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# HUMAN CAPITAL, TECHNOLOGICAL DEVELOPMENT, INFRASTRUCTURE, AND MANUFACTURING SUBSECTOR PERFORMANCE IN NIGERIA

**Lionel Effiom**
Department of Economics, University of Calabar, Calabar, Nigeria
leoeff2002@yahoo.com

**Okoiarikpo Benjamin Okoi**
Department of Economics, University of Calabar, Calabar, Nigeria
okoibenokoi@gmail.com

**Abstract**

*This study examined the relationship among human capital, technological development, infrastructure, and the performance of the manufacturing sub-sector in Nigeria between 1970 and 2015 through the use of the Autoregressive Distributed Lag (ARDL) model/ Bounds test and the Toda-Yamamoto causality test. The findings revealed, among others, that the development of human capital, infrastructure and technology do not lead to improvements in the performance of the manufacturing sector in Nigeria. Based on the findings, the study recommended, inter alia, that the government should formulate and implement policies aimed at improving the quantity and quality of the nation`s economic infrastructure, the quantity and quality of the health services, the quantity, and the quality of the nation`s human capital.*

*Keywords: Human capital, technological development, infrastructure, Manufacturing Subsector Performance, Autoregressive Distributed Lag Model*

## INTRODUCTION

Throughout the course of recorded history, the manufacturing sector has stood out as one of the most important sub-sectors of the industrial sector and a key determinant of the pace and sustainability of the processes of economic growth and development. This is reflected in the fact that the revolution and rapid spread of manufacturing activities was at the heart of the industrial revolution in the major countries in Europe which resulted in its emergence as world economic and political power. The importance of the manufacturing sector as a major determinant of the pace of growth and development lies in its role as the most dynamic component of the industrial sector.

The development of the manufacturing sector has been an integral part of the development objective of the Nigerian government since the country attained political independence in 1960. This has been pursued through several avenues with particular emphasis on investment in human capital (HC) and technological development. Equally, government has, within this development matrix, invested hugely in infrastructure (roads, energy, telecommunications, etc.) and other social overhead capital (education and health). Copious evidence of these efforts abound in the sheer number of primary and secondary schools, universities, polytechnics, colleges of education and various other research and educational institutions established by government. The efforts made by the government in the development of HC, technology and infrastructure derives from the general recognition of the fact that human capital is the major source of wealth, and by implication economic development (Jhingan, 2004). There is also convergence of opinion that investments in human capital and technology are central to improvements in the level of productivity, and the pace of economic growth and development (Posu, 2006; Olayemi, 2012). This is reflected in the requirement by the United Nations Development Program (Olayemi, 2012) that attempts at economic development should place emphasis on the development of human capital via the effective management of the economy and the equitable distribution of wealth.

These strides notwithstanding, Nigeria is still deficient with respect to the development of human capital. For instance, in 2016, Nigeria's Human Development Index (HDI) was 0.527, ranking 152nd globally (UNDP, 2016). Equally, constraints in local technological development are also echoed in the nation's poor performance with respect to key development indicators. The country had a low Information and Communication Technology (ICT) Development Index of 2.61in 2015, a ranking of 134th out of 167 countries examined. The country also had a low Network Readiness Index in 2016 of 3.2, with a ranking of 119 out of the 139 countries included in the survey (Aginam, 2015; World Economic Forum, 2016). Furthermore, the country performs poorly with respect to the provision of infrastructure.

Nigeria's poor performance with respect to the development of its human capital, technology and infrastructure casts doubts on its capacity to develop its manufacturing subsector. This is especially so as the nation's manufacturing subsector performance has been dismal over the years. Chete, Adeoti, Adeyinka and Ogundele (2013) showed that the industrial sector in Nigeria accounts for only 6 percent of economic activity, while the manufacturing sector contributed only 4 percent to GDP in 2011. Affirming this dismal state, Ubi and Effiom (2012) submit that manufacturing sector output growth fell by an average of 1.5 per annum from 1980 to 1984. The importance of manufacturing lies in the fact that the more the value added in production, the greater the domestic and international value of the product or service.

With the above context, there is a need for the assessment of the impact of human capital, infrastructure and technological development on the performance of the manufacturing subsector as reflected in its output value added. Specifically, the study is burdened to providing answers to the following questions: what is the impact of HC development on the performance of the manufacturing subsector in Nigeria? What is the impact of technological development on the performance of the manufacturing subsector in Nigeria? Has the development of infrastructure in Nigeria had any significant impact on manufacturing subsector performance?

## REVIEW OF LITERATURE AND THEORETICAL ISSUES

The respective impact of human capital development (HCD), infrastructure and technology on economic growth has received much attention in the literature. These interests stems from their importance in the attainment of sustained rates of growth, and ultimately, economic development. Studies on the growth impact of HCD in Nigeria include the study by Isola and Alani (2012) which examined the impact of the development of HC on economic growth in Nigeria between 1980 to 2005 using the ordinary least squares (OLS) method of estimation. The study found that adult literacy rate, which was used as a measure of HCD has a positive and significant impact on economic growth in Nigeria. On the other hand, the second measure of HCD, life expectancy at birth, had a positive but non-significant impact on economic growth in Nigeria. Another study by Adekola (2014) evaluated the effect of regime shifts in government investment in HC and economic growth in Nigeria between 1961 and 2012. Employing Vector error correction model (VECM), the results revealed that the expenditure on HCD at both the state and federal levels have a positive impact on economic growth in Nigeria.

The findings of the study by Ojokuku and Sajuyigbe (2015) which examined the impact of the development of HC on the performance of small and medium scale enterprises (SMEs) in Nigeria revealed that HCD, as reflected in on-the job training, participation in workshops, conferences and seminars, and the level of formal education of the employees of SMEs, has a

significant impact on SME performance in Nigeria. The study was based on the random selection of 80 small and medium enterprises (SMEs) based in Ibadan, the capital of Oyo state, Nigeria. Both the multiple regression analysis and Pearson product moment correlation coefficient were used in the analysis of the data derived from the SMEs.

Similarly, Anumudu (2010) used the OLS method in the examination of the effect of HC on the productivity of labour in Anambra and Enugu states of Nigeria. The results of the study revealed that HC has a positive impact on the productivity of labour in the manufacturing sector. In particular, medicare, research, education and training were found to have a strong correlation to the level of productivity in both states. The results further revealed that the impact of HC on the productivity of manufacturing activities was highest in the Onitsha Aluminium manufacturing company. On the other hand, the findings of the study by Anochiwa and Maduka (2014) which investigated the impact of HC and infrastructure on economic growth in Nigeria within the period 1970 to 2010 revealed that of HChas a positive but insignificant impact on economic growth in Nigeria. The study was based on the use of the Johansen cointegration test and the error correction model (ECM).

With respect to the industrial sector, the study by Adejumo, Olomola and Adejumo (2013) assessed the role of human capital in the development of the industrial sector in Nigeria between 1980 and 2010 using the Johansen cointegration technique. The results revealed that while HC has a significant impact on the value added in the industrial sector, its impact on the sector's output is small. A related study by Olayemi (2012) investigated the relationship between the investment in HC and productivity in the industrial sector in Nigeria between 1978 and 2008 using the Error Correction Model (ECM) and Granger causality test. The results revealed that government expenditure on the health sector has a negative long run relationship with the productivity of the industrial sector, while government expenditure on education has a positive long run relationship with the productivity of the industrial sector.

Existing studies on the relationship between the level of technology and productivity are mostly foreign. The few studies on the effects of technology on the level of productivity in Nigeria are mostly focussed on information and communication technology (ICT). The studies on the impact of technology on productivity includes that of Posu (2006) which assessed the role of (ICT) in Nigeria between 1999 and 2004 using the OLS method of estimation. The study found that ICT has a positive and significant impact on economic growth in Nigeria.

Another study by Madu (2016) evaluated the impact of the choice of production technique and orientation of technology on the performance of manufacturing enterprises in Nigeria. The study was based on the survey of ten manufacturing enterprises in Jigawa, Kano and Kaduna states, and the OLS method of estimation. The results indicated the existence of a

strong and positive relationship between production technique and the performance of manufacturing enterprises within the study area. The results further indicated the existence of a positive relationship between the technological orientation of manufacturing enterprises within the study area and their performance.

Dauda and Akingbade (2011) examined the impact of technological change on the performance of employees in selected manufacturing enterprises in Lagos state, Nigeria through the use of the OLS and the analysis of variance (ANOVA) techniques. The study found that there was a significant relationship between changes in technology and the skills of employees in the sampled enterprises. The study also found that there was a significant relationship between changes in technology and the performance of employees in the selected enterprises. Similarly, Joseph, Julius and Olugbenga (2014) assessed the impact of technological innovations, capabilities and clustering on the performance of firms making furniture in South Western Nigeria. The study found that technological innovations, capabilities and clustering have a positive impact on the performance of firms making furniture in the study area.

Adeyeye, Jegede and Akinwale (2013) examined the effect of technological research and development, and innovation on the performance of firms in the service sector in Nigeria. The results revealed that technological innovation has a positive and significant impact on the performance of firms in the service sector in Nigeria. The study further found that while government support and embodied knowledge do not have a significant impact on technological innovation in Nigeria, factors such as technological acquisition, training, in-house research and development have a positive impact on technological innovation in the country.

