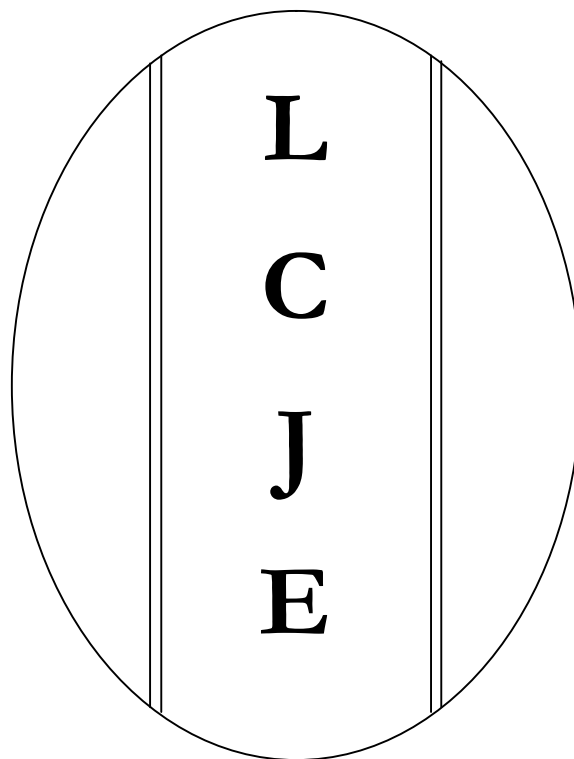


Lead City Journal of Economics



Volume 1 (September, 2020)

ISSN: 2795-2355

LEAD CITY JOURNAL OF ECONOMICS

A Bi-annual Journal of Department of Economics, Lead City University

Publisher: College Press, Jericho, Ibadan, Oyo State, Nigeria

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Transformation from Knowledge-based to Creative Economy: Lessons for Nigeria

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Abstract

The global financial and economic crisis of 2008 led to a sharp decline in global demand and international trade. However, global exports of creative goods and services continued to increase reaching 592 billion dollars in 2008. This was more than double the 2002 value which indicates an annual growth of 14 percent over six consecutive years. This trend continued up to 2015. This is an indication that the creative industries hold great potential for developing countries that seek to diversify their economies. The knowledge-based economy emphasizes a system of consumption and production that is based on intellectual capital. It recognizes the role of knowledge and technology in economic growth. Creativity in itself fosters income generation, job creation and export earnings while promoting social inclusion, cultural diversity and human capital development among others. This paper therefore identifies key indices that must be within the appropriate benchmarks, for transition from knowledge-based to a creative economy to take place. These have generated increasing competitive advantage for emerging and developed economies. It proceeds to identify conceptual models of creativity and draws lessons from the economic transformation experience of some emerging and developed economies for Nigeria. Appropriate indicators that include: Knowledge Economy Index (KEI, KEI-Innovation, KEI-Information Communication Technology), Global Competitiveness Ranking, Human Development Index, Literacy Rate and Research/Development expenditure as percentage of Gross Domestic Product were therefore considered and assessed. The paper recommends that realizing the gains from transformation from a knowledge-based to a creative economy will no doubt involve the government formulating the right public policy mix and strategic choices for harnessing the socio-economic potentials.

Keywords: Knowledge-based Economy, Creative Economy and Knowledge Economy Indicators.

JEL Classifications: O38, O57, P41.

1. Introduction

With a population of over 200 million people, Nigeria is the largest country in Africa and accounts for 47 percent of West Africa's population. It is also the biggest oil exporter in Africa, with the largest natural gas reserves in the continent (World Bank, IBRD – IDA, 2015). As at the year 2015, real Gross Domestic Product (GDP) was estimated to have grown by 6.1 percent owing to the continued strong performance mainly in services, but also industry (apart from oil mining) and agriculture. The sharp decline in oil prices since the third quarter of 2014 has posed major challenges to the country's external balance and public finances. Oil accounts for close to 90 percent of exports and roughly 75 percent of the country's consolidated budgetary revenues. It is noteworthy however that, much lower oil prices will continue to pose strong challenges to public finance at all levels of government as the year goes by and the status quo remains. Furthermore, this will continue to pose greater constraints even to the present democratic dispensation in the country as regards its ability to finance the present development strategy known as the Economic Recovery and Growth Plan (ERGP). The Nigerian economy is faced with other challenges emanating from the declining crude oil prices such as the supply-demand gap in the foreign exchange market due to the import dependent nature of the Nigerian economy.

A Knowledge Economy (KE) is characterized by knowledge-based activities having high – technology industries, accounting for a significant share of employment, GDP and exports. Besides, knowledge becomes a commodity to be traded. The KE is associated with new skills, high performance and new added value as the only way for enterprises and countries to compete in the global economy (OECD, 2010). Creativity in itself is the act of thinking up new things. This fosters income generation, job creation and export earnings while promoting social inclusion, cultural diversity and human capital development among others. The knowledge-based economy (KBE) comprises of a better-informed populace as the government invests more on human capital development. This leads to a highly-educated labour force with skills, ideas and knowledge by utilizing latest technology. A KBE is characterized by a high level of per capita wealth, knowledge-based investment, which generates increasing returns to scale and thus more wealth for all.

A KBE opens an economy to global talent. It is the application of knowledge-based industries where knowledge becomes the key competence. There are ample opportunities for local industries to tap foreign knowledge and learn about best business practices. Furthermore, world class infrastructure will encourage foreign direct investment. Such economies are fully equipped to face global challenges (World Bank, 1999). James (2011), submits however that the development of a KBE requires individuals to acquire measurable knowledge or skills in the form of qualifications through formal education and training which will end up improving competitiveness and productivity. Since Nigeria is highly sensitive to world economic cycles, commodity price trends and exchange rate fluctuations, it is expedient that her economy must be diversified away from crude oil as the country's main income earner. This however implies that Nigeria needs to ensure improved welfare status of the general populace and above all, sustain improved economic growth. Also, in order to be able to maintain herself with the rest of the world, and be able to compete successfully in the fast-moving world economy, Nigeria has to radically reform herself. Most of Nigeria's wealth and contributions to GDP comes from physical assets such as land, oil, few solid minerals such as iron and steel, coal and some other non-oil exports. Despite the fact that apart from crude oil, Nigeria is endowed with large deposits of solid minerals, agricultural products (cash and food crops), arable soil, abundant water resources, but the regulatory quality of the business climate is poor. Based on this background, this paper identifies the indices, within the appropriate benchmarks that must be in place for a transition from knowledge-based to a creative economy. This transition has generated increasing competitive advantage for emerging and developed economies. The paper exposes the conceptual models of creativity. Adopting a descriptive statistical analytical tool, the paper proceeds to draw lessons for Nigeria from the economic transformation experience of some emerging and developed nations.

2. Conceptual Clarifications

The term **“Knowledge Economy”** (KE) refers to a knowledge-based economy (KBE) focused on the production and management of knowledge within the framework of economic constraints. A KE is one that utilizes knowledge as the key engine of economic growth and wealth creation; it is an economy where knowledge is acquired, created,

disseminated and used effectively to enhance economic development. The emergence of KBE provides the platform for rapid economic growth and also enhances competitiveness by complementing and accelerating the economic system from being input-driven to productivity-driven. Furthermore, KBE is classified as the key enabler of better productivity and growth in industries. The World Bank (2008) puts it clearly that stylized characteristics of a KBE are based on the fact that knowledge is information that is interpreted and used by decision makers to meet their desired goals. Knowledge here is seen as a public good, since there is no additional cost when shared with other users while others cannot be excluded from using it once it is created. The World Bank submission proceeded to categorize knowledge into knowledge about technology and knowledge about attributes or tacit knowledge. The latter being the type of knowledge gained from experience and it is often the source of competitive advantage. Knowledge input is ever expanding as technology and innovation improves.

Innovation in technology opens access/enhances connectivity to resources and markets all over the world. This is accompanied with technology sharing and transformation made easy with the free flow of information at lower cost. Access to networking is enhanced as this is essential in acquiring and disseminating knowledge (Daley, 2000). It also encourages increased mobility of workers and capital. The KBE comprises of a better-informed populace as the government invests more on human capital development. This leads to a highly-educated labour force with skills, ideas and knowledge by utilizing latest technology. A KBE is characterized by a high level of per capita wealth, knowledge-based investment, which generates increasing returns to scale and thus more wealth for all. A KBE opens an economy to global talent. It is the application of knowledge-based industries where knowledge becomes the key competence. There are ample opportunities for local industries to tap foreign knowledge and learn about best business practices. Furthermore, world class infrastructure will encourage foreign direct investment. Such economies are fully equipped to face global challenges (World Bank, 1999). James (2011) submits however that the development of a KBE requires individuals to acquire measurable knowledge or skills in the form of qualifications through formal education and training which will end up improving competitiveness and productivity. As a follow up to this submission, various frameworks have been identified as providing a basis

for KE development. These frameworks and their suitability vary per country. The World Bank and the OECD conducted empirical studies which came up with a conceptual framework designed and applied when developing a knowledge economy. They were classified as the **four pillars of the KE** which are: creating effective governmental institutions and economic incentives; ensuring the production of educated and skilled workers who can consciously upgrade and adapt their skills efficiently, thus creating and using knowledge efficiently; providing a modern and adequate information infrastructure that can facilitate effective communication; and finally, an effective innovation system of firms, research centers, the academia, organizations and consultants.

In the KBE, the leverage on information and communication technologies can potentially increase the return on investment over time (Romer, 1990; Romer 1986). This explains part of why sustainability can be achieved by developed countries while this has been a challenge to developing countries, despite their large labour pools and capital. Under this new paradigm, labour and capital are still endogenous factors of production, while knowledge, productivity, education and intellectual capital are conceptualized as exogenous factors of production not explained within the economic system (French, Frederick and McIlroy, 1999). Labour in this model involves physical labour and ideas that reside within human beings. Thus, increased investment in human capital, knowledge and fixed capital play important endogenous roles in economic growth and development.

A knowledge-driven economy is one in which the generation and exploitation of knowledge play the predominant part in the creation of wealth (UK Department of Trade and Industry, 1998). The World Bank Development Report, (1999) makes it clear that for countries in the vanguard of the world economy, the balance between knowledge and resources has shifted so far towards the former, such that knowledge has become the most important factor determining the standard of living more than land, tools and labour. The knowledge economy is thus seen as a state of economic wellbeing and a process in which an economy leverages intensively and extensively on knowledge assets and competencies in order to catalyze and accelerate sustainable and robust economic growth through creative capabilities.

The concept of **Creative Economy** on the other hand has emerged as a means of focusing attention on the role of innovative ability as a force in

contemporary economic life. Creative industries are based on solid, and sound knowledge-based economic activities. They are referred to as the industrial components of the economy in which creativity is an input and content or intellectual property is/are the output. Hence, the role of the KBE in understanding the basics of the creative economy cannot be overemphasized. A creative economy cannot be actualized without a KBE. Furthermore, there is the need to note that economic and cultural developments are not separate, but can be part of the larger process of development. The Creative Economy as defined by Howkins (2001) is “the transactions of creative (new) products that has an economic goods or service which results from the act of thinking up new things (creativity) and has economic value”. According to his submission, creativity focuses on how people make money from ideas. The United Kingdom Department of Culture, Media and Sport (DCMS) define the creative economy as “those industries which have their origin in creativity (thinking up new things), skills and talents, which have a potential for wealth and job creation through the generation of intellectual property” (DCMS, 2013). The United Nations Conference on Trade and Development (UNCTAD) defines the term creative economy as an evolving concept based on innovative assets potentially generating economic growth and development (UNCTAD, 2008). It refers to a creative economy as one that fosters income generation, job creation and export earnings while promoting social inclusion, cultural diversity and human development. It embraces economic, cultural and social aspects interacting with technology, intellectual property and tourism. It is seen as a set of knowledge based economic activities with a development dimension and cross cutting linkages at macro and micro levels with the overall economy. It is a feasible development option for innovation and multi-disciplinary policy responses.

