perennial problem of constant power failure owing to substandard infrastructures and low formation. This greatly affects the country's industrialisation agenda negatively. In Nigeria due to the absence of inexpensive energy source, needed backward and forward linkages between the agricultural and the manufacturing sector are not practicable; leading to increase in households vulnerability to shocks (Ibrahim *et al.*, 2016). Against this background, this study examines the nexus between electricity consumption, manufacturing output and financial development in Nigeria. Rest of the article is partitioned into four parts. Section two contains literature review, section three presents the methodology, section four explains the result and last section concludes the study.

2. LITERATURE REVIEW AND THEORETICAL FRAMEWORK

2.1. Empirical Literature

Extant literature on energy economics argued that electricity is the mainspring for transformation of Sub-Saharan African into modern economy (Yakubu *et al.*, 2015; Chinedum and Nnadi, 2016). Olayemi (2012) studied the consequences of power sector crisis on the productivity of industrial sector in Nigeria using a multiple regression and found that the low electricity generation is hampering manufacturing productivity in the country. According to Mark and Tonye (2009) experiences have shown that energy formation and provision in Nigeria is substandard and incapable to compare with what is obtained in smaller African countries. Inconsistent power supply has led many individuals and industries resort to the generators to compliment the power provided by the national grid. Julia *et al.* (2008) asserted that power generated by the national grid is much cheaper than energy sourced through generator sets.

Chiazoka *et al.* (2013) examine the impact of energy supply on the productivity and industrialisation in Nigeria and found an insignificant contribution of the former. Similarly, Olarinde and Omojolaibi (2014) examined the relationship between energy utilization and economic growth in Nigeria and the study found a positive relationship between electricity consumption and economic growth. Aliero and Ibrahim (2012) evaluate the effect of electricity conundrum on the manufacturing and productivity growth in Nigeria and found that inefficient power supply has led manufacturing sector to focus on other alternative source of power supply. This development has been gradually affecting and controlling cost of production of consumer goods. The development has led to drastic decline in the

exportation of domestically produced goods. Since manufacturers rely heavily on generators to power their plants, automatically goods and services produced under this condition will be relatively expensive. As a result of this, Nigerians patronizes cheap foreign products at the expense of expensive domestic goods. This may eventually lead balance of payment deficit and drains the country's foreign reserve. Lack of adequate capacity to efficiently meet the energy demand of the manufacturing sector is challenging the prosperity of Nigeria Gbadebo and Chinedu (2009). Iwayemi (1991) argued that that Improvements in the quality and volume of infrastructural services would shift the supply curve of producers in the economy outwards. This would encourage increase production activities, a lower cost structure and more competitive industrial environment that meet the tough challenges of the global market.

2.2. Theoretical Framework

Production and consumption activities are impossible in the absence of energy, as a required input, making it indispensable source of economic growth (Ibrahim and Bakori, 2011; Aliero and Ibrahim, 2012). Thus, electricity is believed to be among the prime developmental challenges afflicting third world's manufacturing output. Baxter and Rees (1968) opined electricity and other origins of power can be regarded as inputs within the manufacturing process, just like labor and capital. Sanchis (2007) observed that consistency of power provision will avert paralyzing the manufacturing production. Increased industrial activities could finally increase output. Thus, this submits that electricity production and supply is tantamount to any feasible economic policy, as such, it should be given an utmost priority. Tang (2008) stated that electricity is requisite for driving manufacturing sector output which in turn will spur increase in economic performance. Similarly, Simpson (1969) acknowledged that electricity is the backbone of industrial development in modern Africa, not mere steam engine. Sanchis (2007) viewed that "electricity as an industry substantially controls a great deal of output.

In this sense of hypothesis Adenikinju (2005) presented a substantial debate with regard to the importance of energy supply and the poor state of power supply within Nigeria. Aliero *et al.* (2013) demonstrated clearly that the need to enhance various infrastructure particularly electricity is crucial especially when looked at from the view point of exorbitant cost of alternative power supply and its associated balance of payment impact. Thus, given that industrialization required systematic and constant power supply, unless energy failure is tackle otherwise Nigeria run the risk of industrial backwardness (Udah, 2010).