Ringim, Razalli and Hasnan (2015) investigated the link between information technology capability and the organizational performance of banks in Nigeria using the OLS method. The data for the study was collected using 560 questionnaires. The study found that information technology capability of banks in Nigeria had a significant impact on their performance. A related study by Chinonso (2012) assessed the effect of information technology on the growth and development of the Nigerian banking industry through the use of First Bank, Zenith Bank and United Bank for Africa as case studies. The study was based on the use of the Chi-square technique. The study results indicated that the use of information technologies has resulted in the development of banking activities in Nigeria as reflected in improvements in the quality of services delivered, improvements in the satisfaction of customers, as well as reduction in the incidence of fraud.

While few studies exist on the growth impacts of technology development, several studies exist on the impact of infrastructure development on economic performance, especially

with reference to the Nigerian economy. The studies on the Nigerian economy however mainly focus on the supply of electricity on the performance of the economy. This might be explained by the paucity of data, especially on a time series basis, on the supply and state of other economic and social infrastructure in Nigeria. The studies on the growth impact of the development of infrastructure in Nigeria include the study by Igbokwe (2015) which examined the effect of supply on infrastructure on real growth in Nigeria between 1981 and 2012 through the use of Multivariate Vector Error Correction Model (VECM). The study found that there exists a unidirectional causal relationship running from the investment in infrastructure to the growth in the real GDP in Nigeria. The results also revealed the existence of a one way causality running from the productivity of the manufacturing sector to the growth rate of the real GDP in the country.

A related study by Akiri, Ijuo and Apochi (2015) assessed the impact of the supply of electricity on the productivity of the manufacturing sector in Nigeria within the period 1980 and 2012 through the use of the Pearson product correlation coefficient. The study found that the supply of electricity had a positive impact on the level of productivity within the manufacturing sector within the study period. The results however also indicated that the impact of the supply of electricity on the productivity of the manufacturing sector was relatively low. This was attributed to the unstable and limited amount of electricity supplied to the sector due to the inefficient allocation of resources to unproductive sectors by the government.

Another study by Ogwo and Agu (2016) investigated the impact of the transport infrastructure and the performance of the manufacturing sector on the growth of the GDP in Nigeria between 1999 and 2011 through the use of the Pearson product correlation coefficient. The results of the study indicated that the road network in Nigeria has a negative impact on the manufacturing sector with respect to the marketing of its output as reflected in its sales and profitability. The study results also revealed that the quality of road infrastructure does not have an impact on the level of capacity utilization in the manufacturing sector, though it was found to have a significant impact on the index of manufacturing production. In a similar vein, the study by Chinedum and Nnadi (2016) evaluated the impact of the supply of electricity on manufacturing sector in Nigeria between 1981 and 2013 through the use of the Johansen cointegration test and the Vector Autoregressive (VAR) model. The study found that while there is a long-run relationship between electricity supply and output of the manufacturing sector in Nigeria, the former does not have a significant impact on the latter.

Another study by Mesagan and Ezeji (2017) evaluated the impact of economic and social infrastructure on the performance of the manufacturing sector in Nigeria through the use of the Error Correction Model (ECM). The results of the study revealed that the effect of growth

in government expenditure on the education sector and its capital expenditure has a significant and positive impact on the value added within the manufacturing sector in Nigeria. On the other hand, the effect of the growth in government expenditure on the generation of electricity and the health sector, the consumption of electricity, the prime lending rate and the rate of inflation had non-significant impacts on the value added in the manufacturing sector. The results of the study further revealed that the level of tele-density had a positive impact on the performance of the manufacturing sector in Nigeria.

The review of literature on the subject matter of the study shows that while several studies have been carried out to examine the economic impact of HC, infrastructure and technology in Nigeria, such studies mainly focused on the growth impacts of these variables. The existing industry related studies on the economic impact of HC in Nigeria such as those of Adejumo et al. (2013) and Olayemi (2012) focus on the industrial sector as whole, while the study by Anumudu (2012) on the impact of HC on the manufacturing sector focussed on firms in Enugu state. The studies on the economic impact of technology in Nigeria such as Madu (2016) Adeyeye et al. (2013) and Dauda and Akingbade (2011) focus on manufacturing firms at the state level, while others such as Ringim et al. (2015) and Chinonso (2012) focus on the impact of technology on the performance of banks in Nigeria. Finally, the studies on the economic impact of the supply of infrastructure in Nigeria such as Akiri (2015) and Chinendum and Nnandi (2010) mainly use the supply of electricity as their main measure of the supply of infrastructure.

This study departs from the approach adopted by the aforementioned studies by focussing on the manufacturing sector at the national level, while using ratio of the output of the manufacturing sector to the GDP as a measure of the sector`s performance. The study also emphasises the importance of the provision of adequate health infrastructure through the use of the infant mortality rate. Furthermore, in capturing the impact of technology on the performance of the manufacturing sector, the study uses the imports of machinery and transport equipment as a measure of the level of technology. Finally, the study also uses a different methodology from those used in the existing studies.

## OVERVIEW OF THE PERFORMANCE OF THE MANUFACTURING SECTOR IN NIGERIA

The overview of the performance of the manufacturing sector is carried out using the rate of growth of the contribution of the manufacturing sector to the GDP and the imports of manufactured goods contained in Tables 1 and Table 2, and Figures 1 and 2. The data in Table 1 shows that there has been a steady increase in the contribution of the manufacturing sector to the GDP over the years. This is reflected in the increase in the contribution of the manufacturing

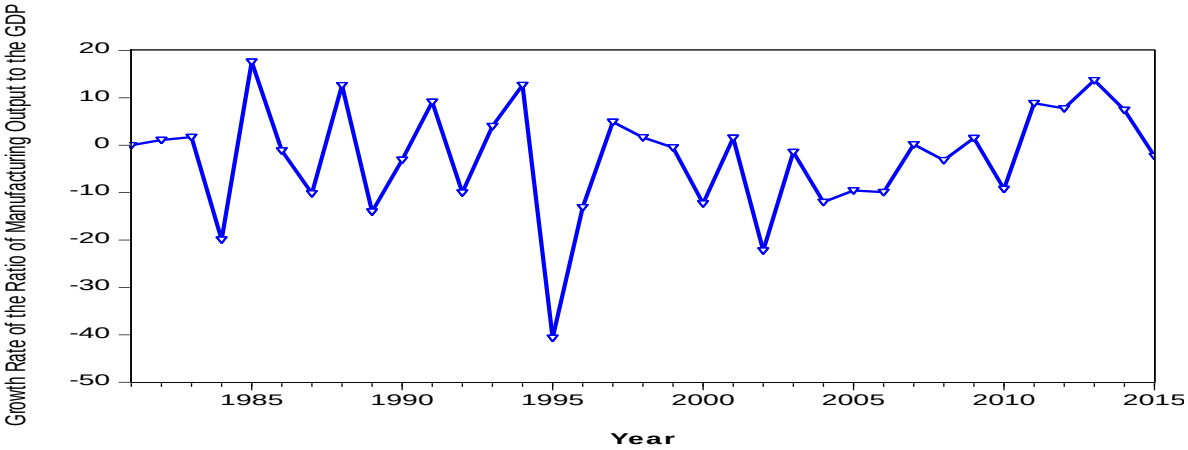
sector to the GDP from 26.89billion naira in 1981, to 546.71billion naira in 1997, 2,082.49billion naira in 2006, and 8,973.77billion naira in 2015. However, the data in Table 1 also reveals that performance of the manufacturing sector, as reflected in the growth rate ratio of manufacturing output to the GDP has been cyclical. For instance, while the growth rate ratio of manufacturing output to the GDP was positive in the years; 1982, 1983, 1988, 1991, 1993, 1994, 1997, 1998, 2001, 2007, 2009, and 2011 to 2014, it was negative within the years: 1984-1990; 1992, 1995, 2002 to 2006, 2008, 2011 and 2015. In particular, high negative growth rates occurred during the years 1989 (-14.02%), 1992(-10.0%), 1995(-40.65%), 2000(-12.3%) and 2002(-22.24%). In 2015, the sector had a negative growth rate of -2.33% of the GDP. On the other hand, high growth rates were recorded in the years 1985 (17.57%), 1988(12.62%), 1994(12.66%), and 2013(13.70%).

The ten year averages for the growth of the ratio of manufacturing output to the GDP and the imports of manufactured goods are presented in Table 2. The data in the Table shows that on the average, growth rate of the ratio of manufacturing output to the GDP was negative in the first ten years of the study period, while an average of 3.6billion Naira was spent on the importation of manufactured goods. The average growth rate of the ratio of manufacturing output to the GDP declined to -4.4275 per cent in the second ten year period (between 1991 and 2000), while the average amount spent on the importation of manufactured goods increased to 154.02 billion naira. There was a further decline in the average ten year growth rate of the ratio of manufacturing output to the GDP between 2001 and 2010 to -6.4509 per cent. During the same period, the average amount spent on the importation of manufactured goods increased to 983.55billion Naira.