However, at the heart of the creative economy are the creative industries. Human creativity and innovation at both individual and group level are the key drivers of creative industries which have become the wealth of nations in the 21st century. “Unlocking the potentials of the creative economy therefore involves promoting the overall creativity of societies, affirming the distinctive identity of the places where it flourishes and clusters thus improving the quality of life where it exists, enhancing local image, and prestige and strengthening the resources for imagining diverse new futures” (UNDP/UNESCO, 2013). The United Nations

Conference on Sustainable Development (2012), resolve that “there is the need to find new development pathways that encourage creativity and innovation in the pursuit of inclusive, equitable and sustainable growth and development.” The report proceeds to emphasize the fact that the creative economy has become a powerful transformative force in the world today.

Ideas and creativity are referred to as determinants of economic growth in the creative economy, since they integrate concepts of labour and capital. They both increase output and hence productivity of goods produced through labour and capital. In the creative economy, the production and consumption of information goods and services are not as limited by labour and capital as in an industrial economy. This is because of the possibility of replication (Mosco, 1989). Thus, increasing rather than diminishing returns on technological investments can be achieved with the introduction of new technologies (French, Frederick and McIlroy, 1999). Technology then, including its knowledge base, is an inherent component of an economic system. Knowledge therefore becomes a third endogenous factor of production in the advanced economies of the world (Romer, 1990; Romer, 1986).

Creative industries are seen as growth drivers even as the agricultural sector in economies is seen as transforming the manufacturing sector, all things being equal. Seven models of “Creative Industries” have been identified in literature as key in illustrating the variety of ways in which the creative industries are defined and have been refined over time. Five of these models are briefly discussed in this paper.

- i) **The Howkins Model:** This broadly outlines 15 industries that contribute to the creative economy by generating innovative products and services ranging from the arts to science and technology which has economic value (Howkins, 2001).
- ii) **UK Government Department of Culture, Media and Sport (DCMS) Model:** Here, creative industries are defined as those requiring creativity, skills and talent with the potential for wealth and job creation through the exploitation of their intellectual property (DCMS, 2001).
- iii) **Concentric Circles Model:** This model asserts that creative ideas originate from the core creative arts in the form of sound, text and image and that these ideas and influences diffuse

outwards through a series of layers or concentric circles with the proportion of cultural to commercial content decreasing as one moves outwards from the center (Throsby, 2001).

- iv) **WIPO Copyright Model:** This model is based on industries involved directly or indirectly in the creation, manufacture, production, broadcast and distribution of copyrighted material. The emphasis here is on intellectual property as a result of creativity invested in the making of the goods and services included in the classification. A distinction was found existing between industries that produce the intellectual property and those that distribute the goods and services to consumers (WIPO, 2017).
- v) **UNCTAD Model:** This model is based on enlarging the concept of “creativity” from activities having a strong artistic component to “any economic activity producing symbolic products with a heavy reliance on intellectual property and for as wide a market as possible (UNCTAD, 2008).

It is noteworthy however, that all these models leverage on the indicators of a knowledge-based economy.

3. Theoretical Framework

This section exposes the theoretical underpinning of this paper which is anchored on the Arrow/Romer Endogenous Growth Model and the Schumpeterian Growth Model (Jhingan, 2012).

3.1 Arrow Endogenous Growth Model

Arrow (1962), based his submission on the concept of “learning by doing,” which he regarded as endogenous in the economic growth process. He assumes that at any moment of time, new capital goods incorporate all the knowledge available based on accumulated experience. Such knowledge once built; their productive deficiencies cannot be changed by subsequent learning. Arrow thus considers knowledge as an input in the production function which is presented as:

$Y = A(R)F(R_i, K_i, L_i)$, where: Y is aggregate output, A is public stock of knowledge from research and development, R is research and development, R_i is the stock of results from expenditure on research and development by firm i and is treated as rival good, K_i is capital stock of

the firm, L_i is the labour stock of the firm and function F he assumes is homogenous of degree one in all its inputs R_i , K_i and L_i .

3.2 Romer Endogenous Growth Model

Romer in his own submission to the endogenous growth model introduced three key elements: externalities, increasing returns in the production of output and diminishing returns in the production of new knowledge. Romer submits that it is the spillover from research efforts by a firm that leads to the creation of new knowledge by other firms. In this model, new knowledge is the ultimate determinant of long run growth which is determined by investment in research technology. Research technology however exhibits diminishing returns which means that the firm investing in research technology will not be the exclusive beneficiary of the increase in knowledge as other firms also make use of the new knowledge due to the inadequacy of patent protection and increase their production. Thus, production of goods from increased knowledge displays increasing returns and competitive equilibrium is consistent with increasing aggregate returns owing to externalities. Based on this analogy, Romer takes investment in research and development as endogenous factor in terms of the acquisition of new knowledge by rational profit maximization firms. Furthermore, Romer's model of endogenous technical change of 1990 identifies a research sector specializing in the production of ideas. The research sector invokes capital along with the existing stock of knowledge to produce ideas or new knowledge. Ideas according to him are more important than natural resources. He cites the example of Japan that has very few natural resources but was open to new western ideas and technology. Japan imported machines from the United States of America during the Meiji era, dismantled them to see how they worked and manufactured their better prototypes. Therefore, idea/knowledge are acquisitions essential for the growth of an economy. In the Romer model, new knowledge enters the production process through: i) a new design used in the intermediate goods sector for the production of a new intermediate input, ii) labour, human capital and available producer durables producing the final product, iii) a new design increases the total stock of knowledge which increases the productivity of human capital employed in the research sector. Technology is endogenous in the Romer's production function when more human capital is employed for research and development of new designs, then technology increases by a larger

amount. The Romer's production function is expressed as: $Y = A(R)F(R_i, K_i, L_i)$, where Y = aggregate output, A = public stock of knowledge from research and development, R = research and development, R_i = stock of results from expenditure on research and development by the firm i respectively. This is reflected on the quantity and quality of output of the firm. K_i and L_i are capital stock and labour stock of firm respectively while F = homogenous of degree one in all its inputs R_i , K_i and L_i with R_i being referred to as a rival good.

3.3 Schumpeterian Model of Economic Growth

Schumpeter strongly emphasizes the importance of innovation in economic growth and development. Innovation he submits can be in form of: introduction of a new product; introduction of a new method of production; opening up of a new market; the conquest of a new source of supply of raw materials or semi-manufactured goods; the carrying out of the new organization of any industry like the creation of a monopoly, all of which lead to development. He proceeds to assign the role of an innovator to the entrepreneur and not to the capitalist. The entrepreneur he sees as the one who introduces something entirely new, he does not provide funds, but directs the use of funds. He is motivated by the will to creating and getting things done. The entrepreneur according to Schumpeter requires the existence of technical knowledge which he can tap from the reservoir of untapped technical knowledge, in order to produce new products. The entrepreneur innovates to earn profits.

The core of the Schumpeterian model is the breaking up of the circular flow with an innovation in form of a new product by an entrepreneur for the purpose of earning profits. The innovating entrepreneur is financed by bank credit on which he pays interest. Once the new innovation becomes successful and profitable, other entrepreneurs adopt it in "swarm-like clusters". There comes the cyclical process. Since investment is assumed financed by bank credit, it increases money income and prices. This helps to create a cumulative expansion throughout the economy. With increase in the purchasing power of consumers, the demand for the products of the old industries increase in relation to supply, prices rise, profits increase and old industries expand by borrowing from banks. In the long run, new products start to appear in the market displacing the old products, thus enforcing a process of liquidation, re-adjustment and absorption. The demand for old products

decreases and the price will fall. This ends the relevant aspect of the Schumpeterian model of economic growth to this paper.

4. Drivers of Transformation from KBE to Creative Economy: The Status of Nigeria

Since Nigeria is highly sensitive to world economic cycles, commodity price trends and exchange rate fluctuations, it is expedient that her economy must be diversified away from crude oil as the country's main income earner. After going to the polls in 2015 and successfully democratically elected a president that is in its second term presently, Nigeria needs to encourage and ensure lasting peace, economic freedom/improved welfare status of the general populace and above all, sustain improved economic growth and development. Also, in order to be able to maintain herself with the rest of the world, and be able to compete successfully in the fast-moving world economy, Nigeria has to radically reform herself. It is important to mention at this juncture that most of Nigeria's wealth and contributions to GDP come from physical assets such as land, oil, few solid minerals such as iron and steel, coal and some other non-oil exports. Despite and apart from crude oil, Nigeria is endowed with large deposits of solid minerals, agricultural products (cash and food crops), arable soil, abundant water resources, the regulatory quality of the business climate is poor.

Nigeria ranks 170 out of 189 economies in 2015 and 169 by 2016 as regards the Ease of Doing Business. This is lower than the 2013 ranking of 147 (World Bank Group, Doing Business, 2013-15). A high ease of doing business means the regulatory environment is more conducive to the starting and operation of a local firm. Ten indicators are considered here which include; ease of starting a business, dealing with construction permits, availability of power supply, among others. There is the need to generate wealth and employment through knowledge creation, diffusion and the creation of an enabling environment for business to thrive.

The competitiveness of an economy is increasingly dependent on its capability to create, use and diffuse knowledge. The Global Competitive Ranking (GCR) assesses the ability of a country to provide high levels of prosperity to her citizens. The Global Competitiveness Index measures the set of institutions, policies and factors that set the sustainable current and medium-term levels of economic prosperity. The GCR for Nigeria was 124 out of 146 countries in 2015. This ranged between 94 and 127

from 2008 to 2015 (WEF, Global Competitive Report, 2015) (See Figure 7). The World Bank ranking benchmark indicates that a rank of 1= the best GCR. Furthermore, three key variables serve as proxies for each Knowledge Economy pillar. They are: Economic Incentive and Institutional Regime (EIR), Education, Innovation and Information Communications Technology (ICT). The EIR comprises of incentives that promote the efficient use of existing and new knowledge with flourishing entrepreneurship.

An efficient innovative system made up of firms, research centers, universities, consultants and other organizations can tap into the growing stock of global knowledge, adapt it to local needs and create new technological solutions. An educated and appropriately trained population is capable of creating, sharing and using knowledge. The KEI for Nigeria in 2012 was 2.20 with a rank of 119 out of about 146 (KEI, World Bank, 2012). High KEI implies high ICT and Innovation ranking. With the World Bank benchmark for KEI, stating that 0 is the lowest, while 10 is the highest. The KEI-Innovation Index for Nigeria is 2.56 in 2012. This puts the innovation ranking for the country at 116 (KEI, World Bank, 2012) (See Figure 4). The innovation indicators include; capacity for information mobilization, quality of scientific research institutions, spending on research and development (R&D), University – Industry collaboration in R&D, government procurement of advanced technology products and so on. The values of the indices and ranking out of 146 countries indicate that innovation system in Nigeria is weak and there is low level of R&D activities in the country (KEI, World Bank, 2012 and WDI, 2015). The KEI-Innovation and GCR for Nigeria are classified as being on the low range. The 2014–2015 Global Competitiveness Report emphasizes the fact that Nigeria still lags behind in the area of innovation/sophisticated production processes.