3. METHODOLOGY

The annual time series secondary data for the relevant variables, covering from 1981 until 2015, were obtained from National Bureau of statistics (NBS) and Central Bank of Nigeria (CBN). For modelling process, the variables are firstly expressed as functional form:

$$MANQ_t = f(ELEC_t, FINDEV_t\ INF_t, INT_t)\ldots\ldots\ldots\ldots\ldots..(1)$$

Where MANQ is manufacturing output, ELECT is electricity consumption, INF is inflation rat INT is interest rate and $_{ti}$ is time series operator. For econometric estimation which would permits proper capturing of the nonlinear property and heteroscedasticity of the variables, equation (1) was transformed into linear model below:

$$MANQ_t = \beta_o + \beta_1 ELEC_t + \beta_2 FINDEV_t + \beta_3 INF_t + \beta_4 INT_t + \mu_t \ldots\ldots\ldots\ldots.(2)$$

Conventionally, time series analysis requires thorough examination and analysis of all the properties of the variables just to avoid having spurious regression. A preliminary check on individual series also helps in determining the order of integration. This study adopted Augmented Dickey-fuller (ADF) unit root test because of its power in small sample, as well as, being free of serial correlation when appropriate lags are included in the model. The study further used Johansen and Juselius (1990) in analysing the long-run relationship among the variables. This method requires common order of integration, say I(1) of all the variables. After establishing

cointegration relation, causality test was then run in the form of vector error correction model (Engel and Granger, 1987):

$$(1 - L) \begin{bmatrix} lnMANQ_t \\ lnELEC_t \\ lnFINDEV_t \\ lnINF_t \\ lnINT_t \end{bmatrix} = \begin{bmatrix} a_1 \\ a_2 \\ a_3 \\ a_4 \\ a_5 \end{bmatrix} + \sum_{i=1}^{p}(1 - L) \begin{bmatrix} b_{11i} & b_{12i} & b_{13i} & b_{14i} & b_{15i} \\ b_{21i} & b_{22i} & b_{23i} & b_{24i} & b_{25i} \\ b_{31i} & b_{32i} & b_{33i} & b_{34i} & b_{35i} \\ b_{41i} & b_{42i} & b_{43i} & b_{41i} & b_{45i} \\ b_{51i} & b_{52i} & b_{53i} & b_{54i} & b_{55i} \end{bmatrix} \times \begin{bmatrix} lnMANQ_{t-1} \\ lnELECT_{t-1} \\ lnFINDEV_{t-1} \\ lnINF_{t-1} \\ lnINT_{t-1} \end{bmatrix} + \begin{bmatrix} \mu_1 \\ \mu_2 \\ \mu_3 \\ \mu_4 \\ \mu_5 \end{bmatrix} ECT_{t-1} + \begin{bmatrix} \varepsilon_1 \\ \varepsilon_2 \\ \varepsilon_3 \\ \varepsilon_4 \\ \varepsilon_5 \end{bmatrix} \ldots\ldots\ldots3$$

The coefficients of the Error Correction Terms (ECT_{-1}) are expected to portray negative signs and it then conveys the speed of adjustment for the short-run to converge into long-run equilibria. The statistical value of the coefficient reveals the existence of long-run relationship between the variables. While the statistical value of F-statistic using Wald-test by integrating differences including lagged differences of independent variables in the model exhibits the short-run causality. According to Shahbaz et al. (2016) the dual importance of both lagged error term differences and lagged difference of independent variables provides joint long-and short-run causality.

4. FINDINGS AND DISCUSSION

The result of unit root estimation is shown in Table 1. Each series was examined at the level and differenced form as shown below:

Table-1. Augmented Dickey-Fuller Unit root test

Series	Levels	1st Difference
MANQ	1.99	-3.55**
ELECT	-0.52	-6.55***
FINDEV	5.54	-3.69**
INF	-2.64	-5.54***
INT	-2.23	-5.95***

***&** denotes rejection of the hypothesis at the 0.01 & 0.05 levels

It is clear from the results above that all the series were not stationary at the respective levels based at 5% levels of significance; however the null hypothesis of unit root is rejected at the differenced series. As such, the series fulfilled the condition necessary for Johansen and Juselius cointegration analysis. The lag selection test was determined before applying cointegration regression and all the test shows lag 4, except LR test which reveal lag 3 (see Table 2).

