Causality between Manufacturing Efficiency, Energy Use and Economic Growth in Nigeria

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Abstract: **Studies on whether manufacturing productivity with interaction of energy use promotes economic growth are of cardinal importance as a result of the fact that energy use measured in kilogramme of oil equivalent per capita is a major factor that engineers the growth of manufacturing productivity. Using the unrestricted Vector Auto-regression (VAR) approach, the study examines the causality between manufacturing productivity, energy use and economic growth in Nigeria from 1985 to 2018. The Augmented Dickey Fuller unit-root tests, Pairwise and Wald test statistics Granger causality tests were employed. Results reveal two-way causality between manufacturing productivity and economic growth in Nigeria. While economic growth and manufacturing productivity (MP) Granger cause energy use (EU) and not vice versa, jointly examined, MP and EU promote growth in Nigeria, GDP and EU promote MP, and GDP combined with MP enhances the use of energy in Nigeria. It is therefore recommended that adequate energy supply should be made available to the manufacturing sector for meaningful economic growth to occur in Nigeria.**

Keywords: **Augmented Dickey Fuller, Nigeria, Pairwise and manufacturing growth**

JEL Codes: ***F4 & O4***

I. INTRODUCTION

The question of whether manufacturing productivity promotes economic growth is addressed in this study. This is germane because the growth of any economy has a direct or indirect effect in promoting the economic growth of other neighbouring countries. Among other direct effects, growth in the economy of one country enhances trading confidence in the manufactured products of such country. As a result of this, most neighbouring countries rely on manufacturing output for their productive activities. On the other hand, the indirect impact may be as a result of the interest that the foreign investors may cultivate in doing business with the region when progressive growth are exemplified in many countries within the region. In the previous literature, there is near-consensus that manufacturing is the high road to development (see, Verspagen, 1999; Szirmai, 2013; Haraguchi et al, 2017).

This consensus cannot be generalized in all cases, for instance, in advanced countries, service sector account for over two third of gross domestic product. This implies that activities in service sector like telecommunication, finance and advertisement promote economic growth and development. In the case of Nigeria, ever since the country has recorded a negative growth in 2016 to the tune of 0.36%, -0.52% and -1.49% in the first, second and third quarter respectively, the country's growth has not been encouraging (National Bureau of Statistics, 2016). The report from the manufacturing sector shows that the sector declined in output for about -7 % in the first quarter of 2016. Although, the latest statistics from the National Bureau of Statistics (2017) indicates that the country has exited recession with a growth in Gross Domestic Product (GDP) from -1.49% in the corresponding quarter of 2016 to 0.55% in the second quarter (Q2) of 2017, this growth performance is not impressive in any way. In such line, efforts by scholars to further address the major growth drivers in the context of Nigeria are still currently on-going. Onakoya's (2015) research for instance, is quite relevant to this current study. His research which employed Dynamic model of the Verdoorn's Law to investigate the long-term relationship between labour productivity as a measure of economic growth and manufacturing output, concludes that manufacturing output promotes economic growth. The study does not indicate the Granger causality between the two variables.

Other authors who have also investigated the relationship between manufacturing output and economic growth using time series data, limited their studies to the developed countries without considering the peculiar nature of the developing nations that are grossly under-developed in the corridor of industrialised machines which formed the backbone of manufacturing activities (see, Stoneman, 1979; Drakopoulos and Theodossiou, 1991; Bairam, 1991). To the best of our knowledge, research in this field on African nations are scanty, particularly on the causality between manufacturing productivity and economic growth.

Consequently, this current paper is to examine whether manufacturing productivity can Granger cause economic growth in Nigeria or the resultant effect would be two-way causality effect. More so, previous literatures have not tested the causality between manufacturing productivity and economic growth in Nigeria. Therefore, this current study covers this gap. The study also determines whether cause-effect relationship could occur in other controlling variable that may significantly affect the economic growth of Nigeria, since electricity plays an effect role in the performance of the manufacturing sector. Thus, the presence of energy use measure in kilogramme of oil equivalent per capita is added as

part of the controlling variable which other old studies failed to put into consideration.

This study is divided into five sections. Section one covers the introductory aspect of the study while section two reviews relevant literature, section three explains the methodology, section four presents and analyse the empirical results and the last section, concludes the study and recommends the policy implications for future economic growth.

II. LITERATURE REVIEW

Manufacturing, over the years, has been seen and considered as an engine of economic growth (Kaldor, 1967); an engine that has been seen working through the mechanism of its contribution to employment, its share of aggregate productivity and output and its spillover effect on non-manufacturing sector. Attention of researchers has been lingering around the evaluation of manufacturing and its significance for quite a number of reasons. Arguments have been put forward that with manufacturing, there are greater opportunities for economies of scale with the low average cost of production when compared with agriculture and the services sector. Its degree of capital accumulation cannot be overemphasized (Szirmai 2013).