Finally, the data in the table shows that the average growth rate of the ratio of manufacturing output to the GDP improved to 3.539 per cent. However, this improvement represents a five year average for the period 2011 to 2015. The negative growth in the contribution of the manufacturing sector to the GDP in 2015 may be seen as an early signal of the latter slide of the economy into a recession and may be explained by several factors including the worsening of the foreign exchange constraint to local manufacturers and the significant outflow of foreign capital from the economy which started in 2014. The positive growth rates between 2011 and 2015 may be attributed to increased capital inflows into the economy during the period. The negative growth rates during the 1980`s may be attributed to the effects of the recession of the late 1970s and early 1980s, as well as the lag from the implementation lag associated with the Structural Adjustment Program (SAP) which was introduced in 1986.

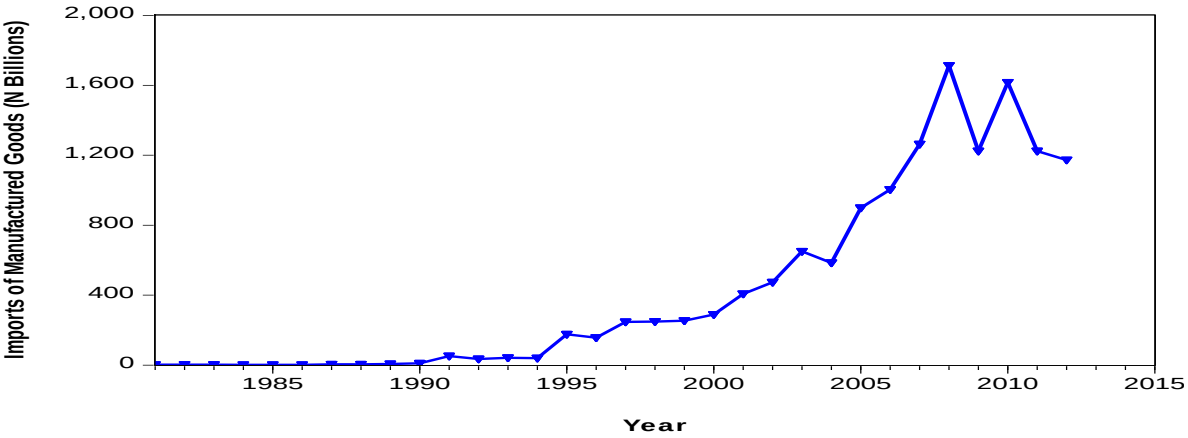
On average, it can be seen that the manufacturing sector performed poorly within the period under consideration. This is reflected, as shown in Table 1, in the increase in the imports of manufactured goods from 2.3billion naira in 1982 to 172.96billion naira in 2012. In particular, the data in Table 2 and Figure 2 shows that there was a significant increase in the imports of manufactured goods within the period 1995 to 2008. This is a reflection of the increased import orientation within the period, and may account for the poor performance of the manufacturing sector within that period. The decline in the imports of manufactured goods within the period 2010 and 2012 may be attributed to the increased challenge posed by the foreign exchange constraint as a result of the continued depreciation in the value of the naira.

Figure 1. Growth Rate of the Ratio of Output of Manufacturing to GDP in Nigeria (1981-2015)




Source: Authors' computation using data from the Central Bank of Nigeria Annual Statistical Bulletin (2015).

Figure 2. Imports of Manufactured Goods in Nigeria (1981-2012)




Source: Authors` computation using data from the Central Bank of Nigeria Annual Statistical Bulletin (2016).

Table 1. Growth Rate of the Ratio of Manufacturing Output to GDP, and the Imports of Manufactured Goods in Nigeria

| Year | Contribution of the Manufacturing Sector to the GDP[1] | The Growth Rate of the Ratio of Manufacturing Output to the GDP[2] | Imports of Manufactured Goods[1] |
|---|---|---|---|
| 1981 | 26.89 | 0 | 2.6 |
| 1982 | 29.09 | 1.090438 | 2.3 |
| 1983 | 31.13 | 1.711845 | 2 |
| 1984 | 27.12 | -19.9426 | 1.4 |
| 1985 | 37.14 | 17.57795 | 1.6 |
| 1986 | 38.65 | -1.16793 | 1.2 |
| 1987 | 43.22 | -10.2005 | 4.5 |
| 1988 | 63.52 | 12.62788 | 4.5 |
| 1989 | 72.9 | -14.0298 | 6.5 |
| 1990 | 84.27 | -3.11089 | 10.2 |
| 1991 | 110.6 | 9.111048 | 52 |
| 1992 | 153.47 | -10.0029 | 35.3 |
| 1993 | 221.23 | 3.998839 | 42 |
| 1994 | 354.66 | 12.66616 | 40 |
| 1995 | 414.13 | -40.6557 | 175.9 |
| 1996 | 477.95 | -13.1007 | 156.4 |
| 1997 | 546.71 | 4.885999 | 247 |
| 1998 | 620.2 | 1.615489 | 248.7 |
| 1999 | 713.82 | -0.48611 | 253.6 |
| 2000 | 826.03 | -12.3074 | 289.3 |
| 2001 | 989.11 | 1.515468 | 406.7 |
| 2002 | 1,127.23 | -22.2475 | 473.5 |
| 2003 | 1,304.07 | -1.46033 | 650.4 |
| 2004 | 1,516.05 | -12.0125 | 584.6 |
| 2005 | 1,778.73 | -9.58268 | 899.1 |
| 2006 | 2,082.49 | -9.93116 | 1,004.10 |
| 2007 | 2,401.19 | 0.162065 | 1,263.60 |

Table 1...

| | | | |
|---|---|---|---|
| 2008 | 2,761.55 | -3.19061 | 1,712.60 |
| 2009 | 3,170.82 | 1.502798 | 1,224.10 |
| 2010 | 3,578.64 | -9.26517 | 1,616.80 |
| 2011 | 4,527.45 | 8.845053 | 1,223.60 |
| 2012 | 5,588.82 | 7.757494 | 1,172.90 |
| 2013 | 7,233.32 | 13.70789 | - |
| 2014 | 8,685.43 | 7.41149 | - |
| 2015 | 8,973.77 | -2.33178 | - |

Source: [1]Central Bank of Nigeria Annual Statistical Bulletin (2016). [2]Author`s computation using data from the Central Bank of Nigeria Annual Statistical Bulletin (2016).

Table 2. Average Growth Rate of the Ratio of Manufacturing Output to GDP, and the Imports of Manufactured Goods in Nigeria

| Year | [1]Average Contribution of the Manufacturing Sector to the GDP | [2] The Average Growth Rate of the Ratio of Manufacturing Output to the GDP | [3]Imports of Manufactured Goods |
|---|---|---|---|
| 1981-1990 | 26.89 | 0 | 2.6 |
| 1991-2000 | 4438.8 | **-4.4275275** | **154.02** |
| 2001-2010 | 20709.88 | **-6.4509619** | **983.55** |
| 2011-2015 | 25,602.61 | **3.5390147** | - |

Source: Central Bank of Nigeria Annual Statistical Bulletin (2016). [1,2,3] Authors` computation using data from the Central Bank of Nigeria Annual Statistical Bulletin (2016).

## THEORETICAL ISSUES

The theoretical anchor of the study is based on Romer`s endogenous growth theory, which highlights the role of knowledge as an input in the production process. An outgrowth of the neoclassical growth theory, the Romer theory explains growth in the long-run via the endogenization of technological growth, something explained away as exogenous in the neoclassical model. Thus, an economy can continue to grow as long as it has an abundance of new knowledge or ideas. The theory is based on the assumption of increasing returns to the basic factor inputs of labour and capital in the long run, and the creation of new technology. The theory also assumes that investment in research by private firms is the main source of new

knowledge and that such firms have market power which ensures that they extract monopoly profits from their investments, and that knowledge is a non-rival good. According to Romer`s theory, the creation of new knowledge by the individual firm, its eventual spill-over, and subsequent adoption and adaptation of same by other firms in the economy is one of the consequences of investment in research (Jhingan, 2007). The mathematical formulation of the Romer model is expressed as follows:

$Y = A(R)\ f\ (Ri, Ki, Li)$

Where:

Y = Aggregate output

A = Public stock of knowledge from research and development (R),

Ri = Stock of results from the stock of expenditure on research and development (the prevalent technology).

Ki = Capital stock of firm i

Li = Labour stock of firm i

**RESEARCH METHODOLOGY**

The theoretical underpinning for this study is the Romer`s endogenous growth theory. The endogenous growth model proceeds from the basic neoclassical Cobb-Douglass production function of the form:

$$Y_c = A_t K_t^{\alpha} L_t^{\phi} \qquad (1)$$

Where *Y* is aggregate output of the economy, *K,* is capital, *L* is labour, and *A*, is the productivity of capital and labour, or technological progress/development. Though equation (1) speaks of economy-wide output, it must be noted that the precursor to this output is the output generated by critical sectors of the economy, of which the manufacturing sector is one of them. Thus there is a conceptual consistency in substituting manufacturing sector output for aggregate output, as done in similar studies deploying the neoclassical production function to model a subset of the economy. Similarly, the variable A, which Romer refers to as "public stock of knowledge from R&D" is relevant in our present context as it reflects the stock of human capital (categorized into education and health) technical progress, and infrastructure in the Nigerian economy which aggregately influence manufacturing output. The model's flexibility allows for augmenting and incorporating other variables into A to properly define the environment under investigation.