Above all, the report emphasizes that the firm's capacity to absorb technology in Nigeria is still low compared with her counterparts in the emerging and other developing nations. The country's products are also yet to compete favorably with the rest of the world markets. This confirms the fact that a nation's competitiveness and prosperity depend on the capacity of its industries to innovate and upgrade despite its resource endowments. Expenditures on Research and Development (R&D) are current and capital spending on creative work undertaken systematically to increase knowledge of humanity, culture/society and the

use of knowledge for new applications. Available statistics indicates that no data is inputted for Nigeria. This speaks volumes as regards the importance the nation attaches to R&D. The Human Development Index (HDI) for Nigeria in 2012 and 2014 are 0.50 and 0.51 respectively. The World Bank benchmark however indicates that HDI of one implies that the country is most developed. Nigeria ranks 152 out of 188 countries (World Bank, Human Development Report, 1980–2014). When compared with the HDI rankings of the sampled emerging and developed nations (See Figure 2). Nigeria still lags behind in the average achievement in the three basic dimensions of human development which include a long, healthy life, and basic standard of living.

Literacy rate (LR) is another indicator that measures the ability to read, write and acquisition of skills to access knowledge through technology. The literacy rate for Nigeria as reported by UNESCO 2015 stands as 59.6% (See Figure 5). This is also categorized as low when compared with the sampled emerging and developed nation's ratings. Closely related to this is the KEI – Information and Communications Technology Index (ICT). A modern and accessible ICT infrastructure serves as a facilitator of the effective communication, dissemination and processing of information. The ICT index was 3.35 in 2012 (See Figure 4). In comparison with the World Bank benchmark, the index is low as it is closer to 0 and farther from the highest value of ten (10). The Education Index (EI) is an indicator that rates the educated and appropriately trained population and the capability of that population to create, share and use knowledge (KEI, World Bank, 2012). Nigeria's EI was 2.20 in 2012 which can still be categorized as low when compared with the UNESCO's benchmark of 0 = lowest and 10 for the highest EI. Nigeria ranks 118 out of 140 countries (UNESCO, 2015). In the KBE, the main source of value and competitive advantage in the new economy is human and intellectual capital. All these identified indicators of KEI are expected to guide the direction of investments and actions in an economy in order to ensure rapid transformation from KBE to a Creative Economy.

5. Drivers of Transformation from KBE to Creative Economy: Status of Emerging and Developed Nations

The BRICS economies; Brazil, Russia, India, China and South Africa are distinguished by their large, fast-growing economies and significant

influence on regional and global affairs. A KEI of 5.48 and 5.58 in 2000 and 2012 respectively, ranks Brazil at 60 out of 146 countries (See Figure 3). The KEI- Innovation and ICT range between 5.83 and 6.31 between 2000 and 2012 (KEI, World Bank, 2012). These indices are relatively high when compared to the World Bank Benchmark (See Figure 4). The literacy rate is relatively high at 92.6 percent. Surprisingly, the GCR is 75 out of about 146 economies. This ranking ranged between 48 and 75 from 2008 to 2015 (WEF, Global Competitiveness Report, 2015) (See Figure 5). The HDI in Brazil is relatively high between 1990 and 2014 (See Figure 2). This is very close to 1 which is the World Bank upper limit benchmark (World Bank, HDR, 1980-2014). Expenditure on R&D as percentage share of GDP between 2000 and 2012 was not up to 1.5 percent share of GDP (WDI, 2015) (See Figure 6). The EI for Brazil in 2012 was 5.58 which is conveniently above average considering the World Bank benchmark (KEI, World Bank, 2012).

China's KEI- Innovation and ICT was 5.99 and 3.79 respectively in 2012. The innovation index is relatively high, while the ICT index is not up to average when considering the World Bank benchmark (See Figure 4). Literacy rate is very high at 96.4 percent (World Bank, 2012). The GCR is relatively high at 28, while for the HDI data is not available. Expenditure on R&D as a percentage share of GDP between 2000 and 2012 is relatively fair compared to other nations (WDI, 2015).

The South African economy is one of the BRICS economies. It is an economy that is efficiency-driven. It possesses high quality institutions, intellectual property protection, efficient legal framework, accountability of private institutions and strong financial market development. It also has efficient markets for the distribution of goods and services. The KEI- Innovation, ICT and EI are all above average with the exception of KEI-ICT which was below average in 2012. However, her high Innovation Index indicates that the innovation system features good scientific research institutions and strong collaboration between universities and business sector. South Africa ranks 49 out of over 146 countries in the GCR (See Figure 7). This is still relatively above average performance (WEF, Global Competitive Report, 2015).

The developed nations record a high KEI- Innovation ICT, EI (KEI, World Bank, 2012). This explains the progress made in the United States of America. New products/services and more sophisticated production processes have emerged. The GCR for the United States is three which is

not too distant from the World Bank benchmark in 2015 (WEF, Global Competitive Report, 2015). The implication of this recorded performance is that, there has been an enhanced increased global competition through reduced communication costs which have opened up new markets. Costs of international transport have reduced, while goods and services can be delivered via telephone contacts. Sizes of markets have increased. Products and services become quickly out of date which then means that businesses need to innovate more quickly and make use of its knowledge and creativity in order to survive.

Singapore can be categorized as an advanced emerging nation rated 2nd most competitive country in the world and consistently being the highest ranked country in Asia in the last decade. A high share of Singapore's exports is classified as technology-intensive. So, Singapore has worked effectively over the years to attain knowledge-based economy. A KEI of 8.26 in 2012 ranks the country 23 in the world (KEI, World Bank, 2012). Based on the country's capability to create, acquire, disseminate and apply knowledge to sustain its economic growth, capital and labour are becoming less important as drivers of economic growth. Singapore has benefitted so much from good governance, strong commitment towards development and good institutional frameworks. Singapore's 2012 ranking on EIR is 1st in the world as the economy benefits from world-class infrastructure (excellent roads, ports, air transport facilities, sound macroeconomic environment and fiscal management. The KEI-Innovation, ICT and Education Index are relatively high. They record 9.49, 8.78 and 5.09 respectively in 2012. (World Bank, 2012). Her HDI and literacy rate are also very high (World Bank, HDR, 1980-2014). The GCR for Singapore ranks 2 (WEF, Global Competitive Report, 2015) out of over 140 countries in 2015 which is very close to the World bank bench mark of 1 = the best. Literacy rate in 2015 was 94.3 percent. All these indices indicate the nation's strong focus on education. The Singaporean workforce is highly educated and highly motivated, highly skilled and highly productive. Furthermore, the country produces diversified products such as electronics, transportation, equipment /machineries all of which are knowledge intensive (WEF, Global Competitive Report, 2015). Increased speed of scientific and technological advancement has also been experienced in the developed nations. Scientific researchers are on the increase and increased expenditures on research and development have led to the growth of

scientific and technological knowledge. The high KEI indices are also transforming other sectors of the economy in terms of processes, nature of final product, branding and design all which account for increased demand for the produced goods and services. Innovation and creativity have been enhanced.

Sweden is another developed country with the most advanced knowledge economy. The country has strong institutions regarded as transparent and efficient, excellent infrastructure and healthy macroeconomic conditions with low levels of fiscal deficit. Sweden creates the right set of conditions for innovation and scores well with respect to royalty payments and receipts, science and engineering journal articles and patents. New goods are being produced with the use of sophisticated production process. Swedish firms are among the best performing in the world, while its ICT adoption is among the highest in the world. For instance, in 2012 the KEI – ICT Index was 9.49 which is very close to the extreme World Bank benchmark of 10. It has succeeded in building a strong knowledge foundation in both the public and private spheres of the society which translates into creativity. The nation records increase in infrastructural development and total factor productivity. It ranks nine in its GCR for 2015 (WEF, Global Competitive Report, 2015), while it ranks one for the KEI of 9.43 in 2012, which is high following the World Bank Benchmark.

It is however worthy to note that the correlation between the economic wealth of nations and the “citations intensity” enhances transformation from a KBE to a creative economy via innovation. South Africa for instance is clustered with countries such as Poland, Russia and Brazil. This has enabled the country to join the ranks of wealthier nations thus placing some demands on the nation. This requires increase in its knowledge output substantially/increase in research and development expenditures. Available statistics puts it that OECD countries between 2005 and 2012 invests about 2.3% -2.6% of GDP on R & D, China invests between 1.5 and 1.9% of GDP while the share of GDP for South Africa declined from 0.9 to 0.7 within the same period (WDI, 2015). Government growth targets require a significant investment in innovation for a KBE to transform to a Creative Economy. Nigeria has a lot to benefit from South Africa among Sub-Saharan African nations and other emerging economies due to their high connectivity with the rest of the world.

6. Lessons for Nigeria

Since knowledge acquisition has been identified as enhancing innovation and creativity, the innovation strategy will require policy leadership by the Ministry of Science and Technology. Such policies will be strengthened through co-operation across the three tiers of government. There is the need for greater networking and collaboration across all sectors of the economy (academia, science councils, industry and government). Thus, an economic incentive and institutional regime that provides good economic policies and institutions must be in place. This will ensure efficient mobilization/allocation of resources, stimulate creativity and incentives for the efficient creation, dissemination and use of existing knowledge. Enhancement of high-technology shared in manufacturing production and exports will also lead to output growth.

An improved funding mechanism, especially in the area of fund application for the necessary R&D expenditures, and investment in appropriate infrastructures cannot be overemphasized. The key sector of the economy must be R&D driven. This provides a basis for a well-functioning national innovative system. Presently, no data is available on expenditure for R&D by the government in Nigeria. This speaks volumes as regards the nation's commitment to such. Furthermore, Human and Social Dynamics should be seriously revisited in Nigeria. This involves creating knowledge-intensive service sector such as education, communications and information. Establishing an educated, skilled, competitive and innovative workforce through optimum investment in human capital cannot be overemphasized. Thus, it becomes necessary for human capital development to be ensured via increased budgetary allocation to education. This will involve the government ensuring compliance with the United Nations benchmark on education expenditure. Human Capital will be the key driver for growth in the KBE and this will determine the extent of creativity and competitive position of the nation.

Also, the quality of education and training system must be reviewed by the regulatory authorities. Institutional framework must ensure an adequate supply of appropriately qualified and skilled manpower. Review of primary, secondary and tertiary education curriculum, teaching methods, increased access to tertiary education, improved quality of teachers teaching must be in tandem with the prevailing manpower needs

and appropriate student-teacher ratio, cannot be overemphasized. Vocational and Technical education will have to be given greater prominence to produce the required skills for a knowledge economy that can conveniently transform into a creative economy. No nation can develop beyond its investment in education.

Raising the knowledge content in Agriculture, Manufacturing and Services sectors is also of great importance. All sectors of the economy must be knowledge-intensive through increase in knowledge content. Greater application of knowledge will strengthen as well as increase the dynamics and competitiveness of these sectors and contribute to sustained rapid economic growth. Also, rapid advancement in ICT will enhance economic growth as new activities/investments are generated and developed in these sectors. As the industries within the sectors improve their technology content, they are able to produce high quality products that will generate value added. Furthermore, a modern and adequate information infrastructure will facilitate the effective communication, dissemination and processing of information and knowledge. There is the need to reconcile traditional methods of production with new methods generated through basic research efforts and educating new generations of scientists and engineers. Above all, there is the need to translate technological change into productivity gains via increased output growth.

7. Conclusion

It is evident from this paper that for a transformation from knowledge-based to creative economy to take place, the four pillars of the knowledge economy must be within the appropriate benchmarks. Knowledge acquisition enhances innovation which transforms the economy through creativity. The KEI-ICT, KEI-Innovation, EI and the GCR must all be maintained and sustained within the framework of the World Bank benchmark. The importance of Nigeria's government maintaining a high and stable Literacy Rates, Human Development Index and an appreciable percentage share of expenditure on R&D in Gross Domestic Product as it operates in the emerging and developed nations cannot be overemphasized. Realizing the gains from the transition from knowledge-based to creative economy will no doubt involve the government formulating the right public policy mix and strategic choices for harnessing the socio-economic potentials.