Manufacturing remains the core in the formation and accumulation of substantial economic growth because specialization in primary goods export may not generate adequate incentives for other economic activities. Linkage effects are also particularly strong in manufacturing, which has higher backward linkages in general, and forward linkages in resource-based industries, than agriculture and services (Hirschman, 1958). An increase in manufacturing output further induces production in the manufacturing sector as well as in other sectors through direct production linkages and indirect multiplier effects, thereby influencing the growth of the whole economy.

As countries' incomes increase, demand effects can provide impetus to manufacturing development, which in turn may stimulate economic development through the manufacturing sector's positive features. Following the logic of Engel's law, an increase in income in developing countries, particularly at a lower income level, tends to raise the share of income spent on manufacturing goods more than the share of income spent on primary products and services. However, the impact of demand effects on manufacturing development is likely to be limited to relatively low-income countries and may possibly be extended if a country succeeds to produce technology-intensive products (Haraguchi et al 2017).

Literature on manufacturing economic growth nexus continues to grow with an impulsive industrial structural change which is becoming an issue of concern, thereby giving rise for low level of industrialisation. A decline of manufacturing value added and employment shares in many developing countries might be caused by country policies and comparative advantages (Haraguchi et al 2017).

The relationship between per capita GDP and share of industry or manufacturing is curvilinear rather than linear, with low levels of per capita GDP associated with low shares of manufacturing, intermediate levels with high shares and high income economies with lower shares (Rowthorn and Coutts, 2004). For developing countries, this implies a positive relationship between GDP per capita and shares of manufacturing (Szirmai and Verspagen, 2015).

2.1 Empirical Literature

Szirmai and Verspagen (2015) tested the relationships between the value-added share of manufacturing and growth of GDP per capita using fixed effects, random effects, Hausman–Taylor estimations and between effects models for an unbalanced panel of 92 countries. This relationship was examined for three periods, 1950–70, 1970–90, and 1990–2005, and compared with the results for the service sector. Focusing primarily on the results of conservative Hausman–Taylor estimations, the study presented the contribution of manufacturing to GDP per capita growth conditional on the level of education and stage of development. It showed that manufacturing acts as an engine of growth for low- and some middle-income countries, provided that they have a sufficient level of human capital. Such growth engine features were not found in the service sector. Interestingly, their findings for more recent periods indicated that a higher level of human capital (at least seven to eight years of education) was necessary for manufacturing to play a role as an engine of growth in developing countries. Su and Yao (2016) assess, among others, whether the manufacturing sector drives the growth of the services sector. The results from all three methodologies used for the analysis—long-run Granger causality tests, cross-sectional regression and panel regression—show that manufacturing sector growth drives services sector growth, not the other way around. These findings have led the authors to conclude that manufacturing is indeed the growth engine of economies and hence, that premature deindustrialization has negative effects on economic growth.

Marconi et al. (2016) examined the engine of growth hypothesis by evaluating Kaldor's two laws based on a dynamic panel data for a sample of 63 countries, which includes 32 low and lower middle-income countries (from US$ 1,036 to US$4,085 GDP per capita) and 31 upper middle and high-income countries (over US$ 4,085 GDP per capita) for the period 1990–2011. The results confirm the validity of Kaldor's two laws, demonstrating that higher increases in manufacturing output lead to higher economic growth (Kaldor's First Law) and manufacturing productivity (Kaldor's Second Law) for both income groups, with a higher effect on low and lower middle-income countries. Necmi (1999) tested whether Kaldor's conclusions continued to be valid beyond the peaks of rapid industrialization and catch-up in the 1970s, applying an instrumental variable econometric technique for 45 mostly developing countries for the period

1960–94. The results confirmed Kaldor's argument that ''manufacturing is an engine of growth" for developing countries, with the possible exception of sub-Saharan countries. Even for developed countries, McCausland and Theodossiou (2012) find that Kaldor's thesis largely held true for the period 1992–2007.

Fagerberg and Verspagen (1999) indicated that manufacturing only acted as an engine of growth in developing, but not in developed countries, in the 1970s and 80s. A cross-sectional regression study by Dasgupta and Singh (2006) involving 48 developing countries from 1990 to 2000 concluded that manufacturing continued to play an engine of growth role, but that services played a similarly important role during that period. Chakravarty & Mitra (2009) covered the period 1973–2004 and found that manufacturing had been one of the drivers of growth, together with construction and services. Kathuria and Natarajan (2013) tested the hypothesis for all 15 states of India in the period 1994–95 to 2005–06, and concluded that manufacturing had indeed acted as an engine of growth in India, despite its declining share in GDP.