Based on the above, *A* in equation (1) becomes:

$$A = f(HC, INFRA, TECH) \qquad (2)$$

Substituting equation (2) into equation (1), we have:

$$Yc = f(HC_{hlt}, HC_{edu}, INFRA, TECH\ K_t^{\alpha} L_t^{\phi}, U) \qquad (3)$$

Where Y is manufacturing sector output, HC is human capital disaggregated into its twin components of health and education, TECH is technology, K, is capital, L is the labour force, and U captures other control variables.

Equation (3) is expressed in its econometric form as:

$$MAPE = \alpha 0 + \alpha 1 GSER + \alpha 2 INFM + \alpha 3 ECON + \alpha 4 TECH + \alpha 5 LABR + \alpha 6 KAPT + U \quad (3.1)$$

$$MVAD = \lambda 0 + \lambda 1 GSER + \lambda 2 NFM + \lambda 3 ECON + \lambda 4 TECH + \lambda 5 LABR + \lambda 6 KAPT + U \quad (3.2)$$

$\alpha_0$, $\lambda_0$,$\alpha_1$, $\lambda_1$, $\alpha_3$, $\lambda_3$,$\alpha_4$, $\lambda_4$, $\alpha_5$, $\lambda_5$,$\alpha_6$, $\lambda_6$> 0 and $\alpha_2$, $\lambda_2$ < 0

Where

MAPE = Manufacturing sector performance

MVAD = Manufacturing value added

GSER = Gross secondary school enrolment ratio

INFM = Infant mortality rate (per 1,000 live births)

ECON = Electric power consumption (kWh per capita)

TECH = Technology

LABR = Labour

KAPT = Capital

U = Stochastic error term

The study uses the ratio of the contribution of the manufacturing sector to the GDP and the value added in the manufacturing sector as measures of the performance of the manufacturing sector. The gross secondary school enrolment ratio and infant mortality rate are also used as measures of the performance of the investments in the educational and health. Both variables are used as measures of the development of HC. Electricity consumption is used as a measure of the level of infrastructural development in the country. The level of technological development is captured using the imports of machinery and transport equipment.

The methodology for the study involves the use of both descriptive and quantitative methods of analysis. The latter entails the use of the Augmented Dickey-Fuller unit root test, the Autoregressive Distributed Lag (ARDL)/Bounds test approach, and the Toda-Yamamoto causality test. We employ time series data derived from various issues of the CBN statistical bulletin and the World Bank`s World Development Indicators covering the period 1970 to 2015.

## ANALYSIS AND RESULTS

The results of the estimation of the two study models are presented in tables 3 to 9. The first table contains the descriptive analysis. The result of this analysis shows that that the average values of variables such as GSER (24.73604),, INFM (117.0652), LECON (4.390229), LTECH

(10.65193), LABR (17.40824), MVAD (24.78848), and KAPT (11.69654) was positive during the study period. On the other hand, the average value MAPE (-3.017725) was negative. The descriptive statistics in Table 3 also shows that there is a significantly wide divergence between the maximum and minimum values of GSER, INFM, LECON, KAPT, MVAD, and TECH. On the other hand, there is divergence between the maximum and minimum values of LABR and MAPE is minimal.

Table 3 also contains the standard deviations of the variables from their mean values. The result shows that the deviation of capital, GSER, INFM, MAPE and TECH is relatively higher than the deviation of the other study variables from their mean values. The descriptive statistics further reveal that GSER, INFM, LECON, MAPE and TECH are negatively skewed. All the other study variables are positively skewed. Finally, the statistical distribution of all the study variables is also Leptokurtic, which implies that their distribution assumes more extreme values.

Table 3. Descriptive Statistics

| | GSER | INFM | LECON | LKAPT | LMAPE | LMVAD | LTECH |
|---|---|---|---|---|---|---|---|
| Mean | 24.73604 | 117.0652 | 4.390229 | 11.69654 | -3.017725 | 24.78848 | 10.65193 |
| Median | 25.25287 | 124.1000 | 4.462953 | 11.32467 | -2.909872 | 24.20287 | 10.88943 |
| Maximum | 43.83671 | 168.9000 | 5.048922 | 15.25236 | -2.259787 | 29.82533 | 15.14062 |
| Minimum | 7.608820 | 69.40000 | 3.192458 | 9.082448 | -3.989748 | 22.27082 | 5.653541 |
| Std. Dev. | 10.20393 | 24.55853 | 0.460433 | 2.163522 | 0.540573 | 2.500976 | 2.979823 |
| Skewness | -0.207008 | -0.167994 | -0.811143 | 0.409110 | -0.403388 | 0.602107 | -0.007886 |
| Kurtosis | 2.130173 | 2.617279 | 3.171083 | 1.633186 | 1.943797 | 2.126525 | 1.673697 |
| Jarque-Bera | 1.778684 | 0.497113 | 5.100407 | 4.863859 | 3.385703 | 4.241755 | 3.372045 |
| Probability | 0.410926 | 0.779926 | 0.078066 | 0.087867 | 0.183994 | 0.119926 | 0.185255 |
| Sum | 1137.858 | 5385.000 | 201.9506 | 538.0406 | -138.8153 | 1140.270 | 489.9890 |
| Sum Sq. Dev. | 4685.408 | 27140.46 | 9.539933 | 210.6371 | 13.14987 | 281.4696 | 399.5705 |
| Observations | 46 | 46 | 46 | 46 | 46 | 46 | 46 |

Table 4. Augmented Dickey-Fuller Unit Root Test

| Variable | At Level (t-Statistic) | Critical Value | At First Difference (t-Statistic) | Critical Value | Order of Integration |
|---|---|---|---|---|---|
| GSER | -2.109397 | -3.513075 | -6.673091 | -3.515523 | *I* (1) |
| KAPT | 3.959157 | -3.529758 | - | - | *I* (0) |
| LABR | 1.495177 | -3.513075 | -5.123478 | -3.515523 | *I* (1) |
| TECH | 1.965366 | -3.536601 | 4.511630 | -3.536601 | *I* (1) |
| ECON | -3.089559 | -3.513075 | -9.004780 | -3.515523 | *I* (1) |
| MAPE | -2.449290 | -3.520787 | -3.849948 | -3.520787 | *I* (1) |
| MVAD | 3.819339 | -3.526609 | - | - | *I* (0) |

The results of the unit root test conducted on the study variables are presented in Table 4. The results reveal that KAPT and MVAD are stationary at levels. On the other hand, GSER, LBAR, LMAPE, LECON and TECH are all stationary after first differencing. Based on the order of integration, and in line with the assumptions of the respective econometric techniques, the study employs the Auto-Regressive Distributed Lag (ARDL) model/Bounds testing approach to test for the possibility of the existence of cointegrating relationships among the study variables. The results of this test are presented in table 5 to 8.

Table 5. ARDL/Bounds Test Result for the Manufacturing Output-GDP Equation

| **Test Statistic** | **Value** | **k** |
|---|---|---|
| F-statistic | 3.169614 | 6 |
| **Critical Value Bounds** | | |
| **Significance** | **I0 Bound** | **I1 Bound** |
| 10% | 2.12 | 3.23 |
| 5% | 2.45 | 3.61 |
| 2.50% | 2.75 | 3.99 |
| 1% | 3.15 | 4.43 |

The Bounds test result in Table 5 indicates the rejection of the null hypothesis of no cointegration for only the lower bounds at one, five and ten per cent levels of significance. The null hypothesis of no cointegration is accepted for the upper bounds at one, five and ten per cent levels of significance. The study thus concludes that the variables included in the industrial output-GDP equation are not cointegrated. The relationship between them cannot therefore be expressed using the error correction model.

Table 6. ARDL/Bounds Test Result for the Manufacturing Value-Added Equation

| **Test Statistic** | **Value** | **K** |
|---|---|---|
| F-statistic | 65.50474 | 6 |
| **Critical Value Bounds** | | |
| **Significance** | **I0 Bound** | **I1 Bound** |
| 10% | 2.12 | 3.23 |
| 5% | 2.45 | 3.61 |
| 2.50% | 2.75 | 3.99 |
| 1% | 3.15 | 4.43 |

The results of the Bounds Test performed on the MVAD equation presented in Table 6 indicates the rejection of the hypothesis of no-cointegrating relationships between the variables included in the model at all levels of significance for the upper bounds. Thus, the study concludes that

the variables included in the manufacturing value-added equation are cointegrated. Thus, the relationship between the variables in the manufacturing value added equation can be expressed using the error correction model. The short and run models are given in Tables 7 and 8.