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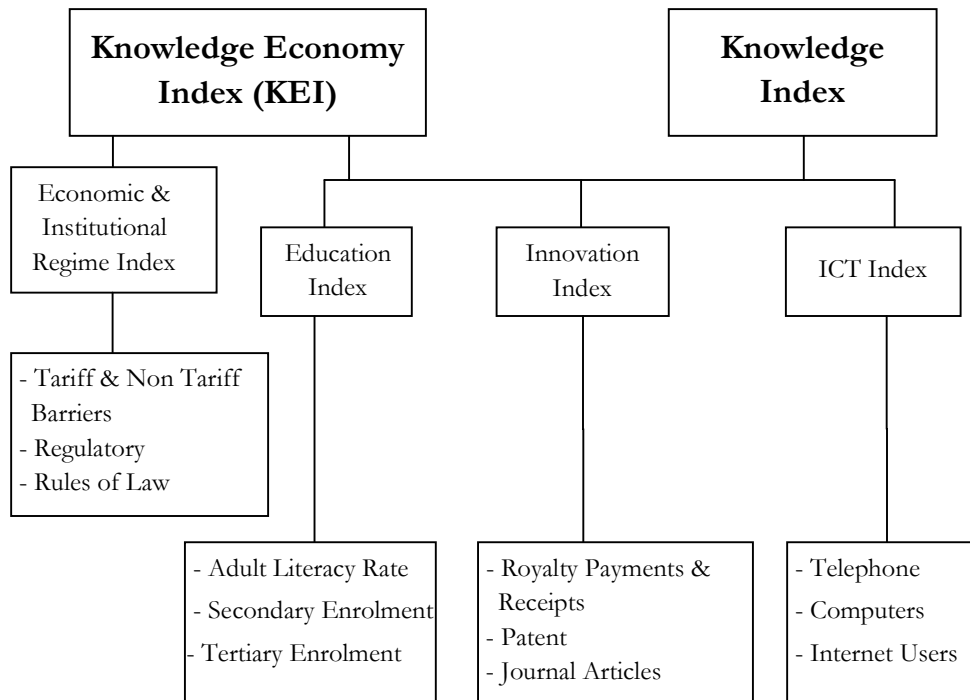
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Appendix

Chart 1: Knowledge Index (KI)



Source: Adapted from World Bank's Knowledge Assessment Methodology (KAM, 2012).

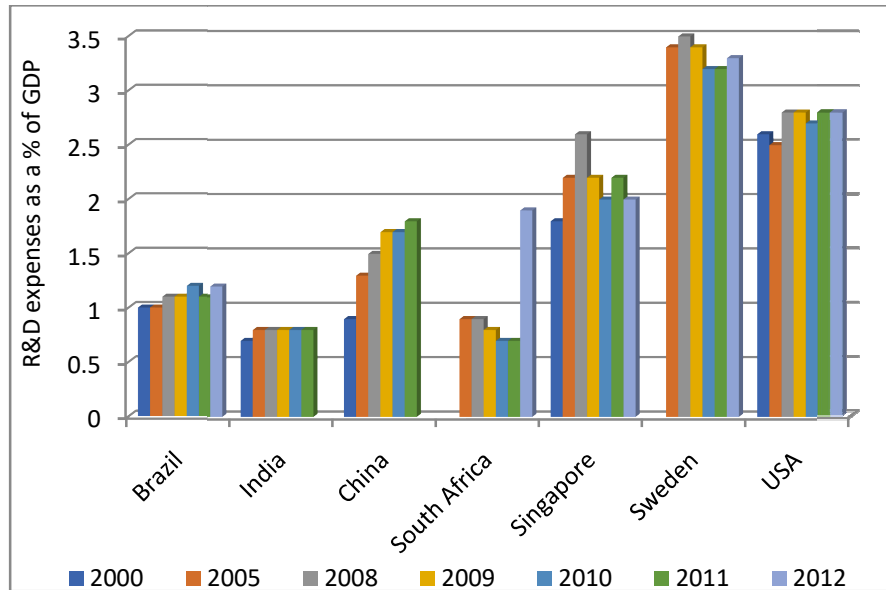


Figure 1: Research and Development Expenditure (% of GDP)

Source: World Development Indicators (2015).

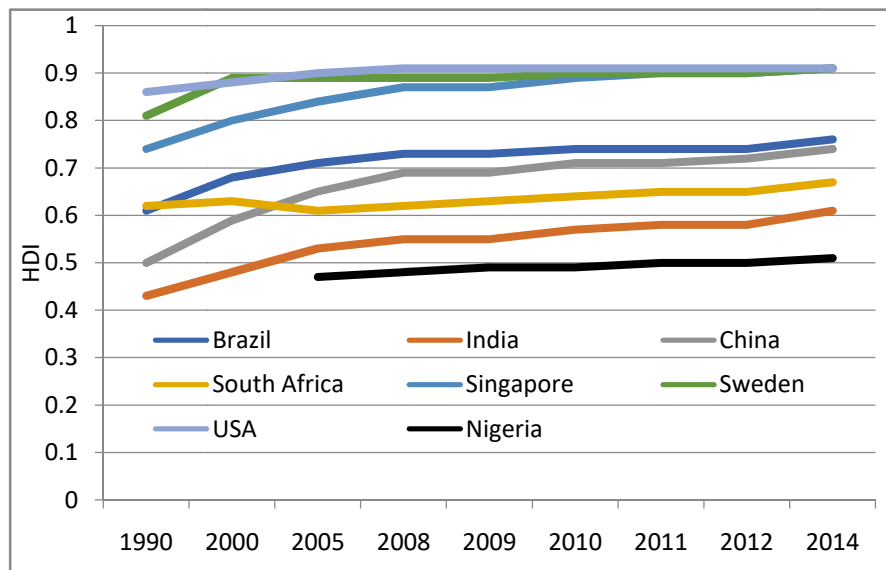


Figure 2: Human Development Index (HDI).

Source: United Nations Development Programme (2015).

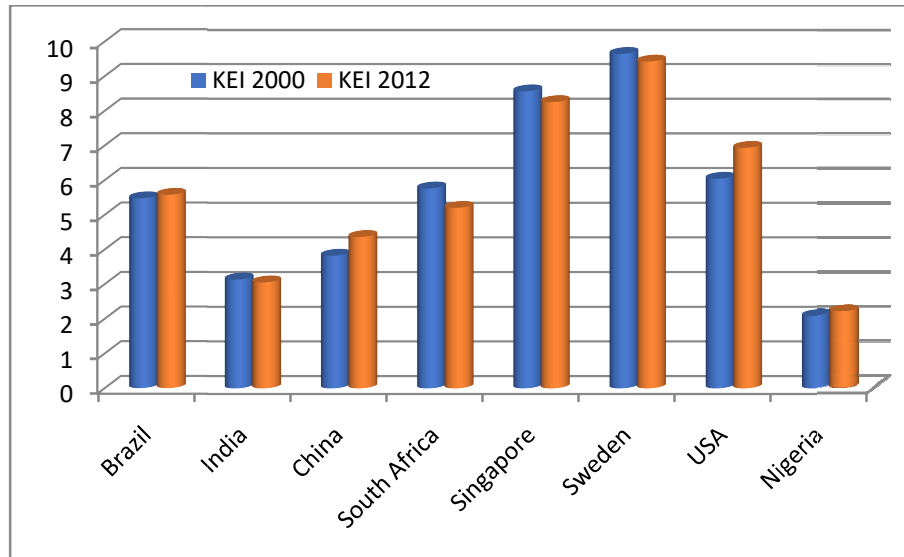


Figure 3: Knowledge Economic Index of Selected Emerging and Developed Countries

Source: World Bank Group (2015).

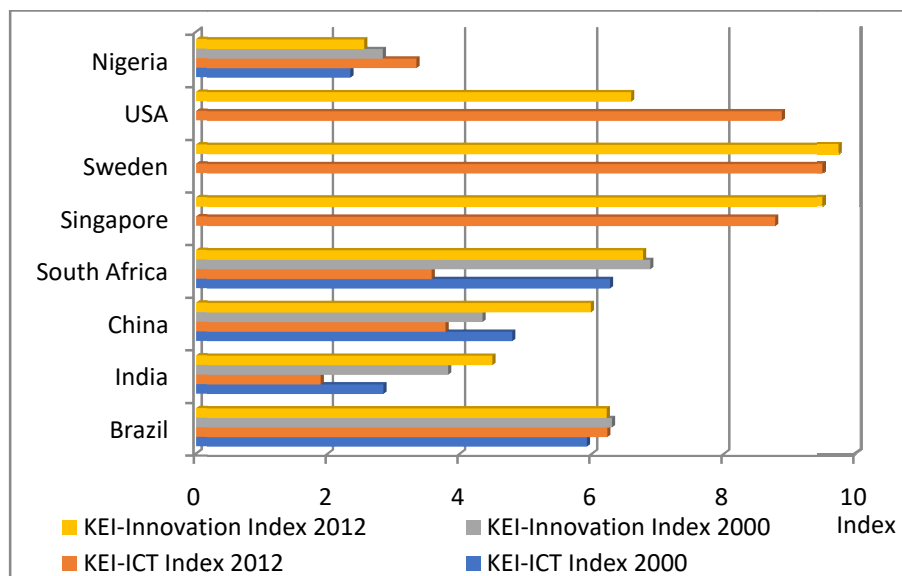


Figure 4: KEI-Innovation and KEI-ICT Index for Selected Emerging and Developed Countries.

Source: World Bank Group (2015).

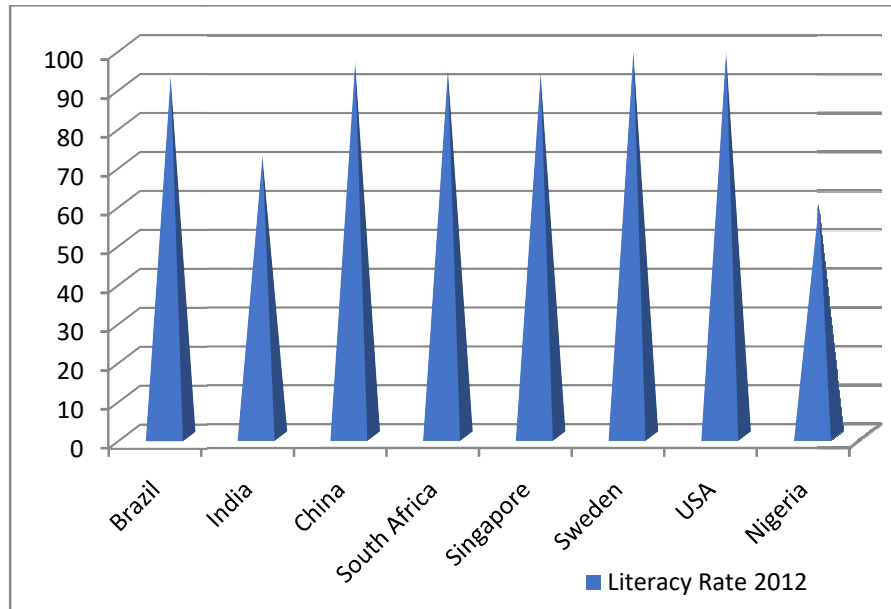


Figure 5: Literacy rate of Emerging and Developed Countries in 2012
Source: World Development Indicators (2015).