Table-2. Selection-order criteria

Lag	LL	LR	FPE	AIC	HQIC	SBIC
0	-1378.04	-	7.8e+41	110.644	111.05	111.219
1	-1387.99	191.87	2.8e+39	104.969	105.464	1106.475
2	-1387.99	67.278	1.8e+39	104.278	105.39	107.245
3	-1331.77	79.692*	1.3e+39	103.09	105.717	108.415
4	-1263.63	-592.29	1.0e+39*	-101.38*	102.878*	106.419*
5	-127.88	-545.21	1.0e+11	-100.04	101.231	102.431

* Indicates lag order selected by the criterion
LL: Log likelihood, LR: sequential modified LR test statistic, FPE: Final prediction error, AIC: Akaike information criterion, HQ: Hannan–Quinn information criterion, SC: Schwarz information criterion

Johansen and Juselius cointegration was based on the principles guided by null hypotheses in which λmax and λtrace were the yardsticks for decision making in terms rejecting or otherwise of the result. The findings of the Johansen and Juselius cointegration test presented in the Table 3 shows one cointegration exist in the equation at

5% significance level, at that position p=value (0.2369) is greater than 5%. More so, critical value (47.86) is greater than t-test value (39.28) of the λtrace value. This signifies the existence of a long-run relationship between the variables in question. This finding is consistent with the findings of Olayemi (2012); Chiazoka *et al.* (2013); Chinedum and Nnadi (2016); Ugwoke *et al.* (2016) and Yakubu *et al.* (2015) which revealed the existence of a long-run relationship between electricity supply and manufacturing output.

Table-3. Johansen and Juselius cointegration

Hypothesis	λ_{trace}	5% Crit. Value	Prob.**	Eigenvalue	λ_{max}	5% crit. Value	Prob.**
None*	70.61	69.82	0.0432	0.673	31.33	33.87	0.0977
At most 1	39.28	47.86	0.2495	0.539	21.69	27.58	0.2369
At most 2	17.59	29.80	0.5966	0.309	10.36	21.13	0.7101
At most 3	7.23	15.50	0.5516	0.204	6.38	14.25	0.5645
At most 4	0.84	3.84	0.3588	0.030	0.84	3.84	0.3588

λtraceeigenvalue test indicates 1conitegrating equations at the 0.05 level
*denotes rejection of the hypothesis at the 0.05 level
**Mackinnon *et al.* (1999) p-values

Once cointegration relation is established, then the direction of causation both in shot-run and long-run can be detected via multivariate error correcting process (the result of which is showed in Table 4). The result shows that causality does not exist between manufacturing output and electricity consumption in the short-run. This perhaps might have simply occurred due to the increasing dependence of manufacturing sector on its own energy source in Nigeria.

Table-4. VEC Granger Causality

Short run						Long run
Independent variables	**MANQ**	**ELECT**	**INFLATION**	**FINDEV**	**INTEREST RATE**	**ECT$_{t-1}$**
ΔMANQ	-	1.963 (0.3747)	1.065 (0.5870)	1.181 (0.5540)	3.421 (0.1807)	0.0908 (1.494)
ΔELECT	0.8021 (0.6696)	-	0.0248 (0.9876)	2.247 (0.3250)	2.163 (0.3390)	-0.227** (-2.155)
ΔINFLATION	1.624 (0.4438)	0.950 (0.6218)	-	0.208 (0.9008)	2.450 (0.2930)	0.00085 (0.823)
ΔFINDEV	8.316*** (0.0156)	6.323** (0.0422)	0.727 (0.6950)	-	4.132 (0.1266)	89.344 (4.081)
ΔINTEREST RATE	1.625 (0.4436)	1.702 (0.4269)	6.2960** (0.0429)	5.420 (0.0665)	-	-0.0003 (-1.275)

***&** denotes rejection of the hypothesis at the 0.01 & 0.05 levels

The instability in energy supply in the country has force the manufacturing enterprises to diversify and source their own energy in the form renewal energy, solar and other power generating sets. However, despite the increasing poor electricity production and supply exhibited in the country, manufacturing firms and households are made to pay their electric bills. This has triggered consumers' outcry that they are not getting the value for their money. The finding further indicates that both manufacturing sector and electricity consumption Granger causes financial sector development without feedback.