Table 7. Short-Run ARDL Results for the Manufacturing Value-Added Equation

Dependent Variable: MVAD

| Variable | Coefficient | Std. Error | t-Statistic | Prob. |
|---|---|---|---|---|
| D(MVAD(-1)) | -1.359814 | 0.215104 | -6.32166 | 0 |
| D(MVAD(-2)) | -1.476013 | 0.306201 | -4.82041 | 4E-04 |
| D(MVAD(-3)) | -0.977832 | 0.200497 | -4.87704 | 4E-04 |
| D(INFM) | -60702079738 | 63427700214 | 0 | 0 |
| D(INFM(-1)) | 1.45759E+11 | 1.07244E+11 | 0 | 0 |
| D(INFM(-2)) | 1.09709E+11 | 1.02053E+11 | 0 | 0 |
| D(INFM(-3)) | -1.058E+11 | 43841638730 | 0 | 0 |
| D(GSER) | -4037177564 | 3089063973 | 0 | 0 |
| D(GSER(-1)) | -3980646348 | 4395697391 | 0 | 0 |
| D(GSER(-2)) | 7481120837 | 3604404965 | 0 | 0 |
| D(ECON) | 308156195.7 | 521480834.1 | 0 | 0 |
| D(ECON(-1)) | -3032153113 | 630559271 | 0 | 0 |
| D(ECON(-2)) | -1428490947 | 700213237.3 | 0 | 0 |
| D(TECH) | 473061.8628 | 104693.6405 | 4.518535 | 7E-04 |
| D(TECH(-1)) | -2158910.242 | 277041.8705 | -7.79272 | 0 |
| D(TECH(-2)) | -1554225.195 | 181060.416 | -8.58401 | 0 |
| D(TECH(-3)) | -292886.1716 | 209741.1638 | -1.39642 | 0.188 |
| D(LABR) | -14268.36315 | 12851.59061 | -1.11024 | 0.289 |
| D(KAPT) | -147662.8986 | 112198.1831 | -1.31609 | 0.213 |
| D(KAPT(-1)) | 483013.0343 | 70896.7651 | 6.812907 | 0 |
| D(KAPT(-2)) | 1328731.964 | 224638.1571 | 5.914988 | 1E-04 |
| D(KAPT(-3)) | -1368953.301 | 155192.2028 | -8.82102 | 0 |
| CointEq(-1) | -0.812295 | 0.125606 | -6.46699 | 0 |

Cointeq = MVAD - (15299900176.6112*INFM -3446801223.4682*GSER +
8870223619.9712*ECON + 7731465.1187*TECH -65872.4979*LABR
-2016160.9905*KAPT -565283331006.6443)

The short run result for the manufacturing value added equation presented in Table 7 show that the one, two and three year lags of manufacturing value added have a negative and significant

impact on manufacturing value added in Nigeria. The one and two year lag of technology also have a negative and significant impact on manufacturing value added. On the other hand, the three year lag of technology has negative and non-significant impact on manufacturing valued, while the un-lagged coefficient of technology has a positive and significant impact on manufacturing value added.

The short-run result also reveals that the un-lagged coefficient of infant mortality rate has a negative and non-significant impact on manufacturing value added, while its one, two and three year lags have a positive and significant impact on manufacturing value added. The gross secondary school enrolment ratio and its one year lag have a negative and non-significant impact on manufacturing value added, while its two year lag has a positive and non-significant impact on manufacturing value added. Electricity consumption has positive but non-significant impact on manufacturing value added, while its one and two year lags have a negative and non-significant impact on manufacturing value added. The results also show that the labour force has a negative and non-significant impact on manufacturing value added. Furthermore, capital has a negative and non-significant impact on manufacturing value added, while its one and two year lags have a positive and significant impact on manufacturing value added. On the other hand, the third year lag of capital has a negative and significant impact on manufacturing value added in Nigeria. Finally, the error correction term (Cointegrating equation (-1)) is negatively signed and statistically significant. The estimated coefficient which is in line with theoretical expectations implies that 81.22 per cent of the short-run deviation of manufacturing value added from its equilibrium position is corrected in the long run. This implies that the estimated model has a rapid speed of adjustment.

Table 8. Long-Run ARDL Results for the Manufacturing Value-Added Equation

Dependent Variable: MVAD

| **Long Run Coefficients** | | | | |
|---|---|---|---|---|
| **Variable** | **Coefficient** | **Std. Error** | **t-Statistic** | **Prob.** |
| INFM | 1.53E+10 | 4.35E+09 | 3.520682 | 0.0042 |
| GSER | -3.4E+09 | 5.81E+09 | -0.59342 | 0.5639 |
| ECON | 8.87E+09 | 1.6E+09 | 5.55849 | 0.0001 |
| TECH | 7731465 | 1279943 | 6.040475 | 0.0001 |
| LABR | -65872.5 | 20102.48 | -3.27683 | 0.0066 |
| KAPT | -2016161 | 445481.2 | -4.52581 | 0.0007 |
| C | -5.7E+11 | 9.6E+11 | -0.58885 | 0.5669 |

The long-run results for the manufacturing value-added model are presented in Table 8. The results show that infant mortality rate, electricity consumption and technology have a positive

and significant impact on manufacturing value added in Nigeria in the long-run. On the other hand, labour and capital have negative and significant impact on manufacturing value-added in Nigeria in the long-run, while the gross secondary school enrolment ratio has a negative and non-significant impact on manufacturing value-added in Nigeria in the long-run.

Based on the results of the ADF test, the study proceeds to test for the existence of causal relationships among the variables in both equations through the use of the Toda-Yamamoto causality test. The use of this test is informed by the order of integration of the study variables, which is a mixture of I(0) and I(1) series. The results of the Toda-Yamamoto test (at 5 per cent level of significance) are presented in Tables 9 and 10.

Table 9. Toda-Yamamoto Causality Test Result for the Manufacturing Output-GDP Equation

Dependent variable: MAPE

| Excluded | Chi-sq | df | Prob. |
|---|---|---|---|
| INFM | 3.120208 | 2 | 0.2101 |
| GSER | 3.828801 | 2 | 0.1474 |
| ECON | 0.413010 | 2 | 0.8134 |
| TECH | 0.357992 | 2 | 0.8361 |
| LABR | 0.439716 | 2 | 0.8026 |
| KAPT | 0.742276 | 2 | 0.6899 |
| All | 12.15296 | 12 | 0.4335 |

Dependent variable: INFM

| Excluded | Chi-sq | df | Prob. |
|---|---|---|---|
| MAPE | 9.608174 | 2 | 0.0082 |
| GSER | 2.965549 | 2 | 0.2270 |
| ECON | 0.462753 | 2 | 0.7934 |
| TECH | 0.677738 | 2 | 0.7126 |
| LABR | 17.24728 | 2 | 0.0002 |
| KAPT | 3.457664 | 2 | 0.1775 |
| All | 149.1384 | 12 | 0.0000 |

Dependent variable: GSER

| Excluded | Chi-sq | df | Prob. |
|---|---|---|---|
| MAPE | 1.087665 | 2 | 0.5805 |
| INFM | 3.535578 | 2 | 0.1707 |
| ECON | 0.361132 | 2 | 0.8348 |
| TECH | 5.136588 | 2 | 0.0767 |
| LABR | 0.990003 | 2 | 0.6096 |
| KAPT | 2.363879 | 2 | 0.3067 |
| All | 22.58973 | 12 | 0.0314 |

Table 9....

Dependent variable: ECON

| Excluded | Chi-sq | df | Prob. |
|---|---|---|---|
| MAPE | 4.605321 | 2 | 0.1000 |
| INFM | 6.545883 | 2 | 0.0379 |
| GSER | 3.458455 | 2 | 0.1774 |
| TECH | 5.725341 | 2 | 0.0571 |
| LABR | 2.044138 | 2 | 0.3598 |
| KAPT | 9.085652 | 2 | 0.0106 |
| All | 36.41915 | 12 | 0.0003 |

Dependent variable: TECH

| Excluded | Chi-sq | df | Prob. |
|---|---|---|---|
| MAPE | 1.017895 | 2 | 0.6011 |
| INFM | 1.962475 | 2 | 0.3748 |
| GSER | 2.516341 | 2 | 0.2842 |
| ECON | 5.024637 | 2 | 0.0811 |
| LABR | 0.792317 | 2 | 0.6729 |
| KAPT | 31.09493 | 2 | 0.0000 |
| All | 79.09051 | 12 | 0.0000 |

Dependent variable: LABR

| Excluded | Chi-sq | df | Prob. |
|---|---|---|---|
| MAPE | 7.114188 | 2 | 0.0285 |
| INFM | 0.196553 | 2 | 0.9064 |
| GSER | 3.710996 | 2 | 0.1564 |
| ECON | 2.842915 | 2 | 0.2414 |
| TECH | 0.244488 | 2 | 0.8849 |
| KAPT | 0.056694 | 2 | 0.9721 |
| All | 18.09277 | 12 | 0.1129 |

Dependent variable: KAPT

| Excluded | Chi-sq | df | Prob. |
|---|---|---|---|
| MAPE | 0.492266 | 2 | 0.7818 |
| INFM | 1.921712 | 2 | 0.3826 |
| GSER | 1.217619 | 2 | 0.5440 |
| ECON | 5.375927 | 2 | 0.0680 |
| TECH | 30.65152 | 2 | 0.0000 |
| LABR | 0.031985 | 2 | 0.9841 |
| All | 76.10113 | 12 | 0.0000 |

The results of the Toda-Yamamoto causality test for the manufacturing output-GDP equation are presented in Table 9. The result shows the existence of only one causal relationship running

from manufacturing output-GDP to infant mortality rate. This implies that while improvements in the performance of the manufacturing sector will lead to improvements in the quality of the health infrastructure and health care delivery in the country, such improvements are not translated to improvements in the manufacturing output-GDP ratio.

