MACROECONOMIC FACTORS AND THE PRODUCTIVITY OF MANUFACTURING SECTOR IN NIGERIA

*DR (MRS) TITILOLA OSHATI *AJUNWA FELIX OGECHI & **MOSHOOD ABDULRAHIM
*Productivity Capacity Building (PCB) Department, National Productivity Centre, Headquarters, Abuja **Consultancy and Business Development (CBD) Department, National Productivity Centre, Headquarters, Abuja

Abstract:
The achievement of sustainable economic growth in furtherance of economic development is the major aim of policy makers in various countries as this affects positively on the citizenry. This paper examined the impact of the changes in the macroeconomic factors on the productivity of the manufacturing sector in Nigeria from 1986 to 2015. Secondary data was extracted from the Central Bank of Nigeria 2015 Statistical Bulletin on the various variables of interest which included Gross Domestic Product (GDP), unemployment rate, inflation rate, exchange rate, interest rate and manufacturing output. A preliminary evaluation of the data was conducted using both descriptive statistics and stationarity evaluation. The test indicated that all the variables are not normal. The occurrence of mixed order integration at level and first difference necessitated the deployment of the Autoregressive Distributed Lag (ARDL) technique as the estimation tool. The Generalized least Squares regression was deployed based on the result of the Hausman test which pointed to the direction of long-run connection amongst the variables. The follow-up check of short-run error correction mechanism discovered a 45 percent disequilibrium adjustment. The result findings revealed that inflation and exchange rate contributed positively to manufacturing output in the long run. The influence of the rates of interest rate and unemployment were also positive in the short run but had negative impact in the long run. Also, the relationship between manufacturing output and GDP was positively and significant at 1 percent level. The results showed
that manufacturing was a veritable engine of economic growth. In order to check the validity and robustness of the estimation model, the Ramsey RESET test; Cross dependence test; Autocorrelation test and Heteroscedasticity tests were conducted. The tests showed no presence of serial correlation but of heteroscedasticity which although makes the model inefficient but estimator is still unbiased. The study recommended the harmonization of both fiscal and monetary policies for the attainment of macroeconomic stability.

**Keywords:** exchange rate, Gross Domestic Product, inflation rate, interest rate, manufacturing productivity, Unemployment rate.

**Introduction**

Although important, the manufacturing sector is not the primary driver of the economy of developed nations. The service sector has gained ascendancy (Arnold, Javorcik & Mattoo, 2011; Aviral, 2011); Szirmai and Verspagen, 2011). However, the contrary position as reported by Onakoya (2004a) and Szirmai (2009) is that in most of the developing countries the manufacturing sector is the major driving engine of economic growth. The virility of the manufacturing sector in the opinion of Amakom (2012) stimulates the economic efficiency of a country. The Verdoorn's (1949) and Kaldor's (1975) second laws attest to the primal significance of the manufacturing sector to the economy. The basic conclusion being that increased labour productivity in manufacturing sector is positively related to rise in the growth of manufacturing output because of the effect of increased economies of larger production and technical progress. This has also been re-echoed by Libanio (2006) and (Thirlwall, 2013) who found that the productivity-enhancing innovations technologies deployed in manufacturing sector engenders economies of scale in greater proportion than the spill-over effects of in both of the service and agricultural sectors.

The economy of the Nigeria is structured typologically along that of a developing nation. The primary sector (agriculture and mining and quarrying) dominated the economic activities since independence in 1960 (Chete, Adeoti, Adeyinka & Ogundele, 2014). The connection between the manufacturing productivity growth and macroeconomic variables has become one of particular policy relevance in light of the recent economic crisis in Nigeria.
The contributions of the Nigerian manufacturing sector to GDP has fluctuated widely over the years. From a paltry 4.8% at independence in 1960, it grew fifteen years later to 7.4% in 1975. By the end of 1980 its contribution tumbled to 5.4% only to surge to its peak of 10.7%, five years later in 1985. Since then, the manufacturing portion of GDP had declined; 1992 (7.9%), 1997 (6.3%). The lowest ebb ever was 3.4% recorded in 2001, beyond which some traction of 4.21% was gained in 2009 (Central Bank of Nigeria, 2012). The contributions of manufacturing sector to GDP further moved up to 6.67% and 6.83% respectively in 2012 and 2013 (National Bureau of Statistics, 2014).

The recent economic recession also affected the manufacturing sector. Indeed, there was 8.7% reduction in industrial production in the fourth quarter of 2016 over the same quarter in 2015. The average production growth was 1.35% from 2007 until 2016 with a peak of 20.10% in the first quarter of 2011 and the lowest record of -10.10% in the quarter 1 of 2016. Similar fluctuating trends hold for the growth rates of the macroeconomic variables (see Figure 1). The expectation is that they may affect the real sector in different ways.

![Trend of the Variables 1982 - 2015](image)

**Figure 1: Trend of the Variables**
Where: LNMANU = logged Manufacturing output; INF = Inflation rate; IR = Interest rate; LNEXRmTAGE = logged Exchange rate; LNGDP = Logged Gross
Domestic Product; LNMS2 = Logged Money Supply; UNEMPLOYR = Unemployment rate
Source: Authors Presentation using Microsoft Excel Work Package 2013

The Structural Adjustment Programme implemented by the federal government of Nigeria in 1986, and consequential economic reforms process over the years have had mixed results. The economic liberalization and deregulation of policies have also attracted both external shocks and generated internal concerns. The shocks amongst others comprise of foreign capital flight, oil price shocks and consequential volatility in the exchange rate, industrial restructuring etc. These have contagion effects with uncertainty and attendant risks in terms of liquidity, inflation, exchange rate, unemployment and interest rates. These risks, in a varied manner, affect the performance of manufacturing companies given its susceptibility to variations in interest rates, skilled labour shortages, exchange rates, external reserve, foreign direct investment, foreign exchange rates. Indeed, manufacturing has become more capital-intensive, with greater dependence on international markets, especially the West African sub-region. The disparate and conflicting results obtained on the impact of the macroeconomic variables, from the literature makes this research necessary.