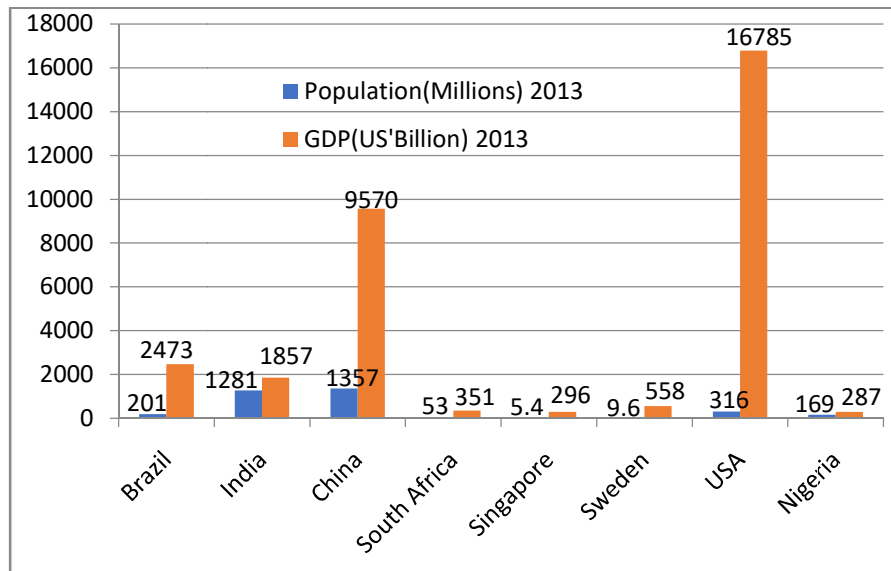


Figure 6: Gross Domestic Product (GDP) and Population of Selected Emerging and Developed Countries.
Source: World Bank Group (2015).

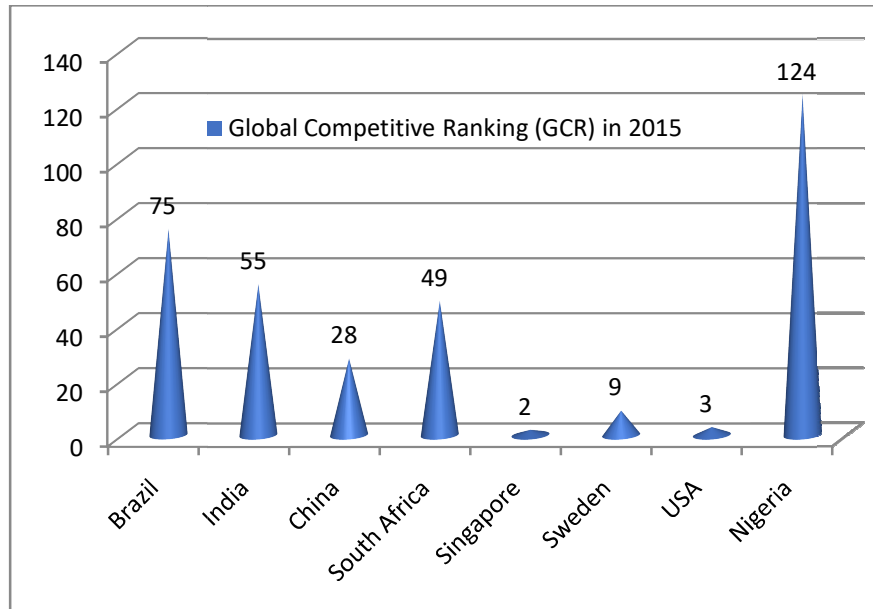


Figure 7: Global Competitive Ranking (GCR) in 2015.

Source: Global Competitiveness Report (2015); World Economic Forum (2015).

Understanding the Pathways to Industrialization in Nigeria: Is Remittance-Finance Nexus Substitute or Complement?

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Abstract

This study examines the role of financial market development in remittance-industrialization relations in Nigeria for a period straddling from 1981 to 2018. We established the following findings using the fully modified least square method. First, the unconditional impact of Diaspora remittance on industrialization is found to be negative and statistically significant. Second, poor financial market development has an unqualified negative influence on industrialization. In particular, low domestic credit to the private sector by banks unrestrictedly affects industrialization whereas the impact of broad money is statistically irrelevant. Third, the marginal effect of interactions between remittance and domestic credit to the private sector is statistically negative. Fourth, the corresponding net effects of the interactive term of remittance and domestic credit are in the same way negative on industrialization. It implies that financial market development does not play a cooperative role in improving the links between Diaspora remittance and industrialization in Nigeria. This confirms that remittance and financial market development are substitute and not complement. Fifth, domestic credit to the private sector by banks to GDP will modulate a direct impact of Diaspora remittances on industrialization at the rate of 11.8%. Finally, the amplifying effects of capital investment, trade openness and government consumption expenditure on industrialization are notable statistically. On the policy front, emphasizing remittance inflow is not just sufficient but putting appropriate measures on how to make sure these transfers are put into productive use and ensure industrialization are equally necessary.

Keywords: Diaspora remittance, industrial performance, domestic credit, broad money, Nigeria.

JEL Classification: E44, F24, L16.

1. Introduction

Understanding the long-run drivers of industrialization is vital in the development process of every economy. There are several reasons why these drivers are important given that sustainable industrialization provides a lifelong settlement to economic development. A good number of these reasons originated from Kaldor's law as it employed a conceptual framework to explain the existing relationship between manufacturing productivity and economic growth (Haraguchi, Martorano and Sanfilippo, 2019). It should be pointed out that the promoters of industrialization based their arguments supporting the productive yields of the manufacturing sector over other sectors including the high forward and backward externalities that arise from manufacturing growth (Szirmai, 2012). Additional benefits of industrialization include savings improvement, capital accumulation and creation of investment opportunities (Szirmai and Verspagen, 2015; Alimi and Alese, 2017). Scholars like Arrow (1971) and Thirlwall (2003) noted that industrialization drives technological progress through economies of scale. Hirschman (1958) also believed that it provides a spillover effect through connections with other economic subdivisions. With regards to the above discussion, it is crucial to understand the pathways to industrialization and find out how the financial resources of industrialization are obtained from both internal and external sources. Likewise, it is worth noting that the capital reliance of many developing countries has departed from the external financial resources because of the shocking effects of the global financial crises experienced in 2008. Conversely, this has rekindled the interest of scholars from the well-known external sources (such as foreign direct invest, foreign private investment, and official development assistance) to other superficially sources of finance for industrial growth (Ajide and Alimi, 2019; Olayungo and Quadri, 2019). Apparently, Diaspora remittance stands as a better alternative source of finance owing to the fact that it easily rebound back compared to other capital flows during the periods of economic turmoil and macroeconomic shocks (Ratha, Mohapatra and Xu, 2008).

In recent times, remittance transfers have been documented as one of the most pertinent source of finance for the Sustainable Development Goals (SDG) in the course of discussing financing options for development during the United Nations Third International Conference on Financing

Development in Addis Ababa in July 2015 (Sobiech, 2019). In Africa, professionals have recognized remittance transfer as a more dependable source for financing development (Adeoye, Nwokolo and Igboanugo, 2020). International organizations like the African Development Bank (ADB) and the United Nations Economic Commission for Africa (UNECA) informed African countries to redirect their attention by leveraging on migrants' transfers. In recent years, statistics have shown that remittance inflow into many African countries supersedes other forms of capital flows. For example, Diasporas' remittance into Nigeria is 11 times the foreign direct investment in 2018 and 7.4 times higher than the net official development assistance in 2017 (KNOMAD, 2019). Also, the US\$23.63 billion remittances in 2018 represent 6.1% of the country's gross domestic product and 14% above remittance transfers in 2017. According to PricewaterhouseCoopers (2019) and Xpressmoney (2020), a large amount of this transfer comes from the United States amounting to about 30% together with some Europe and Africa countries such as Switzerland, United Arab Emirates, Cameroon, Russia, and China and so on. They further noted that about 70% of the remittance transfers are directed towards consumption expenditure while the remaining 30% are channelled to finance capital investment. Thus, this implies that a large share of these transfers was made to support families in developing countries. Recognizing the significant impacts of remittance in supporting relatives are imperative and the need for countries to have a well-functioning financial market to boost remittance transfer through cheap fees and improved service availability cannot be overemphasized. It, therefore, suggests that financial market plays a significant role in the nexus between remittances and industrialization. In a nutshell, the financial institution is a channel through which remittance transfers influence industrialization and economic growth. Past studies that have lent support to this fact are Giuliano and Ruiz-Arranz (2009), Barajas *et al.* (2009), Sobiech (2019), and Adeoye, Nwokolo and Igboanugo (2020) among others.

What is more, there is continuing controversy surrounding the issues on whether remittance transfers and financial markets are a substitute (Barajaz *et al.*, 2009; Giuliano and Ruiz-Arranz, 2009; Sobiech (2019), Adeoye, Nwokolo and Igboanugo, 2020) or complement (Mundaca, 2009; Nyamongo *et al.*, 2012). They are considered to be a substitute if the coefficient of the interaction between remittance transfer and

financial market is negative and otherwise complement if the parameter is positive. In the case of substitute, the interpretation is that if the financial sector is more developed, constraints affecting credit allocations are removed and therefore remittance transfers from abroad do not need to be utilized in productive investment (Barajaz *et al.*, 2009; Giuliano and Ruiz-Arranz, 2009). Meanwhile, if the financial sector is poorly developed, remittance becomes an important source of improving economic activities. As for complement, it means that as financial deepening increases, the direct links between remittance and growth become stronger rather than deteriorating (Mundaca, 2009; Nyamongo *et al.*, 2012).

Based on the above consideration, this study investigates the links between Diaspora remittance and industrialization as well as the confounding role of financial market development in the relationships. We used the data of the Nigerian economy to investigate the tripartite links between remittance, financial market and industrialization within the period of 1981 to 2018. The study contributed to the extant literature in the following three ways. First, the unconditional effects of both remittance transfers and financial market development on industrialization are investigated by augmenting the empirical model with salient economic drivers of industrialization. The study presented the economic drivers in a single empirical model to assess their effects on industrialization. Second, the study detected whether the interactions between remittance and financial institutions are substitute or complement. This also makes it possible for us to estimate the threshold point at which financial sector mediates in the nexus between remittance and industrialization in Nigeria. As a final point, the study utilized both the maximum likelihood test connected with Johansen and Juselius (1990) for cointegration test and fully modified ordinary least square (FM-OLS) to estimate the parameters as they were found more efficient for studies where the regressors are endogenous (Mesagan, Ogbuji, Alimi and Odeleye, 2019).

Apart from the introductory part, the remaining sections are divided into four parts. The second part synthesized the extant literature into a brief discussion on theories, empirical studies and conceptual links between remittance, financial market and industrialization. The methodology, data sources and descriptions were presented in the third part. In the fourth

section, empirical results and discussion of findings are undertaken. The last part concludes with policy implications.

2. Synthesizing the Literature

In this section, we explained salient theories and empirical literature. According to the theoretical literature, factors determining the financial supports by migrants to their relatives at the home country are classified into two i.e. pure altruistic motive and self-interest purpose. In the case of altruistic motive, migrants make financial assistance to relatives at the home country to improve their welfare. As a result, migrants become satisfied when the consumption pattern and wellbeing of family members are not worse-off. Summarily, when the family members of a migrant are affected by the economic and financial condition back at home, remittance then becomes a device that absorbs the shock. Thus, remittance is then perceived as a countercyclical instrument because it is a compensatory transfer that augments the consumption of migrants' families during economic downturns. On the other hand, the self-interest purposes argued that fund remitted by migrants is lowered owing to the harsh economic condition in the home country. The proposition of the thought contravenes the countercyclical characteristic of remittance. According to Lucas and Stark (1985:904), they noted that "migrant remit money for investment or acquisition of assets in their home country and for them to be respected when they return to their home country" (Stark, 1991, 1995).