Table 10. Toda-Yamamoto Causality Test Result for the Manufacturing Value-Added Equation

| Dependent variable: MVAD | | | |
|---|---|---|---|
| Excluded | Chi-sq | df | Prob. |
| INFM | 0.667696 | 2 | 0.7162 |
| GSER | 2.255745 | 2 | 0.3237 |
| ECON | 0.868025 | 2 | 0.6479 |
| TECH | 14.28959 | 2 | 0.0008 |
| LABR | 0.162067 | 2 | 0.9222 |
| KAPT | 1.816614 | 2 | 0.4032 |
| All | 65.81672 | 12 | 0.0000 |

| Dependent variable: INFM | | | |
|---|---|---|---|
| Excluded | Chi-sq | df | Prob. |
| MVAD | 11.56875 | 2 | 0.0031 |
| GSER | 3.217702 | 2 | 0.2001 |
| ECON | 7.509346 | 2 | 0.0234 |
| TECH | 4.315455 | 2 | 0.1156 |
| LABR | 37.21909 | 2 | 0.0000 |
| KAPT | 12.49994 | 2 | 0.0019 |
| All | 158.1845 | 12 | 0.0000 |

| Dependent variable: GSER | | | |
|---|---|---|---|
| Excluded | Chi-sq | df | Prob. |
| MVAD | 13.93506 | 2 | 0.0009 |
| INFM | 15.34234 | 2 | 0.0005 |
| ECON | 0.231244 | 2 | 0.8908 |
| TECH | 0.434799 | 2 | 0.8046 |
| LABR | 6.109050 | 2 | 0.0471 |
| KAPT | 0.141285 | 2 | 0.9318 |
| All | 44.61848 | 12 | 0.0000 |

| Dependent variable: ECON | | | |
|---|---|---|---|
| Excluded | Chi-sq | df | Prob. |
| MVAD | 0.108825 | 2 | 0.9470 |
| INFM | 2.912986 | 2 | 0.2331 |
| GSER | 2.096386 | 2 | 0.3506 |
| TECH | 3.460775 | 2 | 0.1772 |
| LABR | 0.654796 | 2 | 0.7208 |
| KAPT | 6.831041 | 2 | 0.0329 |
| All | 27.66587 | 12 | 0.0062 |

Table 10...

Dependent variable: TECH

| Excluded | Chi-sq | df | Prob. |
|---|---|---|---|
| MVAD | 13.88524 | 2 | 0.0010 |
| INFM | 2.627434 | 2 | 0.2688 |
| GSER | 6.599799 | 2 | 0.0369 |
| ECON | 4.158204 | 2 | 0.1250 |
| LABR | 2.566031 | 2 | 0.2772 |
| KAPT | 22.04329 | 2 | 0.0000 |
| All | 125.4241 | 12 | 0.0000 |

Dependent variable: LABR

| Excluded | Chi-sq | df | Prob. |
|---|---|---|---|
| MVAD | 0.507441 | 2 | 0.7759 |
| INFM | 1.931201 | 2 | 0.3808 |
| GSER | 1.119194 | 2 | 0.5714 |
| ECON | 5.210890 | 2 | 0.0739 |
| TECH | 0.740790 | 2 | 0.6905 |
| KAPT | 0.844291 | 2 | 0.6556 |
| All | 9.477594 | 12 | 0.6617 |

Dependent variable: KAPT

| Excluded | Chi-sq | df | Prob. |
|---|---|---|---|
| MVAD | 0.918417 | 2 | 0.6318 |
| INFM | 1.177743 | 2 | 0.5550 |
| GSER | 1.079044 | 2 | 0.5830 |
| ECON | 4.662457 | 2 | 0.0972 |
| TECH | 24.72347 | 2 | 0.0000 |
| LABR | 0.023949 | 2 | 0.9881 |
| All | 77.61980 | 12 | 0.0000 |

The result of the Toda-Yamamoto causality test for the manufacturing value-added equation given in Table 10 reveals the existence of a bidirectional causality running from technology to manufacturing value added in Nigeria. This means that improvements in the levels of technology will lead to improvements in the value added in the manufacturing sector which will in turn have the feedback effect of further improving the level of technology in the country. On the other hand, the results show the existence of unidirectional causality running from manufacturing value-value added to the infant mortality rate, and from manufacturing value-added to the gross secondary school enrolment ratio. The implication of this finding is that while improvements in manufacturing value-value added in the country lead to improvements in the quality of the health infrastructure and HCD, such improvements in health infrastructure and HCD have not been translated to improvements in manufacturing value-value added in the

country. This indicates the existence of a disconnect between the country`s educational institutions and the peculiar needs of the country`s manufacturing sector.

**DISCUSSION OF FINDINGS**

The analysis of the results of this study revealed several dimensions of the relationship between the development of human capital, infrastructure and technology, and the performance of the manufacturing sector in Nigeria. For instance, the results revealed that technology has a positive and significant impact on the value-added in the manufacturing sector in the short-run. This finding is buttressed by the results of the long run analysis which revealed that technology has a positive and significant impact on manufacturing value-added in the long-run. Furthermore, the relationship between technology and manufacturing value-added is further confirmed by the finding from the results of the Toda-Yamamoto causality test which revealed the existence of bidirectional causality between technology and manufacturing value-added in Nigeria. The aforementioned findings are in line with those made by Sauda and Akingbade (2011), Joseph et al., (2014), and Madu (2016). The implication of these findings is that any efforts on the part of the government and the private sector towards the development of indigenous technology, and technological transfer will lead to improvements in the value added of the manufacturing sector. Such improvements will not only lead to improvements in the output of the manufacturing sector, but enhance the exportability of such output.

results of the study also revealed that the infant mortality rate (used as a measure of the development of health infrastructure), gross secondary school enrolment rate (used as a measure of human capital development), labour and capital have negative and non-significant impact on manufacturing value added in the short-run in Nigeria. On the other hand, the study found that while infant mortality rate has a positive and significant impact on manufacturing value-added in Nigeria in the long-run, capital and labour have a negative and non-significant impact on manufacturing value-added. The results further revealed that the gross secondary school enrolment ratio has a negative and non-significant long-run impact on manufacturing value-added in Nigeria. The finding with respect to the measure of human capital development does not conform to the findings of Adejumo et al., (2013). On the other hand, the finding with respect to the measure of HCD and the infant mortality rate are not in line with the findings of Olayemi (2012).

The negative and insignificant relationship between the gross secondary school enrolment ratio and labour indicate the inadequacy of the nation’s human capital in meeting the human resource needs of the manufacturing sector. It also highlights a major issue in the country, namely, the dearth of real entrepreneurial, innovative and inventive capacities in the

country. This is an indictment of the nation`s efforts towards the development of its human capital, as reflected in the lack of attention given to the nations educational sector, especially with respect to the share of the educational sector in the country's annual budget. The implication of this status quo for the future of the nation is dire. The negative relationship between the gross secondary school enrolment ratio and the labour force justify the high rate of unemployment in the country. By implying that the higher the number of secondary school graduates and the larger the size of the labour force, the lower the value added in the manufacturing sector, the finding highlights the unemployability of the country`s stock of labour, thus providing an explanation for the high rate of unemployment in the country.

Given the importance of HCD to the attainment of the overall objective of the attainment of rapid and sustainable economic growth and development, the need to invest heavily in the nation's educational sector with the objective of providing the necessary infrastructure, personnel, incentives for teachers, researchers, students and other actors in the sector via scholarships, opportunities for self-advancement, etc., cannot be over-stressed. Furthermore, the negative and insignificant impact of the infant mortality rate on manufacturing value-added is a reflection of the inadequacy of the health infrastructure, and the health sector as a whole. This finding partly explains the increase in the losses of labour hours due to health related issues in the country. Finally, the negative and insignificant impact of the stock of capital on manufacturing value added is also indicative of the inadequacy of the available stock of capital in meeting the needs of the manufacturing sector.

Electricity consumption, used as a measure of infrastructural development, has a positive but non-significant impact on manufacturing value added in Nigeria. On the other hand, electricity consumption was found to have a positive impact on manufacturing value-added in Nigeria in the long-run. The aforementioned findings do not entirely conform to the findings of the literature review. While the findings are in line with those made by Akiri et al., (2015), Chinedum and Nnadi (2016) and Mesagan and Ezeji (2017), they are not in line with the findings made by Ibokwe (2015). The insignificant impact the consumption of electricity on manufacturing value added highlights the infrastructural issues the country has had for years, the impact of such infrastructural deficit on the manufacturing sector, and the implications for the overall economic performance of the country. However, the positive relationship between the supply of infrastructure as reflected in the consumption of electricity and manufacturing value-added, and the significant impact of the former on the latter in the long-run, indicates the potential gains with respect to improvements in the value added in manufacturing sector due to increased use of modern-energy reliant technologies which will accrue to the country from

efforts aimed at improving the supply of electricity and infrastructure in general. This calls for efforts to be made to ensure that the objectives of the reform of the power sector are achieved.