There is the challenge of the managing the ‘impossible trinity’ also known as a ‘trilemma’. Specifically, it is impossible to achieve all three of the following: fixed exchange rate, free capital movement and independent monetary policy. This is only a part of the challenge faced by policy makers in managing the constituents-macroeconomic variables. The objective of this study is to understand the extent and direction by which the macroeconomic variables drive the Nigerian manufacturing output.

The rest of the study is planned as follows: The review of literature is presented in the next section. In the third section, the employed methodology is discussed. Empirical results and the discussion of findings are covered in the fourth section. The recommendations and conclusions are provided in the concluding section, five.

**Literature Review:**
Theoretical Framework:
There are few theories directly underlining the macroeconomic variables with respect to the manufacturing sector. The pristine theory in this arena are the
Verdoorn's Law (1949) on the statistical association between the long-run rate of labour productivity growth rate and output growth rate of the manufacturing sector of an economy. This was refined by the Kaldor's (1966) law culminating in the Kaldor-Verdoorn's Law. This is consistent with the Arrow (1962) dynamic technical knowledge learning-by-doing) and the endogenous growth theory spearheaded by Romer (1986).

The latter theory holds that the inherent features in human capital investment and innovative knowledge significantly contributes to the growth of economy. The persistent development of the economy kindles the manufacturing sector productivity with consequential increase in the total output and aggregate productivity of the economy.

The corollary theories on the relationship between gross total output and the various macroeconomic variables include the Okun law (Unemployment), Phillips Curve (inflation), Keynesian, monetarist and neo-Keynesian theories (monetary policy). These theories which indirectly shape the real sector can be condensed into two seemingly conflicting locus. Indeed, the summation of these theories is encapsulated both the finance-led growth hypothesis which states that the development of the financial sector of the economy propels the real sector and accelerates the growth of the economy. There are two main channels through which the financial sector influence long-run growth. These are through the facilitation of physical and human capital accumulation and by raising the rate of technological progress (Mordi, 2010). The other school of thought is the demand-following responses argued that the development of the real sector fast-tracks financial development. This augments the Capital Arbitrage theory propounded by Samuelson (1948) in which the consequential increase in the foreign reserves of the country may lead to increased confidence in the economy and encourage additional foreign direct investments since international ventures seek higher profit. For growth to occur however, there is the need for a relatively stable macro-economic environment characterized with low risk and a condition for attracting investment and boosting entrepreneurial activities. There is therefore the need to keep lending interest rate and inflation at a manageable limit in an environment of stable exchange rate regime.

Review of Empirical Literature:
Some empirical works have explored the connection between the productivity of the manufacturing sector and macroeconomic dynamics. This bring up the
need to understand the concept of productivity which can simply be taken as the rate of real output per unit of input. A broader definition can indeed refer to the affiliation between the production output on the one hand and some inputs resource including capital, labour, equipment and technology. Two sub-concepts of productivity are provided by Anyanwu (2004) and Udo-Aka (1983). These are the ratio of output to the aggregate production factors inputs (total-factor productivity) which. The second sub-concept is the partial productivity which is the percentage of single resource input to the total output. This is calculated using the ex-factory prices of finished products because of the heterogeneous nature manufacturing output (Odior, 2013). The ultimate measure of manufacturing productivity is the sectoral contribution of manufacturing to the GDP.

The first Kaldor (1967) law predicated on a two-year study (1953-1954), conducted using the data of 12 OECD countries established a positive nexus between manufacturing output and economic growth. This hypothesis was also tested by Elhiraika (2008) who evaluated data from 36 countries over eight period (980-2007). Both and confirms compliance. The findings of Millemaci and Ofria (2014) in a study of a cross section of developed countries, and Latin America by Libanio (2006) bear confirmatory testimony together with that of Onakoya (2014b) on the contributions of manufacturing in the context of intersectoral linkages to the growth of the Nigerian economy. On the other hand, Obamuyi, Edun and Kayode (2012) could not confirm an interconnection between economic growth and manufacturing output.

The research by Enu and Havi (2014) examined the influence of the indicators of macroeconomic variables on the industrial production in Ghana. The estimation technique ordinary least squares, employed acknowledged the government spending and import of goods and services as positive influencers. The real exchange rate and petroleum prices were seen as negative deciders influencing agents.

An optimum debt-equity mix as asserted by Bakare (2011), is a basic requirement in for the achievement of optimum manufacturing performance. The stochastic characteristics of each of the macroeconomic variables was by examined Odior (2013) who assessed their influence on the productivity of the Nigerian manufacturing sector between 1975 and 2011. The research reports that loans and advances in addition to foreign direct investment increase the manufacturing productivity level of in Nigeria. The impact of
broad money supply was less felt. In a similar vein the relationships amongst savings, debt–equity ratio of firms, interest rates, cost of capital, investment and growth between 1963 and 1981 in Korean was investigated by Sundararajan (1987). He applied the dynamic framework that takes into consideration the complex linkages and interactions among the variables and report disparate affiliations especially with respect to interest rate and manufacturing productivity.

The influence monetary policy on the performance of the manufacturing sector in Nigeria was investigated by Imoughele and Ismaila (2014). Data covering the period 1986-2012 were obtained from various issues of the Central Bank of Nigeria and the National Bureau of Statistics. The results that reveal whereas the rate of interest and money supply (broad) were statistically insignificant, the rates of inflation and exchange together with the external reserve were significant, and negatively related to the manufacturing sector output in both the current, and the previous year. A uni-directional causality exist between the real rate of exchange and external reserves and the manufacturing output.

The examination of the effect of interest rates adjustments on the development of an emerging market was conducted by Ayanwale (2013) in a study spanning 40 years from 1970 to 2010. Using the Error Correction Model to reconcile the variations in the variables in the short and long run the, fluctuations in the rates of exchange and interest were significant statistically. This is indicative of a short-run influence of the rate of interest on the gross fixed capital formation. This also applies to the changes in inflation with respect to gross domestic product.