The assertions of shrinking opportunities for manufacturing development in developing countries and the decrease in the importance of manufacturing for economic development motivated the study of Haraguchi et al (2017). It was shown that there was no evidence supporting this argument. Even after 1990, the manufacturing sector in developing countries continued to meet the conditions for describing it as a driver of economic development, especially in achieving high sustained growth while retaining at least the same size in GDP and total employment as 1970-90 periods. Thus, the study concluded that the declining manufacturing value added and manufacturing employment share in many developing countries had not been caused by changes in the development quality or quantity of manufacturing activities. In a large number of developing countries, they were mostly attributable to the failures of manufacturing development against the backdrop of a rapid development of manufacturing in few developing countries.

Szirmai (2012) examined the arguments for the engine of growth hypothesis for a limited sample of Asian and Latin American developing countries. He focused on capital intensity and growth of output and labour productivity. His results were somewhat mixed. In general, he found support for the engine of growth hypothesis for some periods, capital intensity in services and industry turned out to be higher than capital intensity in manufacturing. In advanced economies, productivity growth in agriculture is more rapid than in manufacturing.

III. ECONOMETRIC MODEL OF CAUSALITY

To test the three-ways causality between manufacturing productivity, energy use and economic growth in Nigeria, the study adopts the vector autoregressive (VAR) causality model for the study. This VAR short-run causality test will enable short-run dynamic coefficients of the model adjustment in the long –run equilibrium to be determined. The method of Granger causality Wald test is adopted to examine long-run causality between manufacturing productivity, energy use and economic growth in Nigeria. To achieve the objective of the study, the following estimation procedures are carried out; specification of the models, testing of the stationary of the variables, determining the optimal lags length, estimating of the unrestricted VAR, performing the causality tests and finally carrying out the diagnostics tests.

$$lnGDP_t = \alpha_0 + \sum_{i=1}^{k} \beta_i lnGDP_{t-i} + \sum_{j=1}^{k} \emptyset_j lnEU_{t-J} + \sum_{m=1}^{k} \emptyset_m lnMP_{t-m} + u_{1t} \quad (1)$$

$$lnEU_t = \gamma_0 + \sum_{i=1}^{k} \beta_i lnEU_{t-i} + \sum_{j=1}^{k} \emptyset_j lnGDP_{t-j} + \sum_{m=1}^{k} \emptyset_m lnMP_{t-m} + u_{2t} \quad (2)$$

$$lnMP_t = \delta_0 + \sum_{i=1}^{k} \beta_i lnMP_{t-i} + \sum_{j=1}^{k} \emptyset_j lnGDP_{t-j} + \sum_{m=1}^{k} \emptyset_m lnEU_{t-m} + u_{3t} \quad (3)$$

$lnGDP$ is the natural logarithm of real aggregate output proxy by gross domestic product; $lnEU$ indicates natural logarithm of energy use measure in kilogramme of oil equivalent per capita; $lnMP$ is the natural logarithm of manufacturing productivity, k is the optimal lag length, α_0, $\gamma_0$and δ_0 are the intercepts. β_i, $\emptyset_j$ and $\emptyset_m$ are the short-run dynamic coefficients of the model adjustment long-run equilibrium, and u_{1t}, u_{2t} and u_{3t} are the residuals in the equation 1-3.

3.1 Data Source

The data sets used in the paper were obtained from World Development Indicators, World Bank database. The data sets cover 1985-2018.

IV. EMPIRICAL RESULTS

4.1 The unit root test results

In estimating time series macroeconomic data, it is very pertinent to test the stationarity of the data in the regression analysis. This process is to avoid running a spurious regression. In the existing literature, several unit root tests have been proposed by different authors. Some of them are Augmented-Dickey Fuller **(**ADF), Phillips-Perron, Ng-Perron and Dickey-Fuller-GLS. This study adopts the ADF unit root test which implies that the null hypothesis $H_0: \varphi_1 = 1$, i.e. the process contains a unit root and hence it is non-stationary. The alternative hypothesis $H_1: |\varphi_1| < 1$, i.e. the process does not contain a unit root and therefore the data is stationary.

Table 4.1 shows the ADF results for the variables used in this study at first difference 5 percent significance level. At this significance level, all the variables are integrated of the order 1. This implies that at first difference, all the variables are significant.

Table 4.1-Augumented Dickey-Fuller (ADF) unit root test results

Variable	Level			First difference		
	Test statistic	Critical value 1%	Critical value 5%	Test statistic	Critical value 1%	Critical value 5%
*ln*GDP	−2.057	−4.288	−3.560	−5.239	−4.297	−3.218
*ln*MP	−3.038	−4.278	−4.160	−4.350	−4.297	−3.564
*ln*EU	−2.399	−4.288	−3.560	−4.619	−2.457	−1.697

4.2 Selection of optimal lag length

Estimating the optimal lag length in autoregressive process of time series data is a very crucial because the inference of ADF unit root test is sensitive to the optimal lag selection (Schwert, 1989; Harris, 1992). The method of selecting lag length on the basis of information criteria is considered a trade-off between the size distortions because of the inclusion of too few lags and the power losses caused by the inclusion of too many lags (Das, 2019) Table 4. 2 shows the results of various lags selection criteria. Akaike information criterion (AIC) reveals no lag selection while HQIC: Hannan-Quinn information criterion and Schwartz Bayesian information criterion show lag 1. Hannan-Quinn information criterion lag 3 provides the true and consistent optimal lag length 3, therefore, lag 3 is used in this study.