Under the empirical literature, apart from the direct links between remittance and sector growth investigated by existing studies, some have argued that remittances affect industrial growth via indirect channels primarily the human capital development, investment among others (Sobiech, 2019). For the direct channel, the findings of Dzansi (2013) conducted for a cross-section of 40 countries within 1991 and 2004 showed that remittance enhances the output growth of the manufacturing sector at home country. While investigating the relationship between remittances and manufacturing output, Amuedo-Dorantes (2014) found that remittances result in more demand for non-tradable goods compared to the manufactured/tradable commodities. The findings of Acosta, Lartey, and Mandelman (2009) also laid credence into this fact. This invariably affects the productivity of the manufacturing sector. Similarly, for a panel of 109 developing countries

within 1990-2003, Larrey, Mandelman, and Acosta (2008) revealed that the prices of non-tradable goods are greatly affected by remittance inflows compared to tradable commodities. For remittance inflow into Bangladesh, Hossain and Hasanuzzaman (2015) found that remittance impacted positively on the level of investment as well as the economic activities of home entrepreneurs and small businesses in the long run. More so, Brinkerhoff (2006) noted that the skill transfer from Diaspora is another direct channel through which remittance help in improving the output growth of the manufacturing sector in the home country.

In the case of the indirect channels, Some of the factors documented by scholars (like Aggarwal, Demirguc-Kunt, and Peria, 2011; Ojapinwa and Bashiru, 2014; Karikari, Mensah, and Harvey, 2016) include: (a) foreign currency exchange as it influences the productivity of the manufacturing sector negatively by affecting the worth of tradable commodities; and (b) financial institutions as it assists in improving the efficiency of the manufacturing sectors. Empirically, Acosta, Larrey, and Mandelman (2009) noted that the high remittance leading to a rise in exchange rate invariably result in a fall in outputs of tradable goods. Also, Hossain and Hasanuzzaman (2015) established a direct level of association between remittance and investment in Bangladesh. Using a newly created index of financial development that comprised the overall size, depth and efficiency of financial systems for 91 countries over the period 1970-2010, Sobiech (2019) found that the more developed a financial market in a country is, the lesser the effects of remittances on output growth. While examining the relationship between remittance, financial development and industrial output growth for 46 African countries between 1980 and 2017, Adeoye, Nwokolo and Igboanugo (2020) found that remittance only drives industrial growth via the development of financial sectors at the initial phase.

Consequently, the efficiency pace of the financial institutions shows their ability to pool savings as capital for productive investment that can drive long-run industrial growth (Ewetan and Ike, 2014; Olayungbo and Quadri, 2019; Adeoye *et al.*, 2020). As said by Amuedo-Dorantes (2014), Diaspora remittance positively impacted on personal consumption and in turn influenced the industrial output growth of non-tradable commodities. Irrespective of the transmission channel, the most imperative goal is to take full advantage of Diaspora remittance in an attempt to bring about the anticipated growth in industries. For instance,

the central authority needs to more concerned about policies and actions that can be employed to enhance benefits from remittance from migrants. Also, investors have to be involved in the enhancement process via the promotion of Diaspora's input all the way through vertical absorption of businesses at home country. Similarly, households and individuals can equally be involved in the maximization process through skill acquisition and career development. Conversely, the intervention of government is germane towards the utilization of migrant's remittance. One of the key policy targets the central authority need to ensure is the development of financial institutions. For this reason, the involvement of financial market development in remittance-industrialization nexus becomes very important. It means that the role of financial institutions in ensuring that the quantity and quality of personal remittances promote the productive investment of industrial output growth cannot be overemphasized. Following the above discussion, the conceptual link between Diaspora remittance, financial market development and industrialization is depicted in Figure 1.

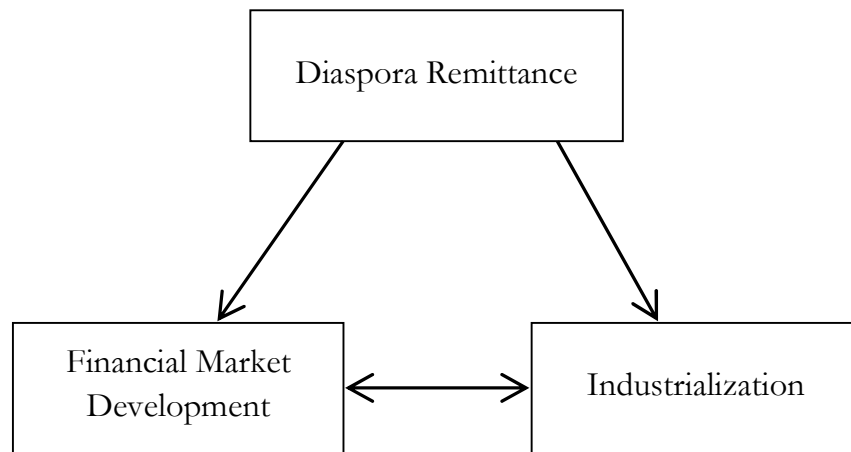


Figure 1: Conceptual Link between Diaspora Remittance, Financial Market Development and Industrialization.

The figure unfolds three different hypotheses: (i) the nexus between financial market development and industrialization is most likely endogenous i.e. possibly resulting to a feedback effect; (ii) Diaspora remittance may promote industrialization directly through skill transfer from overseas to the home country (Brinkerhoff, 2006); and (iii)

Migrants' remittance may contribute to financial market development and in turn, may contribute to industrialization.

3. Data and Methodology

3.1 Data Scope and Details

This study utilized secondary data in a time series form for the Nigerian economy covering the period 1981 to 2018. The data coverage was based on the availability of datasets. The outcome variable is industrialization denoting the level of development of industries in an economy on a wider range. It was measured by the industry (including construction) value added (% of GDP) gathered from the World Development Indicator (WDI, 2019) online record of the World Bank. The two key explanatory variables are Diaspora remittance and financial development. Regarding the Diaspora remittance, it reveals the total sum of personal, current and capital transfers in cash or kind paid or received by resident individuals to or from non-resident households including the net reward of a worker from people working overseas for short periods. The data is obtained as a percentage of GDP from the WDI (2019). Financial development is considered because of its role in converting liquid or short-term savings to illiquid or long-term investments thereby encouraging accumulation of capital (World Bank, 2005). Huang (2011) noted that the financial market has an imperative role to play in transforming capital investment into an uppermost value use. This is captured using financial deepening (i.e. when economies are opened to continuous growth and more opportunities, they experience increasing liquid money) and financial depth (it captures the size of the financial industry to the economy). Specifically, broad money to GDP is used to represent financial deepening while domestic credit to the private sector by bank to GDP denotes financial depth. They are also gathered from the WDI (2019). The study also considered the interactive term of Diaspora remittance and financial market indicators to capture the developmental role of the financial sector in remittance-industrialization nexus in Nigeria. Other controlling variables included in the industrialization model that followed the standard growth literature, were sourced from the WDI (2019). These variables are capital investment proxy by gross fixed capital formation (% of GDP), government consumption General measured as government final consumption expenditure (% of GDP), trade intensity captured by the total trade (% of

GDP), and foreign capital inflow proxied by Foreign direct investment, net inflows (% of GDP).

Table 1: Summary Statistics

Variables Measurements		Mean	Std Dev.	Max.	Min.
ind	Industry (including construction) value added (% of GDP)	29.71	5.453	39.25	18.17
rem	Personal remittances, received (% of GDP)	2.508	2.567	8.312	0.005
fd1	Broad money (% of GDP)	15.93	5.704	27.38	9.063
fd2	Domestic credit to private sector by banks (% of GDP)	9.109	3.587	19.60	4.948
rem×fd1	Interaction between rem and fd1	49.72	55.78	158.23	0.059
rem×fd2	Interaction between rem and fd2	29.43	34.52	123.37	0.029
gfcf	Gross fixed capital formation (% of GDP)	36.22	19.57	89.39	14.169
gcon	Government final consumption expenditure (% of GDP)	3.673	2.853	9.448	0.911
trade	Trade (% of GDP)	32.26	12.57	53.28	9.136
fdi	Foreign direct investment, net inflows (% of GDP)	1.572	1.243	5.791	0.257

Note: Std. Dev. denotes standard deviation; Max. is maximum; Min. represents minimum; total observation is 38.

Source: Authors' computation (2020).

The summary statistics of the sample data are presented in Table 1. The descriptive statistics revealed that the mean of industry value added to GDP stands at 29.71% indicating that its outputs are relatively low compared to the contribution of other key sectors like agriculture and service sectors. The mean of the percentage of personal remittance to GDP is 2.51%, while it peaks 8.31% in 2005 and dips 0.0049% in 1988 for the periods under study. The averages of broad money and domestic credit to the private sector by bank to GDP are 15.93% and 9.11% respectively. More so, the mean of the proportion of capital investment, government consumption, trade and foreign direct investment, all to GDP are 36.22%, 3.67%, 32.26% and 1.57% correspondingly.

Table 2: Correlation Matrix

	rem	fd1	fd2	rem×fd1	rem×fd2	gfcf	gcon	fdi	trade
ind	-0.732	-0.748	-0.799	-0.785	-0.770	0.763	-0.675	-0.057	-0.135
rem	1	0.684	0.735	0.828	0.925	-0.734	0.812	0.238	0.331
fd1		1	0.837	0.887	0.787	-0.692	0.804	0.054	0.133
fd2			1	0.857	0.811	-0.697	0.836	0.122	0.237
rem×fd1				1	0.856	-0.751	0.881	0.139	0.255
rem×fd2					1	-0.704	0.884	0.200	0.264
gfcf						1	-0.658	-0.179	-0.538
gcon							1	0.096	0.232
fdi								1	0.298

Note: ind-Industrialization; rem-Personal remittances received; fd1-Broad money to GDP; fd2-Domestic credit to private sector by banks to GDP; rem×fd1-Interaction between rem and fd1; rem×fd2-Interaction between rem and fd2; gfcf-Capital investment; gcon-Government consumption; trade-Trade openness; and fdi-Foreign direct investment.

Source: Authors' computation (2020).

Afterwards, the correlation matrix of the variables concerning the main outcome variable is presented in Table 2. The correlation result shows that the industrial output is indirectly related to personal remittance, financial development indices as well as their interactive terms. Likewise, government consumption, foreign direct investment and trade correlate negatively with industry output. However, investment has a positive correlation with industrial sector performance. The correlation coefficients are not too high which can likely result in multicollinearity problem associated with regression outcomes.