The provisions of Okun’s law which in its pristine form provide for 1 % reduction in output when the cyclical unemployment rate increases by 2 % (Okun, 1962). The law is often disparaged for being bereft of a theoretical underpinning (Harris & Silverstone, 2001 and Kwami, 2005) it has in the main provided a robust explanation for the subsisting relationship between the two variables. However, a contrarian report was made by Malley and Molana (2007) who find a positive association between output and unemployment when an economy operates at an inefficient, or ‘low-effort’. The divergent finding was borne out of a stylised model of an imperfect supply market of goods and labour using G7 countries data from 1960 and2001. The German data was strongly suggest persistent negative association between the rate of
unemployment and the level of output. Conflicting results have been reported on the applicability of Okun’s law in the Nigeria. They report a stagflation situation (Njoku, & Ihugba, 2011; Sanusi, 2012; Amassoma & Nnwosa, 2013) with conflicting results; they indeed report a stagflation situation. The import of these for the manufacturing industry is that imperfections in the market could hinder the smooth working of expansionary and/or stabilization macroeconomic policies.

The importance of the manufacturing was reiterated by Owyang, Sekhposyan & Vermann (2013) who found that changes in unemployment are more responsive to changes in output in areas with more manufacturing workers. Indeed, a 1% -point rise in the percentage of payroll employment from manufacturing increases Okun’s coefficient by 0.01. This is corroborated by the work of Berument, Dogan and Tansel (2009) who evaluated macroeconomic policy and unemployment by sectoral economic activity with evidence gathered from Turkey. The researchers employed the VAR model found that positive income shock is followed by a reduction in unemployment in all economic activity groups including the manufacturing sector.

The cointegration and error correction techniques were deployed in finding out the determinants of manufacturing output in Ghana by Anaman and Osei-Amponsah (2009). The research covering 1974 to 2006 report a long-run nexus between the output of the manufacturing sector and political stability, the level of per capita real GDP, and the export-import ratio. Using similar technique, a long-run connection was established in the investigation into the efficacy of monetary policy on manufacturing sectoral output. The econometric Nigerian study by Imoughele (2014) between 1986 and 2012 deployed the Johansen Co-integration and Granger Causality test. The findings show that indeed, inflation, exchange rate and external reserve positively propelled the growth in the manufacturing sector.

These have implications for the performance of the manufacturing sector.

**Methodology:**

The ipso facto empirical research design is employed this research to investigate the connection between the macroeconomic variables (unemployment, rate of exchange, rate of inflation and interest rate) and the sustainability of the manufacturing companies in Nigeria.

**Description and Sources of Data:**

For the purpose of the research objectives, the contribution of the manufacturing sector (MANU) to GDP is the dependent variable. The independent variables are the macroeconomic variables consisting of the GDP, unemployment rate, rate of exchange, the rate of interest and the rate of inflation rate (Kamaan, 2014 and Taylan, 2012).

**Model Specification:**
Several approaches and techniques have been deployed, one which was to regress the macroeconomic variables on manufacturing productivity. The model that will be used for the evaluation of the hypotheses of this research is adapted from the work of Fasanya, Onakoya and Agboluaje (2013). The original model made use of the Keynesian IS-LM framework with consideration given to the liquidity puzzle, the price puzzle and the exchange rate puzzles. The original model used in the work is given as:

\[
\Delta RGD P_t = \alpha_0 + \alpha_1 \Delta GDP_{t-1} + \alpha_2 \Delta M_{2t-1} + \alpha_3 \Delta IR_{t-1} + \alpha_4 \Delta INF_{t-1} + \alpha_5 \Delta REER_{t-1} + \alpha_6 \Delta ER_{t-1} + U_t \quad (1)
\]

Where \(\alpha_1, \alpha_2, \alpha_3, \alpha_4, \alpha_5, \alpha_6\) are parameters for economic growth (GDP), money supply, interest rate, inflation rate, real exchange rate and external reserve. This study adopts this model with some modifications made to the variables. The model to be adopted in this study eliminates external reserve and incorporates unemployment rate. These are regressed against the contribution of the manufacturing sector to the GDP. These is used to establish the relationship between macroeconomic variables and manufacturing contribution to GDP in Nigeria.

The Keynesian IS-LM framework can be linked with the augmented Solow growth model and the endogenous growth theory which form the theories which are adopted in this study. The augmented Solow growth model considers investment in human capital as a driver for economic growth which can be achieved through capital accumulation. For capital to be acquired however, the decisions made as regards to interest rate have to be reasonable as it determines the kind of capital that is existent in an economy (whether it is domestic or foreign capital). Reduction in interest rates triggers inflation and affects the level of investment as people have more capital to purchase goods and services as captured in the liquidity and price puzzles of the
Keynesian IS-LM framework. The endogenous growth model also follows a similar manner as the augmented Solow growth model. According to this model, capital accumulation is key for economic growth, but much emphasis is placed on technological progress. For the purpose of this research, the model to be adopted is specified as

\[ MANU = f(INF, INT, REER, UNEMP) \] \hspace{1cm} (2)

\[ MANU_t = \beta_0 + \beta_1 GDP_{t-1} + \alpha_2 \Delta M2_{t-1} + \beta_3 INF_{t-1} + \beta_4 INT_{t-1} + \beta_5 \Delta REER_{t-1} + \beta_6 UNEMP_{t-1} + U_t \] \hspace{1cm} (3)

Where \( \beta_0, \beta_1, \alpha_2, \beta_3, \beta_4, \beta_5 \) and \( \beta_6 \) are parameters of the model which are Economic Growth (\( GDP \)), Money Supply (\( M2 \)), Interest Rate (\( INT \)), Real Exchange Rate (\( REER \)) and Unemployment Rate (\( UNEMP \)) respectively; \( U_t \) is the disturbance term.