Table 4.2: Optimal lag selection results

Lag	AIC	HQIC	SBIC
0	109.707	109.753	109.841
1	105.235	105.419*	105.774*
2	105.450	105.771	106.392
3	105.682	105.223*	106.569
4	105.831	105.234	106.985

4.3 The Granger causality tests

Since the study is interested in the causality relationship between GDP, MP and EU within the framework of unrestricted VAR model approach, standard pairwise Granger causality test is carried out to discover the direction of causality in line with null hypothesis stated as follows:

H_0: No Granger causality

H_A: Null hypothesis is not true

For robustness check, the study further examined Granger causality test using Wald test approach. The advantage of this method is that it enables two variables to jointly test the cause and effect on the third variable. Table 4. 3 show the result of the Wald test.

First of all, the statistical significant p-values at 5 percent for variables GDPlog and MPlog in Table 4.3 indicates the certainty that both variables promote each other in Nigeria. Therefore, the null hypothesis of no Granger causality is rejected. The p-value of 0.001 indicates there is uni-directional causality running from GDP to EU and not vice versa. Similarly, MP promotes EU and not vice versa. The next step of the test is to find out whether combined two variables can promote the third variable. This is established in Table 4.4 using Wald test statistics. Results show that MP and EU jointly promote economic growth of Nigeria. Also, growth in GDP and EU jointly cause MP to improve. Lastly, the result of combined GDP and MP enhances the efficiency of EU in Nigeria.

Table 4.3 shows Granger causality test results

Variables		Coefficients	Prob. value
GDPlog			
	GDPlog	2.033	0.000*
	MPlog	1.754	0.000*
	EUlog	0.700	0.703
MPlog			
	GDPlog	1.013	0.000*
	MPlog	0.683	0.001*
	EUlog	1.197	0.407
EUlog			
	GDPlog	0.151	0.001*
	MPlog	0.165	0.000*
	EUlog	0.205	0.221

Note: lag length 3 is applied to all the variables

Table 4.4 Granger causality Wald tests results

Equation	Excluded	Chi-square	Prob. value
GDPlog	MPlog	41.778	0.000*
GDPlog	EUlog	0.145	0.703
GDPlog	ALL	84.333	0.000*
MPlog	GDPlog	29.788	0.000*
MPlog	EUlog	0.686	0.407
MPlog	ALL	120.85	0.000*
EUlog	GDPlog	49.024	0.000*
EUlog	MPlog	44.511	0.703
EUlog	ALL	49.026	0.000*

4.4 Diagnostic test results

The diagnostic results in Table 4.5 reveal the fitness of unrestricted VAR model used in this study. Results show that the estimated model is suitable for the study.

Table 4.5 shows the diagnostic test results

	F-statistic (prob.)
Breusch-Pagan-Godfrey Heteroscedasticity	0.66(0.78) 1.50(0.28)
Breusch-Godfrey Serial Correlation	
Jarque-Bera	0.30(0.85) 0.11(0.74)
Ramsey Reset	

V. CONCLUSIONS

This paper focused on testing the Granger causality relationship between manufacturing productivity, energy use and economic growth in Nigeria. The study employed a time series data spanning from 1985 to 2018. Using the pairwise and the Granger causality Wald tests, this article demonstrates that the two-way causality between manufacturing productivity and economic growth in Nigeria is significant. This implies that all things being equal, activities in the manufacturing sector will certainly contribute to the economic growth of Nigeria. The growth of Nigeria's economy would also contribute to the development of the manufacturing sector.

The joint examination of the activities of manufacturing productivity and energy use which is the factor that can induce the growth of the manufacturing sector, indicates that the duo promotes the economic growth of Nigeria. Similarly, combined growth in manufacturing productivity and economic growth have the tendency to jointly improve the use of energy in Nigeria. Subsequently, the development of Nigeria is dependent on the domestic productivity. Based on the comprehensive analysis of causality between manufacturing productivity, energy use and economic growth strongly support the Federal government of Nigeria's current policy on the ban of importation of maize, rice and other consumable goods. This effort is to promote the country's local production.

In conclusion, this study recommends that government should immediately provide sufficient energy supply for use, especially in the manufacturing sector. With this, there is every tendency for an improved economic growth in Nigeria.

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