The results further revealed the existence of unidirectional causality from manufacturing value-added to infant mortality rate and gross secondary school enrolment rate. On the other hand, the study found the existence of unidirectional causality from the infant mortality rate to the manufacturing output-GDP ratio. No causal relationship was found to exist between manufacturing output-GDP ratio and the other variables included in the manufacturing output-GDP equation. The above findings corroborate the earlier findings with respect to the impact of the infant mortality rate and the gross secondary school enrolment ratio on the value-added in the manufacturing sector. The finding highlights the weakness of the country with respect to the provision of health infrastructure and human capital development. While the development of the manufacturing sector has resulted in the increased supply of domestic substitutes for the goods consumed by the educational and health sector, the reverse has not been the case with respect to the impact of both variables on the value-added in the manufacturing sector. This is reflected in the earlier mentioned inadequacy – qualitatively – of the nation's stock of human capital in meeting the needs of the manufacturing sector, as well as the loss of productivity in the manufacturing sector caused by the loss of valuable man hours to health related issues.

Within the context of the existence of a unidirectional causality from the infant mortality rate to the manufacturing value-added, the existence of a unidirectional causality from the infant mortality rate to the manufacturing output-GDP ratio implies that while the health infrastructure has been associated with quantitative increases in the performance of the manufacturing sector, it has not led to qualitative improvement in the sector's output. This finding is important because the exportability of the output of the domestic manufacturing sector and its ability to compete domestically with imported substitutes is a function of its quality.

## CONCLUSION AND RECOMMENDATIONS

The manufacturing sector is one of the most important sectors in an economy. This is reflected in the fact that its performance is a key indicator and determinant of the performance of the overall health of the economy. The performance of the manufacturing sector in turn depends on the availability of critical infrastructure such as good roads, stable supply of electricity, the level of technological development, as well as the quality of a nation's human capital.

In view of the above, and in recognition of the importance of the development of the manufacturing sector to the attainment of the goals of rapid and sustainable economic growth and development in Nigeria, this study attempted to examine the relationship between human capital, technology and infrastructure, and the performance of the manufacturing sector in

Nigeria. Based on the findings, the study concludes that the development of human capital and infrastructure have not resulted in improvements in the performance of the manufacturing sector in Nigeria, while the available technology has had marginal significant impact on the performance of the manufacturing sector. Based on the findings, the study recommends:

i. The formulation and implementation of policies by government aimed at encouraging the development of local technologies, as well as the encouragement of technological transfer. The latter can be achieved through the use of an incentive based scheme whereby foreign investors are granted certain tax privileges for the transfer of advanced technologies from their economy to the Nigerian economy. The Nigerian government can also initiate bilateral and multilateral agreements with advanced countries in which the latter will be obliged to share their production technologies with the country in return for certain trade advantages. The promotion of indigenous technologies can be achieved through the provision of low cost financing to indigenous inventors, as well as the granting of tax privileges to domestic firms who utilize indigenous technologies.

ii. Increased investment in the development of the nation`s human capital. This calls for an increase in the budgetary allocation to the educational sector. The government can also rationalize the expenditure on the educational sector with the objective of making its spending more efficient and result oriented. Furthermore, the private sector should be effectively integrated into the nation`s educational policy. Government educational policy should take into account the need and challenges of the private sector with a view to providing them with the necessary incentives for increased investment in the sector. Emphasis should be placed on the development of skills and capacities for innovation and invention with the objective of enhancing the capacity of the nation`s work force to contribute positively to the attainment of the nation`s macroeconomic objectives. This will lead to improved labour productivity, as well as increases in entrepreneurial activity in the country.

iii. The government should place emphasis on the formulation and implementation of policies aimed at improving the quantity and quality of the nation`s economic infrastructure. This will reduce the cost of doing business in the country, and thereby ensure that the nation`s infrastructure contributes positively to the development of the manufacturing sector. Government should ensure that the goals of the reforms in the power sector are achieved. This will require effective synergy between the government, investors in the sector and consumers with respect to improving the operating environment and the quality of regulation in the power sector.

iv. The government should also implement policies aimed at improving the quantity and quality of the health infrastructure in the country. This not only reduces the amount of work hours lost to illnesses, but also accelerates the pace of the development of human capital in the country.

v. In order to ensure the successful implementation of the above policies, measures should be put in place by government to improve the policy implementation process in the country. Such measures include the strengthening of the nation's institutions and the establishment of policy implementation monitoring and evaluation mechanisms.

## WAY FORWARD

The study recommends that future studies could focus on the impact of human capital, technological development, and infrastructure on the entire spectrum of Nigeria's industrial sector, not just a subset of the sector as done in the present study. This might potentially provide deep insights on the effects of government policy on the industrial sector. Furthermore, we suggest the employment of a different empirical methodology in analysing the data. This might possibly yield better and interesting results for policy and research purposes.

## REFERENCES

Adejumo, A. V., Olomola, P. A., & Adejumo, O. O. (2013). The role of human capital in industrial development: The Nigerian case (1980-2010). Modern Economy, 4, 639-651. http://dx.doi.org/10.4236/me.2013.410069

Adeyeye, A. D., Jegede, O. O., & Akinwale, Y. O. (2013). The impact of technology innovation and R&D on firms` performance: AN empirical analysis of Nigeria`s service Sector. Int. J. Technological Innovation and Development, 6(4), 374-395.

Akiri, S. E., Ijuo, O. A., & Apochi, M. P. (2015). Electricity supply and the manufacturing productivity in Nigeria (1980-2012). IOSR Journal of Economics and Finance (IOSR-JEF), 6(6), 90-94. Retrieved from http://www.iosrjournals.org

Anochiwa, L. I. & Maduka, A. (2014). Human capital, infrastructure and economic growth in Nigeria: An empirical evidence. IOSR Journal of Electrical and Electronics Engineering (IOSR-JEEE), 9(4), 01-06. Retrieved from http://www.iosrjournals.org

Anumudu, C. N. (2010). The impact of human capital on labour productivity in manufacturing industries in Enugu and Anambra states, Nigeria. A Ph.D Thesis Dissertation Submitted to the Department of Economics, University of Nigeria.

Central Bank of Nigeria. (2016). Annual statistical bulletin. Retrieved from http://www.cenbank.gov.ng

Chinedum, E. M. & Nnadi, K. U. (2016). Electricity supply and output in Nigerian manufacturing sector. Journal of Economics and Sustainable Development, 7(6), 154-163. Retrieved from http://www.iiste.org

Chinonso, A. N. (2012). The impact of information technology on the growth and development of banking industry in Nigeria: A case study of United Bank for Africa Plc (UBA), First Bank of Nigeria Plc (FBN) and Zenith Bank Plc. An MBA thesis submitted to the School of Postgraduate studies, Department of Banking and Finance, Faculty of Business Administration, University of Nigeria, Enugu Campus.

Dauda, Y. A. & Akingbade, W. A. (2011). Technological change and employment performance in selected manufacturing industry in Lagos state of Nigeria. Austrian Journal of Business and Management Research, 1(5), 32-43.

Igbokwe, O. (2015). The impact of infrastructure investment on real growth in Nigeria. A Research assignment presented in partial fulfilment of the requirements for the degree of Master of degree in Development Finance at Stellenbosch University. Retrieved from http://scholar.sun.ac.za

Isola, W. A. & Alani, R. A. (2012). Human capital development and economic growth: empirical evidence from Nigeria. Asian Economic and Financial Review, 2(7), 813-827. Retrieved from http://www.aessweb.com

Jhingan, M. L. (2004). Monetary economics (5thed.). Vrinda Publications, Delhi.

Jhingan, M. L. (2007). The economics of development and planning. VRINDA Publications Ltd, Delhi.

Joseph, O. J., Julius, O. O., & Olugbenga, I. M. (2014). Effects of technological capabilities, innovations and clustering on the performance of firms in the Nigerian furniture industry. International Journal of Management Technology, 2(2), 19-28. Retrieved from http://www.ea-jounals.org

Madu, I. (2016). Production techniques and technological orientation on the performance of manufacturing industries in Nigeria. International Business and Management, 13(1), 29-35. DOI:10.3968/8745

Mesagan, E. P. & Ezeji, A. C. (2017). The role of social and economic infrastructure in manufacturing sector performance in Nigeria. Munich Personal RePEc Archive (MPRA), 78310. Retrieved from https://mpra.ub.uni-muenchen.de/78310/

Ogwo, O. E. & Agu, A. G. (2016). Transport infrastructure, manufacturing sector performance and the growth of gross domestic product in Nigeria, (1999-2011). Journal of Business and African Economy, 2(1)1-21. Retrieved from http://www.iiardpub.org

Ojokuku, R. M. & Sajuyigbe, A. S. (2015). Effect of human capital development on the performance of small and medium scale enterprises in Nigeria. Journal of Emerging Trends in Economics and Management Sciences (JETEMS), 6(1), 88-93.