**Method of Data Analysis:**

This study would employ the use of the E-views 9.0 statistical software for the data analysis. The empirical estimation is in three phases. In the first segment - pre estimation, it employs a trend analytical and graphical representation showing the movements over various years of the variables. Other pre estimation tests include the normality tests using the descriptive statistics. The normality tests is on the variables carried out to ensure that they do not violate the properties of a standardized normal distribution. For this purpose, the mean, standard deviation and skewness of the variables is used in addition to the skewness, kurtosis and Jarque Bera values of the variables distribution. Time series data by nature generate a stochastic or random process. The underlying trending characteristics of time series data lend them to random walk. A stochastic process is stationary where the mean value and the value of the variance are constant over time. The additional condition being that the covariance value between two time periods hinges only on the lag between two time periods and not on the actual computed time. The implication of these for time series data is the stationarity condition which if not tested may result in unreliable analytical results. The Augmented Dickey Fuller (ADF) test is applied for testing the presence of stationarity. Based on the result of the stationarity tests, the decision rule is to reject the null hypothesis of no
random walk when all variables are stationary of the order level. In the alternative, the acceptance of non-stationarity leads to the next step of testing for cointegration among the variables.

The second phase in the estimation phase is the test for possible long term cointegration among the variables. The Johansen and Bounds tests are applied. The former test is a multi-model method in contrast to the latter which is a single equation model. The two techniques explains both the short-run and long-run relationship affiliations between them and determines the level of cointegration among them.

Before the estimation of the long-run connection, the lag length to be used in the model is selected using the likelihood ratio (LR). The selection of appropriate lag length would ensure that the residuals do not have significant autocorrelation since autocorrelation leads to inconsistent least square estimates (Enders, 1995). The study complements the LR test with Schwarz Information Criterion (SIC) as well as Akaike Information Criterion (AIC) statistics. These lag selection criteria enables one to select the smallest lag order with no much loss in the degrees of freedom. However, with the availability of Eviews 9, this process has been computerized, as the E-views automatically sieve through the model to present the utmost lag length that is suitable for the purpose of the work, which thus eliminate the need for manual elimination process.

Where the stationarity result reveals a mix of integration and level I(0) and at first difference I(I), the Bound test based on the Auto regressive Distributed Lag (ARDL) is selected. The Johansen cointegration test is deployed if on the other hand all the variables are of the first order (I(I)).

The Autoregressive Distributed Lag (ARDL) model is used to analyse the short run relationship between the dependent variable and the independent variables. It is commonly applied to econometric models within which the data have a long run stochastic trend (cointegration). It gives us the perfect view of the short run behaviour of the variables and how they individually affect the dependent variable. Granger causality test is thereafter deployed to determine the direction of causality amongst two variables in a pair-wise sequence.

The third phase in the estimation process are the post estimation tests, required to determine the robustness of the estimated model. One of the major violations of the basic Least Squares rule is when the error terms of
successive periods are interrelated. The violation of this rule results in lower than acceptable range for the standard errors of the coefficient variables which thus renders them inefficient in the estimation process. It is paramount to carry out the 3 autocorrelation test to determine the level of reliability of the model.

The test for Heteroskedasticity is carried out to determine if the error terms are constant over time, and to be sure that the error terms are not somewhat related or correlated with the explanatory variables. The presence of heteroskedasticity violates the basic Least Square assumptions and renders the standard error of the variables too low and consequently can lead to Type 1 error.

Another post-estimation test involves multicollinearity. This is a must-have in time series variables which is the situation presented in this work. The focus is not the elimination of the presence of multicollinearity in the model, but rather to minimize its effect so as to ensure the consistency of the model estimation.

Findings and Discussions:

Preliminary Analyses:
This section covers the descriptive statistics and stationarity test which are presented in turns.

Descriptive Statistics
The series descriptive statistics are presented in Table 1.

<table>
<thead>
<tr>
<th>STATISTICS</th>
<th>INF</th>
<th>IR</th>
<th>LNEXRATE</th>
<th>LNGDP</th>
<th>LNMANU</th>
<th>LNMS2</th>
<th>UNEMPLOYR</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean</td>
<td>19.72</td>
<td>17.81</td>
<td>3.23</td>
<td>28.49</td>
<td>25.56</td>
<td>27.04</td>
<td>10.43</td>
</tr>
<tr>
<td>Median</td>
<td>12.23</td>
<td>17.80</td>
<td>3.09</td>
<td>28.70</td>
<td>25.69</td>
<td>26.99</td>
<td>7.00</td>
</tr>
<tr>
<td>Maximum</td>
<td>72.84</td>
<td>31.65</td>
<td>5.26</td>
<td>32.17</td>
<td>29.83</td>
<td>30.55</td>
<td>27.40</td>
</tr>
<tr>
<td>Minimum</td>
<td>5.38</td>
<td>8.92</td>
<td>-0.48</td>
<td>24.67</td>
<td>22.27</td>
<td>23.45</td>
<td>1.80</td>
</tr>
<tr>
<td>Std. Dev.</td>
<td>17.94</td>
<td>5.039</td>
<td>1.94</td>
<td>2.53</td>
<td>2.390</td>
<td>1.15</td>
<td>2.44</td>
</tr>
<tr>
<td>Skewness</td>
<td>1.63</td>
<td>0.18</td>
<td>-0.71</td>
<td>-0.12</td>
<td>0.25</td>
<td>-0.02</td>
<td>0.76</td>
</tr>
<tr>
<td>Kurtosis</td>
<td>4.37</td>
<td>3.43</td>
<td>2.15</td>
<td>1.69</td>
<td>2.04</td>
<td>1.63</td>
<td>2.27</td>
</tr>
<tr>
<td>Jarque-Bera</td>
<td>18.17</td>
<td>0.44</td>
<td>4.03</td>
<td>2.58</td>
<td>1.73</td>
<td>2.73</td>
<td>4.17</td>
</tr>
<tr>
<td>Probability</td>
<td>0.00</td>
<td>0.80</td>
<td>0.13</td>
<td>0.28</td>
<td>0.42</td>
<td>0.26</td>
<td>0.12</td>
</tr>
<tr>
<td>Sum</td>
<td>690.01</td>
<td>623.18</td>
<td>112.89</td>
<td>997.23</td>
<td>894.62</td>
<td>946.32</td>
<td>365.10</td>
</tr>
<tr>
<td>Sum Sq. Dev.</td>
<td>10,937.60</td>
<td>863.24</td>
<td>128.12</td>
<td>217.03</td>
<td>194.23</td>
<td>203.18</td>
<td>2,147.26</td>
</tr>
<tr>
<td>Observations</td>
<td>35</td>
<td>35</td>
<td>35</td>
<td>35</td>
<td>35</td>
<td>35</td>
<td>35</td>
</tr>
</tbody>
</table>