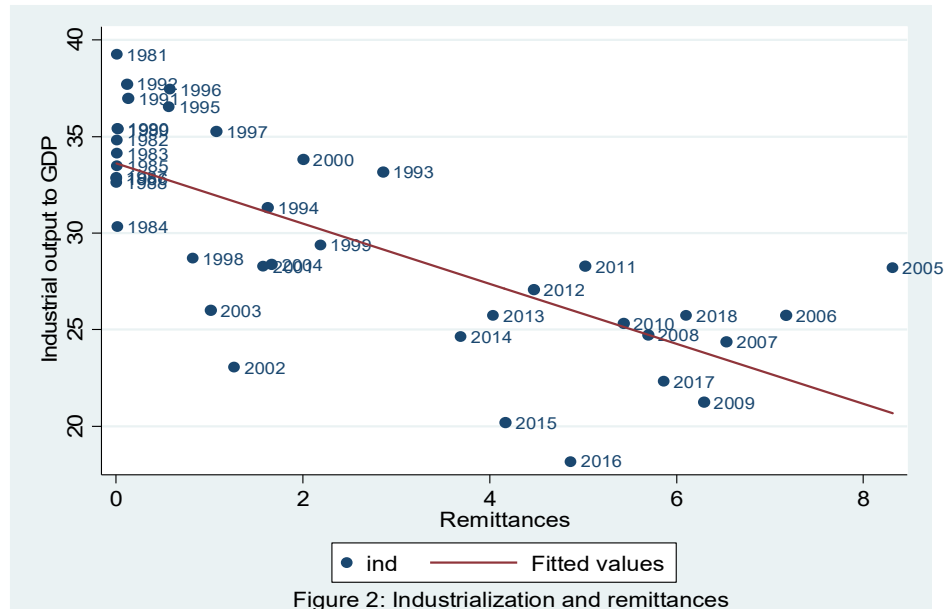


Figure 2: Industrialization and remittances

Figures 2: Scatter plots of industrialization and remittance

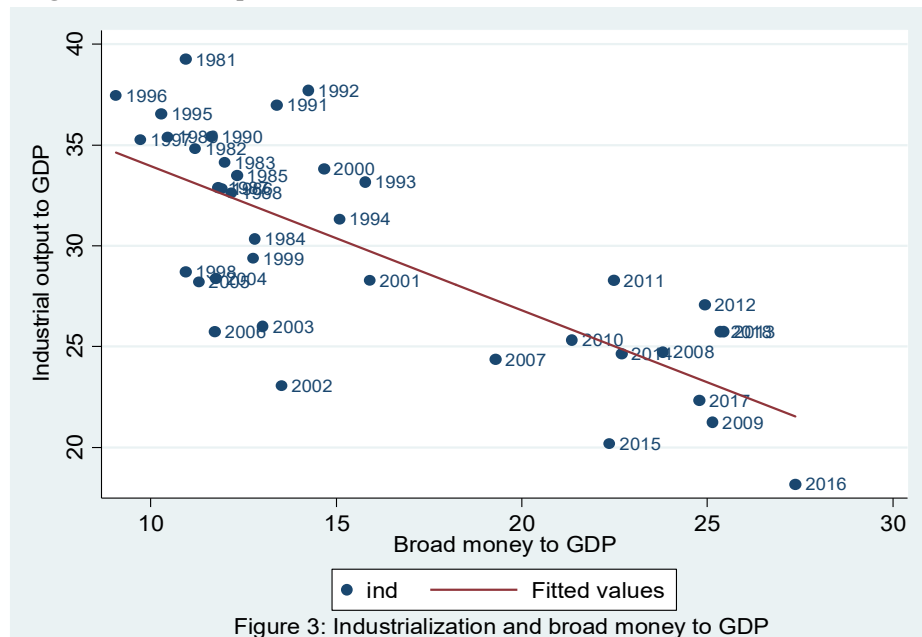


Figure 3: Industrialization and broad money to GDP

Figures 3: Scatter plots of industrialization and financial development measured by broad money as percentage of GDP

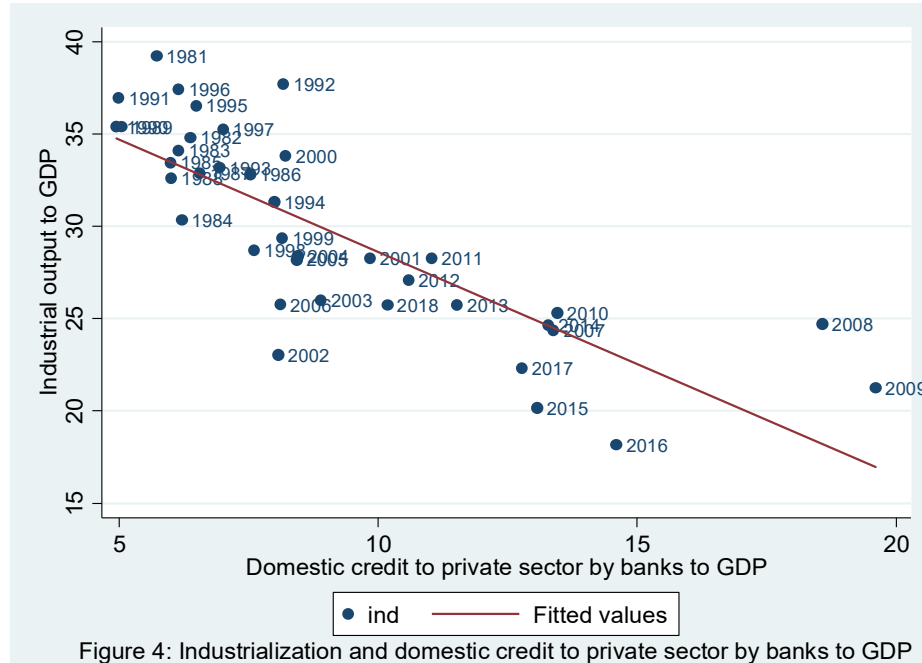


Figure 4: Industrialization and domestic credit to private sector by banks to GDP

The scatter plots of industrial performance with remittance, broad money to GDP and domestic credit to the private sector by banks to GDP are presented in Figures 2, 3 and 4 respectively. Meanwhile, the scatter plots of industrialization and the interaction between remittances and financial development indices are presented correspondingly in Figures 5 and 6. It is also important to note that these are just preliminary analysis which is subject to empirical validation using appropriate estimation approaches.

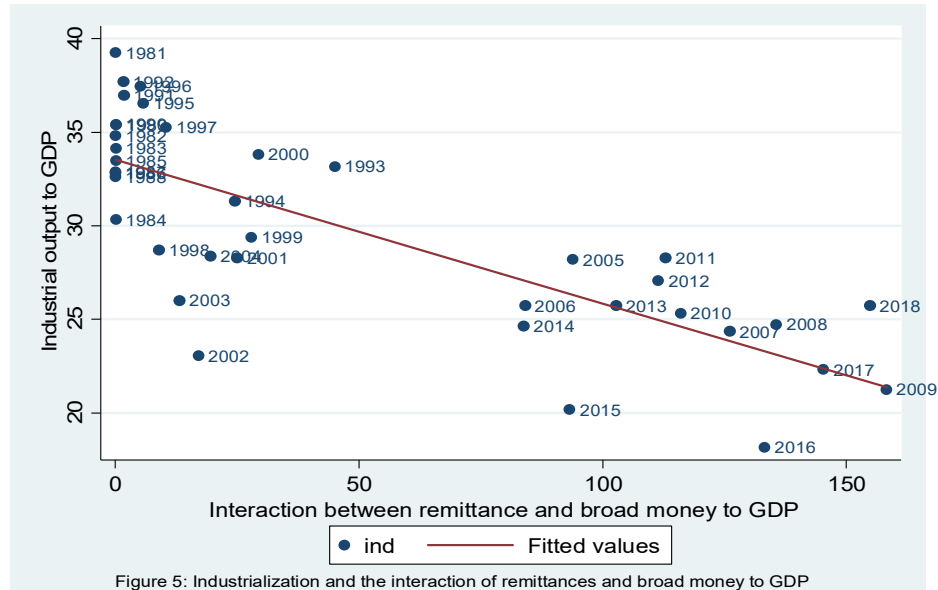


Figure 5: Scatter plots of industrialization and the interaction of remittances and broad money as GDP

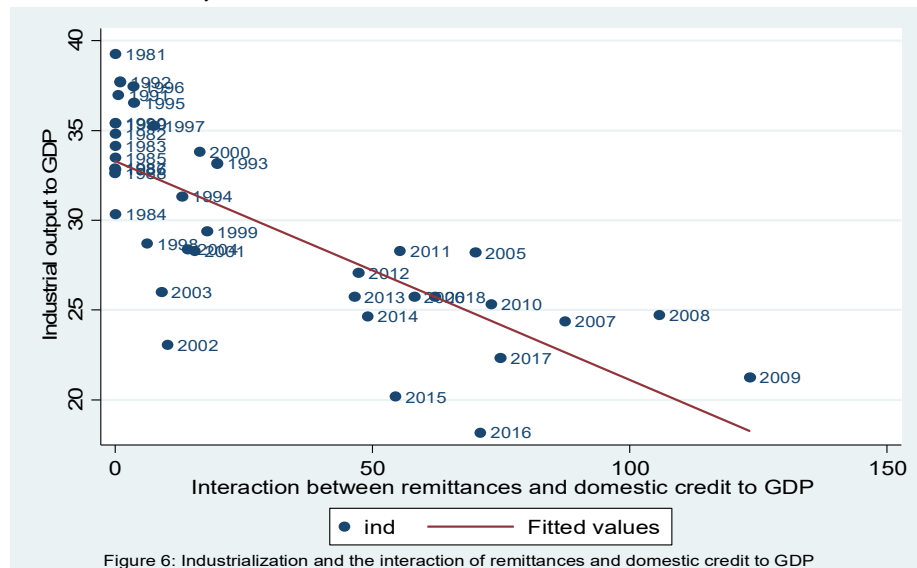


Figure 6: Scatter plots of industrialization and the interaction of remittances and domestic credit to private sector by banks to GDP

3.2 Model Specification and Theoretical Expectation

Adapting the theoretical foundation of the neoclassical growth model, this study modifies the models of Sobiech (2019) to specify the relationship between remittance, financial market development and industrialization as:

$$ind_t = \pi_0 + \pi_1 rem_t + \pi_2 fd_t + \pi_3 (rem_t \times fd_t) + \beta X_t + \mu_t \quad (1)$$

Industrial output performance (*ind*) is regressed on Diaspora remittance (*rem*), a vector of financial development (*fd*) indicators (i.e. broad money and domestic credit to the private sector by banks to the size of the economy); the interaction between Diaspora remittance and financial development (*rem*×*fd*) and control variables (*X*). The parameters are represented by π_0, π_{1-3}, β , time is denoted by *t* and the disturbance term is identified as μ . In accordance to the standard growth literature, other factors determining the performance of industrial sector are capital investment (*gcf*), government consumption (*gcon*), foreign direct investment (*fdi*), and trade openness (*trade*). Regarding the *apriori* expectation, the study expects a direct relationship between the explanatory variables and industrial performance. It, therefore, implies that a higher rate of remittance inflow and financial market development should drive industrialization. In the same way, the study presumes positive relations from capital investment, government consumption, foreign direct investment and trade flow to industrialization.

3.3 Estimation Strategies

The study used the Augmented Dickey-Fuller test statistics to find the stationary level of each variable because of the undependability of some indices in the summary statistics. We decided to confirm the stationarity of the variables prior to the estimation of cointegration tests. Also, the test was conducted by taking into account of constant and trend properties. The finding of the ADF unit root tests of the integration order is presented in Table 3. The results show that all the variables are not stationary at levels at 5% significance level, but they indicate evidence of stationarity at the first difference at 1% significance level. It, therefore, means that the variables are integrated at order one.

Table 3: Order of Integration Test at Constant and Linear Trend (Augment Dickey Fuller test)

	ind	rem	fd1	fd2	rem×fd1	rem×fd2	gfcf	gcon	fdi	trade
At Levels	-3.490*	-2.934	-2.728	-3.532*	-2.316	-2.305	-3.309*	-2.809	-3.437*	-2.328
At 1st difference	-6.45***	-6.20***	-4.83***	-5.39***	-6.26***	-5.54***	-5.36***	-5.46***	-7.84***	-4.58***

Note: ***, ** and * signify significance level at 1%(-4.227), 5%(-3.537) and 10%(-3.200) respectively. Also, ind-Industrialization; rem-Personal remittances received; fd1-Broad money; fd2-Domestic credit to private sector by banks; rem×fd1-Interaction between rem and fd1; rem×fd2-Interaction between rem and fd2; gfcf-Capital investment; gcon-Government consumption; trade-Trade openness; and fdi-Foreign direct investment.