Olayemi, S. O. (2012). Human capital investment and industrial productivity in Nigeria. International Journal of Humanities and Social Science, 2(16), 298-307. Retrieved from http://www.ijhssnet.com

Posu, S. M. (2006). Information communication technologies in the Nigerian economy. Paper Presented at the International Conference on Human and Economic Resources, Izmir, 2006.

Ringim, K. J., Razalli, M. R., & Hasnan, N. (2015). The relationship between information technology capability and organizational performance in Nigerian banks. International Journal of Business Research and Development, 4(2), 1-10. Retrieved from http://www.sciencetarget.com

World Bank. (2017). Nigeria. World Development Indicators. Retrieved from http://www.worldbank.org

**APPENDIX: Data**

| YEAR | Capital | Labour | Manufacturing Output/GDP[1] | Manufacturing Value Added | Technology (Imports of Machinery and Transport Equipment) | Electricity Consumption | Gross secondary school enrolment ratio | Infant mortality rate (per 1,000 live births) |
|---|---|---|---|---|---|---|---|---|
| 1970 | 16026.55778 | 30834419.51 | 0.071651739 | 4985767784 | 285.3 | 24.34819 | 9.230365202 | 168.9 |
| 1971 | 16028.04438 | 30834300.43 | 0.062517855 | 4988575217 | 417.8 | 28.49249 | 9.272664189 | 164.1 |
| 1972 | 15966.38903 | 30834118.92 | 0.071109565 | 4992209265 | 391.9 | 32.63679 | 9.472901392 | 159.2 |
| 1973 | 16017.09765 | 30834603.83 | 0.072116332 | 4982844686 | 491.4 | 35.1992 | 9.100085106 | 154.1 |
| 1974 | 16094.70006 | 30834654.87 | 0.084418401 | 4979441967 | 561.8 | 32.75295 | 9.07581012 | 149.2 |
| 1975 | 16033.9908 | 30833824.11 | 0.054501836 | 4999804949 | 1,561.00 | 45.63789 | 9.441860139 | 144.4 |
| 1976 | 15719.76764 | 30833392.87 | 0.054933677 | 5006745459 | 2,467.20 | 51.4161 | 10.2738502 | 139.9 |
| 1977 | 16219.93211 | 30836543.47 | 0.053793201 | 4945386367 | 3,311.00 | 58.98368 | 7.608819962 | 135.8 |
| 1978 | 16405.10969 | 30834859.02 | 0.084418401 | 4965831094 | 3,573.40 | 60.47856 | 8.978710175 | 132.2 |
| 1979 | 15791.15375 | 30830501.08 | 0.090901662 | 5081256875 | 2,905.10 | 59.60691 | 10.90606022 | 129.3 |
| 1980 | 14462.875 | 30831667.89 | 0.104009041 | 5034507500 | 3,650.40 | 67.80365 | 13.60181046 | 127 |
| 1981 | 18,220.59 | 30849145.89 | 0.098697681 | 4699950000 | 5,668.10 | 50.70674 | 17.00856018 | 125.4 |
| 1982 | 17,145.82 | 30828121.22 | 0.102867008 | 5047610000 | 4,569.90 | 81.57746 | 20.90999985 | 124.4 |
| 1983 | 13,335.33 | 30813069.34 | 0.104372688 | 5542960000 | 3,213.40 | 81.41297 | 25.04047012 | 123.9 |
| 1984 | 9,149.76 | 30836335.09 | 0.081303326 | 4847510000 | 2,568.10 | 61.8158 | 28.68491936 | 123.9 |
| 1985 | 8,799.48 | 30919057.92 | 0.094577781 | 6422640000 | 2,414.40 | 80.12961 | 29.17355919 | 124.3 |
| 1986 | 11,351.46 | 30744022.54 | 0.095320418 | 6591120000 | 2,277.80 | 90.51529 | 27.0830307 | 124.9 |
| 1987 | 15,228.58 | 30752861.83 | 0.070977461 | 7468450000 | 6,827.70 | 88.93497 | 27.07258987 | 125.4 |
| 1988 | 17,562.21 | 30929398.06 | 0.079215992 | 11017780000 | 8,900.60 | 86.77632 | 27.06214905 | 125.8 |
| 1989 | 26,825.51 | 31249949.25 | 0.057544518 | 12475510000 | 12,362.70 | 96.66263 | 24.13202095 | 126 |
| 1990 | 40,121.31 | 30043881 | 0.054951974 | 14702400000 | 18,515.80 | 86.71021 | 24.59581947 | 125.9 |
| 1991 | 45,190.23 | 30788219 | 0.062010688 | 19356000000 | 17,926.20 | 89.21814 | 25.71564484 | 125.8 |
| 1992 | 70,809.16 | 31635543 | 0.050700918 | 27004010000 | 62,158.30 | 89.66875 | 25.37640858 | 125.5 |
| 1993 | 96,915.51 | 32532154 | 0.057009595 | 38987140000 | 74,579.10 | 100.4507 | 24.95497346 | 125.1 |
| 1994 | 105,575.49 | 33417326 | 0.069896945 | 62897690000 | 46,232.00 | 95.14616 | 25.16071159 | 124.4 |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| 1995 | 141,920.24 | 34343507 | 0.054463563 | 1.05E+11 | 206,905.00 | 91.08615 | 25.30193461 | 123.4 |
| 1996 | 204,047.61 | 35194224 | 0.049171613 | 1.33E+11 | 129,404.10 | 85.52179 | 25.19850706 | 121.9 |
| 1997 | 242,899.79 | 36095012 | 0.051430535 | 1.44E+11 | 202,964.90 | 81.6319 | 25.15403168 | 119.9 |
| 1998 | 242,256.26 | 36972865 | 0.052242958 | 1.41E+11 | 195,956.00 | 76.61259 | 25.20379624 | 117.5 |
| 1999 | 231,661.69 | 37946736 | 0.047259177 | 1.51E+11 | 204,392.30 | 75.4092 | 23.41555977 | 114.8 |
| 2000 | 331,056.73 | 38875613 | 0.036672272 | 1.68E+11 | 234,075.80 | 74.13121 | 24.45990944 | 112 |
| 2001 | 372,135.65 | 39626299 | 0.042132423 | 1.99E+11 | 327,206.70 | 75.19744 | 26.86120033 | 109 |
| 2002 | 499,681.53 | 40482284 | 0.034261063 | 2.37E+11 | 378,826.50 | 104.1345 | 29.42100906 | 105.9 |
| 2003 | 865,876.46 | 41221986 | 0.033903418 | 2.88E+11 | 498,815.90 | 101.4018 | 26.03941965 | 102.9 |
| 2004 | 863,072.62 | 42063952 | 0.030612065 | 3.49E+11 | 458,917.10 | 122.9846 | 34.75204086 | 99.8 |
| 2005 | 804,400.82 | 43250245 | 0.028321427 | 4.13E+11 | 613,387.50 | 128.6357 | 34.69911957 | 96.6 |
| 2006 | 1,546,525.65 | 44459832 | 0.025776169 | 4.79E+11 | 680,765.76 | 111.1444 | 34.18740082 | 93.4 |
| 2007 | 1,936,958.21 | 45659878 | 0.025215424 | 5.21E+11 | 856,717.67 | 138.1424 | 31.61383057 | 90.3 |
| 2008 | 2,053,005.95 | 47008096 | 0.024101297 | 5.86E+11 | 1,141,756.57 | 126.5322 | 35.09796143 | 87.3 |
| 2009 | 3,050,575.92 | 48330258 | 0.024695612 | 6.12E+11 | 2,359,345.40 | 119.9494 | 38.90451813 | 84.3 |
| 2010 | 4,012,918.65 | 49706559 | 0.018922315 | 3.58E+12 | 3,762,610.95 | 135.6377 | 43.83671188 | 81.5 |
| 2011 | 4,207,422.64 | 51167238 | 0.018504384 | 4.53E+12 | 3,549,776.68 | 149.3125 | 37.3632555 | 78.8 |
| 2012 | 3330980.79 | 52600554 | 0.021022184 | 5.59E+12 | 2703372.401 | 155.8544 | 38.80061173 | 76.2 |
| 2013 | 3650474.501 | 54199112 | 0.020430686 | 7.23E+12 | 3093776.358 | 141.873 | 39.72627431 | 73.8 |
| 2014 | 3800449.146 | 55784248 | 0.019637411 | 8.69E+12 | 3277384.096 | 145.6694 | 39.93171336 | 71.5 |
| 2015 | 3747331.77 | 57182754 | 0.019820627 | 8.97E+12 | 3156077.383 | 148.1773 | 38.95546373 | 69.4 |

Sources: Central Bank of Nigeria Annual Statistical Bulletin; World Development Indicators; [1]Authors` computation using data from the Central Bank of Nigeria Annual Statistical Bulletin.