Source: Authors’ computation using E-views 8.0 (2017)
Table 1: Descriptive Statistics of the Variables:

The evidence provided in Table 1 show significant trend variations in the variables given the large differences between the maximum and minimum values of the series. Also, all the series were skewed positively except exchange rate, gross domestic product and money supply. The values, exchange rate, gross domestic product, manufacturing output to gross domestic product, unemployment rate and broad money supply ($MS_2$) are platykurtic in nature because its kurtosis value were less than 3 which is the threshold for normal distribution. The variables, Inflation rate and interest rate had values 4.37 and 3.43 respectively as its result which signified that it was leptokurtic in nature because its value is greater than 3 indicating a higher than normal distribution.

The goodness of fit test (Jacque-Bera) statistic signposts the combined skewness and kurtosis standard. The Jarque-Bera $p$-values is indicative of the non-normality of the series. Nevertheless, and in order to check stability of the series, the unit root test had to be conducted. The result of the exercise is made available in the next section.

**Stationarity Test Results:**

The unit root test results are presented in Table 2.

Table 2: Unit Root Test Results: Augmented Dickey Fuller Test:

<table>
<thead>
<tr>
<th>Series</th>
<th>5% Critical Value</th>
<th>ADF Test at first difference (Prob.)</th>
<th>Equation Specification</th>
<th>Order of integration</th>
</tr>
</thead>
<tbody>
<tr>
<td>INF</td>
<td>-2.96</td>
<td>-5.35 (0.00)</td>
<td>Intercept</td>
<td>I(1)</td>
</tr>
<tr>
<td>IR</td>
<td>-2.96</td>
<td>-5.05 (0.00)</td>
<td>Intercept</td>
<td>I(1)</td>
</tr>
<tr>
<td>LNEXRATE</td>
<td>-2.96</td>
<td>-4.96 (0.00)</td>
<td>Intercept</td>
<td>I(1)</td>
</tr>
<tr>
<td>LNGDP</td>
<td>-2.96</td>
<td>-5.48 (0.00)</td>
<td>Intercept</td>
<td>I(1)</td>
</tr>
<tr>
<td>LNMANU</td>
<td>-2.96</td>
<td>-5.45 (0.00)</td>
<td>Intercept</td>
<td>I(1)</td>
</tr>
<tr>
<td>LNMS2</td>
<td>-2.96</td>
<td>-3.27 (0.00)</td>
<td>Intercept</td>
<td>I(1)</td>
</tr>
<tr>
<td>UNEMPLOYR</td>
<td>-2.96</td>
<td>-4.28 (0.00)</td>
<td>Intercept</td>
<td>I(1)</td>
</tr>
</tbody>
</table>

Source: Authors computation using E-Views 8.0 (2017)

Since all the variables in table are all stationary at first the difference the use of the Ordinary Least Square (O.L.S) estimation technique is unsuitable. The Johansen cointegration test is applied for determining the long-run
relationship amongst the variable. This method as designed by Johansen (1988) and Johansen and Juselius (1990) is based on an unrestricted vector autoregressive (VAR) model which is specified in the form of error-correction model. Prior to this estimation, the optimal lag length will have to be calculated because the cointegration technique is lag sensitive.

**Estimation Results:**
Optimal Lag Length Selection:
The lag selected length expounds the consequential implication of the previous year’s result of previous year on the current year. The result is provided in Table 3.

Table 3: Optimal Lag Length Selection Criteria:

<table>
<thead>
<tr>
<th>Lag length</th>
<th>LogL</th>
<th>LR</th>
<th>FPE</th>
<th>AIC</th>
<th>SC</th>
<th>HQ</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>-250.96</td>
<td>NA</td>
<td>0.02</td>
<td>16.12</td>
<td>16.44*</td>
<td>16.22*</td>
</tr>
<tr>
<td>1</td>
<td>-194.14</td>
<td>85.23*</td>
<td>0.02*</td>
<td>15.63</td>
<td>18.20</td>
<td>16.48</td>
</tr>
<tr>
<td>2</td>
<td>-139.38</td>
<td>58.19</td>
<td>0.02</td>
<td>15.27*</td>
<td>20.08</td>
<td>16.87</td>
</tr>
</tbody>
</table>

Source: Authors computation using E-views 8.0(2017)
* indicates lag order selected by the criterion

HQ = Hannan-Quinn information criterion
AIC = Akaike information criterion
LR = sequential modified LR test statistic (each test at 5% level)
SC = Schwarz information criterion
FPE = Final prediction error

The different criterion selected disparate optimal levels. As advised by lowest lag length as prescribed by the Schwarz information criteria (0) is selected. The next step in the estimation process - the Co-integration is presented in the next section.

**Cointegration Test Result:**
Two kinds of tests considered under the Johansen cointegration technique are the Eigenvalue and Trace statistic tests. The Trace statistics in examining the null hypothesis assumes that the number of distinct cointegrating vectors (r) is more than the \( r \) against a general alternative. On the other hand, the
maximal eigenvalue tests measures (r) against the alternative of r+1 cointegrating vectors. The respective equations are as follows:

\[ \lambda_{\text{trace}} = -T \sum_{i=r+1}^{n} \ln (1 - \lambda_i^2) \]  
(4)

\[ \lambda_{\text{max}} = -T \ln (1 - \lambda_{r+1}) \]  
(5)

Where:

\( \lambda_i \) = the estimated values of the ordered eigenvalues

\( T \) = the number of the observations after the lag adjustment.

The Johansen Co-integration result based on hypothesized 5 percent level of acceptance is reported Table 4.