Table-5. Variance Decomposition VDC

Variance Decomposition of MANQ					
Periodicity (Yearly	Explained by shocks in:				
	MANQ	ELECT	INFLATION	FINDEV	INTEREST
1	100.00	0.00	0.00	0.00	0.00
2	98.51	0.77	0.06	O.50	0.16
4	84.86	7.75	4.94	1.75	0.70
8	68.31	22.90	3.66	2.87	2.26
10	62.42	27.87	3.60	3.22	2.89
Variance Decomposition of ELECT					
1	26.16	73.84	0.00	0.00	0.00
2	27.32	67.53	1.23	4.01	0.01
4	31.62	45.24	3.13	9.70	10.32
8	31.17	29.90	2.05	19.50	17.37
10	35.42	33.29	2.12	16.31	12.87
Variance Decomposition of INFLATION					
1	0.00	3.62	96.39	0.00	0.00
2	0.97	2.28	95.66	0.83	0.27
4	3.42	5.85	79.61	1.61	9.52
8	3.75	5.75	80.30	3.09	7.12
10	3.79	6.18	79.09	3.40	7.54
Variance Decomposition of FINDEV					
1	0.11	7.64	0.83	91.41	0.00
2	3.40	3.62	0.40	92.35	0.23
4	14.84	17.40	0.16	61.57	6.04
8	22.53	47.73	0.98	17.88	10.89
10	24.42	48.73	1.33	15.58	9.94
Variance Decomposition of INTEREST RATE					
1	14.95	13.19	0.43	4.65	66.81
2	10.08	29.14	4.91	2.75	53.11
4	8.92	36.65	3.35	4.01	47.08
8	5.70	39.59	2.45	9.65	42.61
10	4.03	44.27	1.90	9.62	40.18

Cholesky Ordering: MANQ   ELECT INF FINDEV INT
Standard errors: Monte Carlo (100 repetitions)

This study confirmed that changed in money supply through expansion of credit and lending to the private sector induces interest rate to change, while money supply doesn't response to the changes in interest rate. This lends credence to the finding of Gani and Ibrahim (2015) which casts doubt on the robustness of interest rate mechanism in settling economic imbalances in Nigeria. Table 4 further shows a unidirectional causality running between financial development and interest rate. In the long-run, it appears that stable electricity supply is an essential factor in Nigerian economy as it affects all the macroeconomic variables employed in this study.

The result of variance decomposition in Table 4 shows how each variable contributed to its own shock over the time period. Based on Variance Decomposition (VDC) results for the horizon of 10 years, the study reveals that the variation in the manufacturing output responds more to the shocks of electricity supply than other variables. It accounts for about 28% manufacturing output forecast error variance at the end of 10 years. Responses of manufacturing output to its shocks reduce with the passage of time, thereby allowing the rest of independent variables to exert their relative influences. At the 10th year in manufacturing output forecast error variance reveals that the manufacturing output shocks are 28%, 4%, 3%and 3% accounted by the shocks of electricity, inflation financial development and interest rate, respectively. Moreover, at lag one, 74% of changes in the electricity consumption resulted from its previous shocks while the remaining 24% was accounted by the shocks of manufacturing output. At the 10th year, shocks of manufacturing output have more influence on electricity consumption than its own shocks. Financial development was the second most important variable accounted for the variations of electricity consumption in Nigeria. In addition, the influence of the shock of financial development on

its own shock is 91% while the shocks of inflation affect financial development by 83% at the first year. This is consistent with findings of Ibrahim and Tanimu (2016) which asserts that the shocks in Nigerian economy mainly originated from fraudulent activities in other sector of the economy. Similarly, at year one, 43% shocks of interest rate resulted from inflation shocks, 15% from manufacturing output, 13% from electricity consumption. This further supports the neutrality of money supply and interest rate in Nigeria.

5. CONCLUSION

The study utilizes time series data covering 1981-2015 periods to examine the relationship between manufacturing output and electricity consumption in Nigeria. The finding reveals the existence of cointegration relation among the variables in question. Moreover, The Granger causality test result shows no evidence of causation between manufacturing output and electricity consumption in the short-run. However, the unidirectional casualty moving from financial development and electricity consumption was found. Similarly, in the long-run causality exists moving from electricity supply and consumption to all variables without feedback. Furthermore, VDC results that the variation in the manufacturing output responds more to shocks of electricity supply than ores of the variables. Thus, to ensure efficient manufacturing productivity, concerted efforts are needed to fix the lingering energy sector for robust electricity supply in Nigeria.

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