Table 4: Result of Johansen Co-integration test based on Trace Statistic and Max Eigenvalue:

<table>
<thead>
<tr>
<th>No. of CE(s)</th>
<th>Trace Statistic</th>
<th>Max. Eigen Value</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Eigenvalue</td>
<td>Trace Statistic</td>
</tr>
<tr>
<td>None *</td>
<td>0.93</td>
<td>238.05</td>
</tr>
<tr>
<td>At most 1 *</td>
<td>0.88</td>
<td>156.43</td>
</tr>
<tr>
<td>At most 2</td>
<td>0.76</td>
<td>91.83</td>
</tr>
<tr>
<td>At most 3</td>
<td>0.56</td>
<td>47.05</td>
</tr>
<tr>
<td>At most 4</td>
<td>0.29</td>
<td>21.47</td>
</tr>
<tr>
<td>At most 5</td>
<td>0.20</td>
<td>11.03</td>
</tr>
<tr>
<td>At most 6*</td>
<td>0.12</td>
<td>4.11</td>
</tr>
</tbody>
</table>

Source: Authors computation using E-views 8.0 (2017)

Notes:

Trace test indicates 2 cointegrating eqn(s) at the 0.05 level
Max-eigenvalue test indicates no cointegration at the 0.05 level
* denotes rejection of the hypothesis at the 0.05 level
**MacKinnon-Haug-Michelis (1999) p-values

The Johansen co-integration test are optimized at most 6 which means the presence of a long-run connection between the output of manufacturing and GDP, inflation rate, interest rate, exchange rate, gross domestic product, broad money supply(MS2) and unemployment rate. The result of the estimated long-run relationship is presented in Table 5 and equation (6).
Vector Error Correction Model:
In order to know the existence of possible short-term relationship, the Vector Error Correction Model is estimated. This is done by integrating the multivariate time series, the dynamics of which assists the maintenance of the equilibrium in the long-run. The result is reported in Table 5.

Table 5: Vector Error Correction Model (VECM) Result:

<table>
<thead>
<tr>
<th>Error Correction:</th>
<th>D(LNMANU,2)</th>
<th>D(INF,2)</th>
<th>D(IR,2)</th>
<th>D(LNEXRATE,2)</th>
<th>D(LNGDP,2)</th>
<th>D(LNMS2,2)</th>
<th>D(UNEMPLOYR)</th>
</tr>
</thead>
<tbody>
<tr>
<td>CointEq1</td>
<td>0.63</td>
<td>17.72</td>
<td>-4.47</td>
<td>-0.13</td>
<td>0.42</td>
<td>-0.11</td>
<td>1.20</td>
</tr>
<tr>
<td>(0.198)</td>
<td>(8.19)</td>
<td>(2.02)</td>
<td>(0.22)</td>
<td>(0.09)</td>
<td>(0.06)</td>
<td>(1.30)</td>
<td></td>
</tr>
<tr>
<td>T-stat (Cal)</td>
<td>[3.53]</td>
<td>[2.16]</td>
<td>[2.22]</td>
<td>[-0.61]</td>
<td>[4.61]</td>
<td>[-1.74]</td>
<td>[0.92]</td>
</tr>
</tbody>
</table>

Source: Authors computation using E-views 8.0 (2017)

The null hypotheses is accepted since the tabulated absolute T-stats value (2.05) is greater than the calculated absolute value LNEXRATE (0.61), LNMS2 (1.74) and UNEMPLOYR (0.92). This means that no short run association exists among manufacturing output and each of GDP, exchange rate, broad money supply and unemployment rate. This does not apply to INF (2.16), IR (2.99), LNGDP (4.61) which is greater than the tabulated T–stats value. After normalization with respect to the independent variable, the result of the VECM is presented in Table 6.

Table 6: Result of Vector Error Correction Model Regression Test:

<table>
<thead>
<tr>
<th>Variable</th>
<th>Co-Efficient (After Normalization)</th>
<th>Standard Error</th>
<th>T-Statistic</th>
</tr>
</thead>
<tbody>
<tr>
<td>LNMANU</td>
<td>1.00</td>
<td></td>
<td></td>
</tr>
<tr>
<td>LNGDP</td>
<td>4.85</td>
<td>0.34</td>
<td>14.47</td>
</tr>
<tr>
<td>INF</td>
<td>-0.00</td>
<td>0.01</td>
<td>-0.69</td>
</tr>
<tr>
<td>IR</td>
<td>-0.00</td>
<td>0.02</td>
<td>-0.13</td>
</tr>
<tr>
<td>LNEXRATE</td>
<td>-0.66</td>
<td>0.20</td>
<td>-3.25</td>
</tr>
<tr>
<td>LNMS2</td>
<td>-3.58</td>
<td>0.31</td>
<td>-11.73</td>
</tr>
<tr>
<td>UNEMPLOYR</td>
<td>0.19</td>
<td>0.03</td>
<td>7.45</td>
</tr>
</tbody>
</table>

Source: Authors Computation using E-Views 8.0(2017)

The estimated model is shown in equation 6
\[ \text{LNMANU} = 4.85 \text{LN GDP} - 0.00 \text{INF} - 0.00 \text{IR} - 0.66 \text{LN EX RATE} - 3.58 \text{LN MS2} + 0.19 \text{UNEMPLOYR} \]

R-squared: 0.77  \quad \text{Adjusted R-squared: 0.54} \quad (6)

The equation (6) means that a positive relationship exists between manufacturing output to GDP and gross domestic product. This relationship is statistically significant at 5 percent since the absolute calculated t statistic (14.70) is greater than tabulated t-statistics (2.05 at df \(_{28}\)). A percentage increase in unemployment rate would result in an upward rise in LN MANU which is against the apriori expectation and both variables were statistically significant.

However, a negative relationship existed amongst inflation rate, interest rate, exchange rate and manufacturing output to GDP and all the three variables were not statistically significant with manufacturing output to GDP, LN MANU except exchange rate. Furthermore, an inverse relationship was portrayed between broad money supply and manufacturing output of GDP and both variables were statistically significant based on the absolute calculated t-statistic (11.73) being greater than tabulated t-statistics (2.05 at df \(_{28}\)). The R-squared is 0.77 means that approximately 77\% of the variations in manufacturing output to GDP is explained by gross domestic product, inflation rate, interest rate, exchange rate, broad money supply and unemployment rate. The next in the estimation phase is the conduct of some post-estimation tests to check the validity of the model.

**Post-Estimation Tests:**

The results of serial correlation, autocorrelation of the residuals and heteroscedasticity tests are presented in the next sub-sections.

Serial Correlation (Breusch-Godfrey Lm) Test:
The result of the serial correlation test between the variables using the Breusch-Godfrey Lm test is in Table 7.

Table 7: Serial Correlation (Breusch-Godfrey LM) Test:

<table>
<thead>
<tr>
<th>F-statistic</th>
<th>0.12</th>
<th>Prob. F (2,25)</th>
<th>0.89</th>
</tr>
</thead>
<tbody>
<tr>
<td>Obs*R-squared</td>
<td>0.32</td>
<td>Prob. Chi-Square (2)</td>
<td>0.85</td>
</tr>
</tbody>
</table>

Source: Authors computation using E-views 8.0 (2017)
The presence of serial correlation is confirmed since the chi-square probability value of 0.00 is less than the 5% significance level. The presence of autocorrelation in the residuals is tested next.

### Durbin Watson statistics Tests:
This result of auto-correlation between the residuals is provided in Table 8.

<table>
<thead>
<tr>
<th>DW Value (d)</th>
<th>D-Upper ($d_U, \alpha$)</th>
<th>D-Lower ($d_L, \alpha$)</th>
<th>Decision Criteria</th>
</tr>
</thead>
<tbody>
<tr>
<td>2.14</td>
<td>1.97</td>
<td>1.03</td>
<td>No Decision</td>
</tr>
</tbody>
</table>

Source: Authors computation using E-views 8.0 (2017)

The essence of the autocorrelation test is to ascertain if the error terms are interrelated over time. This test is beneficial for the immediate past period. Since the Durbin Watson (d) value of greater than both the lower and the upper threshold values ($4 - d_U \leq d \leq 4 - d_L$), the presence of autocorrelation result can be taken as being inconclusive.

### Heteroscedasticity (Breusch-Pagan) Tests:
The absence of heteroscedasticity is one of the basic assumptions of OLS. The result of the heteroscedasticity is presented in Table 10.

<table>
<thead>
<tr>
<th>F-statistic</th>
<th>5.40</th>
</tr>
</thead>
<tbody>
<tr>
<td>Prob. F (6,27)</td>
<td>0.00</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Obs*R-squared</th>
<th>18.54</th>
</tr>
</thead>
<tbody>
<tr>
<td>Prob. Chi-Square (6)</td>
<td>0.01</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Scaled explained SS</th>
<th>42.93</th>
</tr>
</thead>
<tbody>
<tr>
<td>Prob. Chi Square (6)</td>
<td>0.00</td>
</tr>
</tbody>
</table>

Source: Authors computation using E-views 8.0 (2017)

After estimation, result shows that the Probability or P Value of the Obs* R-squared is 0.00 which is less than 5% significance level. In effect, the null hypothesis of heteroscedasticity that of the absence of heteroscedasticity, is not accepted. This means that some of the variables are not homoscedasticity. Notwithstanding the presence of heteroscedasticity, the OLS estimator although inefficient is still unbiased because according to Johnson (1972), the true variance and covariance are merely underestimated. This is because as proved by Gujarati and Porter (2009), only the dynamic conditional variances
have been affected and not the unconditional variances. In addition, Fox (1997) as cited by Gujarati & Porter, (2009) except the problem is severe, there is no need to worry about unequal error variance. The model validity is not compromised.

**Discussion of Findings:**
An individual review of each macroeconomic variables shows disparate results as presented in turns. 
GDP: The estimation result of this research is consistent with the findings of Onakoya (2014) with respect to the Kaldor (1966) proposition on the importance of manufacturing industry to the Nigerian economic growth in the long run. This corroborates the findings of Anaman and Osei-Amponsah (2009) in the quest for the determinants of the output of the manufacturing industry in Ghana from 1974 to 2006 reported a connection between manufacturing output and per capita real GDP in the long run. In similar vein, Amakom (2012) attributes the efficiency of a country’s economy to the strength of its manufacturing sector. Even with micro-level data, Fazio, Maltese and Piacentino (2011) who in Italy assessed the classic and augmented forms of Verdoorn’s Law for both the manufacturing sector confirm increasing returns to scale at both levels. The rapidity of manufacturing sector growth as found out by Penélope and Thirlwall (2013) propels the economy on the path of accelerated positive growth because of increased share of the manufacturing sector (Thirlwall, 2013). The extent of growth is however queried by McCombie (1982) who submitted that short run constrictions including as labour and sectoral bottlenecks may hinder such growth.
Interest rate: The reduction in interest rates triggers inflation and affects the level of investment as people have more capital to purchase goods and services as captured in the liquidity and price puzzles of the Keynesian IS-LM framework. This study finds that in Nigeria, the high rate of interest level has deleteriously affected the manufacturing sectoral growth in line with Rasheed, (2010) who ascribed to high production cost. As for Okafor’s (2012) ominous prediction the performance level of Nigerian manufacturing companies will continually wane because of low budget implementation by government.
Inflation: The effects of lasting increases in the inflation rate and increased money supply for long-run activity appear very complex. The agreement about the adverse effect of inflation on real economic growth has explained little, leaving the greater part of the phenomenon undetermined. The negative and non-significant impact recorded by this study is consistent with the findings on non-linear connection between inflation and economic growth. In line with the findings of Li (2014), when rate of inflation is low, the association is insignificant or even positive to explicate the growth of output. At higher levels however, inflation generate a negative and significant impact on economic growth. In Nigeria the inflationary rates have been on the ascendancy. This in congruence with the result of the work of Tomola, Adebisi and Olawale (2012) exposed the significant adverse effect of high bank lending rates on capacity utilization and consequently the drop in the output of manufacturing companies in Nigeria.

Money supply: The Monetarists theory of inflation posits that increased money supply is effective for increasing the level of employment and production only in the short run and not in the long term. This is in similar to the findings of this research which finds an insignificant relationship between broad money supply and manufacturing output in the long run. The reason ascribed to this in theory is that although an expansionary monetary policy causes a rise in the production level and a reduction in the natural rate of unemployment, its effectiveness in the long run diminishes as the rigidities of production and distribution are evened out. The resultant inflation is the consequential effect of such expansionary policy in the long run.

Exchange rate: The impact of last global financial meltdown in 2009 examined by Loto (2012) was insignificant on the Nigerian manufacturing sector due in part to its relative small size. The result of this study is however in line with the findings of Enu and Havi (2014) in Ghana whose study results reveal negatively significant coefficient of log of real exchange rate (-0.32%) meaning that 1% rise in real exchange rate is related to a reduction of 0.32% in industrial output. Indeed, the inelastic real exchange rate in Ghana is similar to the (-0.66%) in Nigeria due in part to the overly dependence of imported raw materials and machinery required to keep the manufacturing sector going in the two developing economy.
Unemployment: The deduction from the third law of Kaldor also holds for this study with respect to the positive relationship between employments in manufacturing sector and manufacturing output growth. Indeed, 1 percent increase in employment is in tandem with 0.19 percent manufacturing growth. The question raised by Nickolas (2015) on how automated work upset structural unemployment rates is germane since this may lead to structural unemployment. It appears that the low level of industrialization and technology adoption in Nigeria may have accounted for the non-crowding out of low skilled workers. Akeju and Olanipekun (2014) and this research paper both concluded that the Okun’s law which stated a negative relationship existed between unemployment rate and economic growth was invalid in Nigeria.

Composite effect: A composite and dynamic discussion reveals that with an adjusted R-squared of 0.54, the identified variables accounted for fifty-four percent of the variations in the output of manufacturing sector in Nigeria. In congruence with the 2008 panel data study by Elhiraika on 36 African countries also deployed the vector error correction model and came to similar conclusions. The research by Amassoma and Nwosa, (2013) is also validated by this paper in terms of the short run and long run relationship and absence of short run relationship with manufacturing productivity and unemployment rate. The paper authored by Imoughele and Ismaila (2014) had similar results with this paper with respect to interest rate and exchange rate which were a negative relationship of the manufacturing contribution to GDP. It however departs from the findings of this study with negative broad money supply and inflation rate.

Managing the ‘five sisters’ – macroeconomic variables is more difficult than managing the impossible trinity (trilemma). There are conflicting interlinkages and spill-over effect. For example, inflation generates adversative effects on the Balance of Payment and the foreign exchange reserves. A high levels of domestic inflation may lead to spike in manufacturing production cost and over valuation of the rate of foreign exchange. Reduction in manufacturing output may arise from structural unemployment as a result of destructive innovation due new technological breakthrough. Exchange rate policy regime fluctuation may lead to loss of confidence and consequential capital flight as experience in the Nigeria in 2016 and the first
half of 2017. These led to closure of factories as the dearth of foreign currency hindered the importation of requisite raw materials, machinery and spare parts for the industrial sector.

**Conclusion**

The focus of this research paper is to identify within an empirical framework, the relationship between manufacturing productivity and some macroeconomic variables, specifically the national output, rates of inflation, interest, exchange rate and of unemployment, in the context of the Keynesian IS-LM framework. The vector error correction model (VECM) was adopted based on the stationarity of the series at the first difference.

The empirical findings in this study reflected the dynamics of the macroeconomic environment. Whereas the output of the manufacturing sector was positively and significantly related to both GDP and unemployment, it was had a negative but statistical insignificant relationship with inflation rate, interest rate, exchange rate. The presence of serial correlation, absence of homoscedasticity, inconclusive result on autocorrelation tests did not invalidate the robustness of the estimation model.

The management of the macroeconomic variables is encapsulated in the fiscal and monetary policies. There is the need for these strands of economic policies to be harmonized if sustainable development is to be achieve. The discordant tunes from the fiscal and monetary authorities to the management of the current economic downturn in Nigeria further compounded the malaise. The Nigerian economy in 2016 went into recession, the first contraction since June 2004 (CITATION). Recession is defined as "a slump in economy of a country for a minimum of two quarters of a year" (CITATION). Nigeria recorded negative GDP growth of -0.36%, -2.06%, -2.4% and -X.YY)% in the first quarter through to the last quarter of 2016. The weakened economy is caused primarily by a dependency on oil which provides over 75% of the national budgeted revenue and over 90% of export earnings (CBN Statistical Bulletins, various years). It was manifested in visible wholesale-retail sales, industrial production and increased unemployment.

The rate of interest rate for example, rose from in Q3 & Q4 from 12% to 15% coupled with an epileptic foreign exchange policy was contrary to the avowed policy of the fiscal authority to 'spend our way' out of recession by expansionary government expenditure. This led to up-trended inflationary
throughout 2016 as evident increase consumer prices from 12.8% in March 2016 through 13.7 % in April and 17.6 % in September. Indeed the core inflation rate in Nigeria increased by 17.85% in January of 2017 over the correspondent period in 2016. Indeed, as at August 2016, about 4.58 million were unemployed. In ratio terms, the figure rose from 12.1% in quarter 1, through 13.3% in quarter 2 and 14% in quarter 3. As at November 2016, the ratio stood at 17.8% foreign direct investments and portfolio investments dropped by -23.75% and -9.49% respectively. Industrial output which stood at -10.1 in the first quarter of 2016 rose to 0.1% in the second quarter only to crash to -3.6% and -8.7% in the third and fourth quarters of 2016 respectively (Nigeria Industrial Production, 2007 to 2017) https://tradingeconomics.com/nigeria/industrial-production).

The Economic Recovery and Growth Plan (2017-2020) of the Nigerian government aimed at stabilizing the macroeconomic environment may be a panacea to this dichotomous planning malaise. However, as observed by Ajayi (2011), the low of the manufacturing sectoral output, can be blamed on poor budget implementation. The government will need to match it words with action by harmonizing both the fiscal and monetary policies in order to achieve sustainable growth and stable macroeconomic stability.

References:


Bakare A.S. (2011). The impact of interest rates policy on the performances of manufacturing sub sector in Nigeria Prime Journals of Business Administration and Management (BAM). 1(8), 250-256