Source: Authors' computation (2020).

What is more, we applied the multiple Johansen-Juselius cointegration approach developed by Johansen (1988) and Johansen and Juselius (1990) to determine the cointegration of Diaspora remittances, financial market development and industrialization as well as the controlling variables (capital investment, government consumption, foreign direct investment and trade openness). The technique has some superior advantages over the previous and traditional cointegration approaches. They are: (i) its properties for two- and more variables system are superior to the previous estimators, and (ii) the estimation method assumes that in the multivariate system all variables are endogenous. Following the vector error correction model (VECM), the model specification of the multivariate cointegration approach of Johansen (1988) and Johansen and Juselius (1990) is stated as:

$$\Delta Y_t = \varphi_0 + \sum_{i=1}^{n-1} \mathbf{B} \Delta Y_{t-1} + \varphi_1 \Delta Y_t + e_t \quad (2)$$

The difference operator is denoted by Δ . $\mathbf{B}$ represents the $(n \times n)$ coefficient matrix wherein the number of cointegrating vectors determines the rank. Further, if $\mathbf{B} = \mathbf{0}$, $\mathbf{B}$ is of either zero rank or full rank, it means there is no cointegration between the indicators in the long-run relationship, thereby indicating that the model is best estimated in the level of first difference respectively. As well, if $\mathbf{B}$ is of reduced form, r (i.e. $r < n$) then $r \times n$ matrices will exist, ϕ and φ in that $\mathbf{B} = \phi\varphi$ where φ is the matrices, whose column are the independent cointegrating vector in a linear form and ϕ matrix is deduced as the adjustment matrix that shows the speed at which the system responds to

last period divergence from each endogenous variable. The Johansen and Juselius (1990) cointegration approach offers two test statistics to confirm the ranks of the matrix or the number of cointegrated vectors. These are Trace statistics, LR (λ_{trace}) and the Maximum Eigenvalue, LR (λ_{max}).

Table 4 presents the Johansen and Juselius (1990) cointegration test results. The test results are computed for four different models. The first and second models were computed by controlling broad money to GDP and domestic credit to the private sector by banks to GDP into the industrial growth models separately. Concerning the third and fourth models, they were computed with the interactive terms of remittance and financial market development indicators. For the first model, it rejected the null hypothesis of no cointegrating vectors at three cointegrating vectors using both trace and maximum Eigen tests at a 5% significance level. As for the second and third models, the null hypotheses of no cointegrating vectors in respect of five cointegrating vectors were not accepted using both trace and maximum Eigen tests at a 5% significance level. Concerning the fourth model, the null hypothesis of no long-run relationship at six cointegrating vectors using both trace and maximum Eigen tests was rejected at the conventional level. Thus, it means that there exists a long-run relationship among the selected economic indicators namely, industrial performance, personal remittances, financial market development, capital investment, government consumption, trade openness and foreign direct investment in Nigeria.

Table 4: Multivariate Johansen Cointegration Test Results

Null	Eigenvalue	Unrestricted Cointegration Rank Test (Trace)			Unrestricted Cointegration Rank Test (Maximum Eigenvalues)		
		Trace statistics	0.05 critical value	Prob.	Max-Eigen statistics	0.05 critical value	Prob.
Series: ind rem fd1 gfcf gcon fdi trade		Lags interval (in first differences): 1 to 2					
r = 0	0.9597	248.35***	125.62	0.0000	112.42***	46.231	0.0000
r ≤ 1	0.8230	135.93***	95.754	0.0000	60.599***	40.078	0.0001
r ≤ 2	0.6567	75.329**	69.819	0.0170	37.416**	33.877	0.0181
r ≤ 3	0.3529	37.913	47.856	0.3058	15.234	27.584	0.7295
r ≤ 4	0.2798	22.679	29.797	0.2622	11.489	21.132	0.5985
r ≤ 5	0.2319	11.190	15.495	0.2001	9.2324	14.265	0.2673
r ≤ 6	0.0544	1.9573	3.8415	0.1618	1.9573	3.8415	0.1618
Series: ind rem fd2 gfcf gcon fdi trade		Lags interval (in first differences): 1 to 2					
r = 0	0.9644	263.78***	125.62	0.0000	116.70***	46.231	0.0000
r ≤ 1	0.7444	147.08***	95.754	0.0000	47.746***	40.078	0.0057
r ≤ 2	0.6840	99.336***	69.819	0.0000	40.318***	33.877	0.0074
r ≤ 3	0.5692	59.018**	47.856	0.0032	29.470**	24.584	0.0283
r ≤ 4	0.4863	29.548***	29.797	0.0434	23.313**	21.132	0.0243
r ≤ 5	0.1605	6.2349	15.495	0.6678	6.1228	14.265	0.5975
r ≤ 6	0.0032	0.1121	3.8415	0.7377	0.1121	3.8415	0.7377
Series: ind rem fd1 rem×fd1 gfcf gcon fdi trade		Lags interval (in first differences): 1 to 2					
r = 0	0.9722	411.31***	159.53	0.0000	125.43***	52.363	0.0000
r ≤ 1	0.9299	285.88***	125.62	0.0000	93.062***	46.231	0.0000
r ≤ 2	0.9259	192.82***	95.754	0.0000	91.099***	40.078	0.0000
r ≤ 3	0.7826	101.72***	69.819	0.0000	53.409***	33.877	0.0001
r ≤ 4	0.4519	48.311**	47.856	0.0453	32.047**	27.584	0.0424
r ≤ 5	0.3006	27.263	29.797	0.0954	12.512	21.132	0.4980
r ≤ 6	0.2526	14.751	15.495	0.0645	10.189	14.265	0.1998
r ≤ 7	0.1222	4.5620	3.8415	0.0327	2.5620	3.8415	0.1327
Series: ind rem fd2 rem×fd2 gfcf gcon fdi trade		Lags interval (in first differences): 1 to 2					
r = 0	0.9989	525.36***	159.53	0.0000	239.72***	52.363	0.0001
r ≤ 1	0.9642	285.64***	125.62	0.0000	116.57***	46.231	0.0000
r ≤ 2	0.8244	169.07***	95.754	0.0000	60.889***	40.078	0.0001
r ≤ 3	0.6766	108.18***	69.819	0.0000	39.513***	33.877	0.0096
r ≤ 4	0.6413	68.666***	47.856	0.0002	35.888***	27.584	0.0034
r ≤ 5	0.4475	32.779**	29.797	0.0220	21.764**	21.132	0.0472
r ≤ 6	0.2571	12.015	15.495	0.1562	10.399	14.265	0.1870
r ≤ 7	0.0451	1.6153	3.8415	0.2037	1.6153	3.8415	0.2037

Note: ***, ** and * signify significance level at 1%, 5% and 10% respectively. More so, ind - Industrialization; rem - personal remittances received; fd1 - broad money; fd2 - domestic credit to private sector by banks; rem×fd1 - Interaction between rem and fd1; rem×fd2 - Interaction between rem and fd2; gfcf - capital investment; gcon - government consumption; trade - trade openness; and fdi - foreign direct investment.

Source: Authors' computation (2020).

Afterwards, the study further used the Fully Modified Ordinary Least Square (FMOLS) method to estimate the long-run parameters of the empirical model. According to Bashier and Siam (2014) and Fereidouni, Al-mulalia and Mohammed (2014), the estimator employs a semi-parametric test approach during the long-run estimation process of the parameters. Also, the parameters are reliable even with small sample size, and it is capable of conquering the setbacks caused by endogeneity, serial correlation, errors of measurement, variable omission, and heterogeneity in long-run parameters (Bashier and Siam, 2014; Fereidouni *et al.*, 2014). In addition, the approach is estimated with a single cointegrating equation having a fusion of first difference variables (Bashier and Siam, 2014). It is equally important to note that the estimator makes a transformation to the data and parameters (Park, 1992). The specification of FMOLS equation is stated as:

$$\hat{\theta}_{FME} = \left(\sum_{t=2}^T Z_t Z_t' \right)^{-1} \left(\sum_{t=2}^T Z_t Y_t^+ - \begin{bmatrix} T \lambda_{12}^+ \\ 0 \end{bmatrix} \right) \quad (3)$$

From equation (3), Priyankara (2018) noted that the two mathematical terms correcting the endogeneity and serial correlation problems are Y_t^+ and λ_{12}^+ . As a final point, the estimator is unbiased asymptotically as it shows an efficient allotment of the normal distribution that allows for standard Wald test via the asymptotic chi-square statistical inference (Adom *et al.*, 2015).

4. Analysis and Discussion of Empirical Results

The results of the links between Diaspora remittance, financial market development and industrialization in Nigeria using the fully modified least square is presented in Table 5. The findings are presented in regards to the confounding role of financial market development in ameliorating the positive impact of Diaspora remittances on industrialization. From the table, the impacts of personal remittances with financial market indices (i.e. financial deepening and financial depth) on industrialization are presented in columns 1 and 2. Meanwhile, the interactive terms of remittances and the financial market indicators respectively are included in the model and presented in columns 3 and 4. Above all, the six key findings noticeable in Table 5 are explained as follows.

First, Diaspora remittance exerts an unconditional negative and statistically significant impact on industrialization throughout the models with the exception of the model specified in the third column which is statistically insignificant at 5%. Second, the unconditional influence of financial market development on industrialization is found to be negative and significant statistically except the broad money supply (measuring the financial deepening) although negative but not statistically relevant. Third, the marginal effect of the interactive terms of financial market and Diaspora remittance is only found to be consistently negative and statistically significant for financial depth variable (i.e. domestic credit to the private sector by banks to GDP). Fourth, the corresponding net effect of the interaction of Diaspora remittance with financial depth is negative. It, therefore, means that the mediating role of domestic credit to the private sector by banks (financial depth) in remittance-industrialization nexus is ineffective. Fifth, the rate at which domestic credit to the private sector by banks to GDP will modulate a positive relationship between Diaspora remittances and industrialization is 11.8%. Finally, the amplifying effects of capital investment, trade openness and government consumption expenditure on industrialization are notable statistically when they are controlled for.

Table 5: FMOLS Estimates of Remittance, Financial Market Development and Industrialization in Nigeria.

Variables	Dependent variable: Industrialization (<i>ind</i>)			
	1	2	3	4
Diaspora remittances(<i>rem</i>)	-0.9112** (0.3947)	-0.7465** (0.3006)	-1.5197 (1.0017)	-2.2030*** (0.6088)
Broad money to GDP (<i>fd1</i>)	-0.2059 (0.1733)		-0.4176 (0.3628)	
Domestic credit to GDP (<i>fd2</i>)		-0.8646*** (0.2117)		-1.7833*** (0.03920)
Remittance(<i>rem</i>)×broad money(<i>fd1</i>)			0.0454 (0.0678)	
Remittance(<i>rem</i>)×domestic credit(<i>fd2</i>)				0.1866** (0.0682)
Capital investment (<i>gcf</i>)	0.1600** (0.0590)	0.1441*** (0.0417)	0.1497** (0.0601)	0.0984** (0.0405)
Government consumption(<i>gcon</i>)	0.2865 (0.3750)	0.6679** (0.2936)	0.2506 (0.3752)	0.4969* (0.2595)
Trade openness (<i>trade</i>)	0.1037* (0.0544)	0.1173*** (0.0392)	0.0967* (0.0546)	0.1173*** (0.0342)
Foreign direct investment (<i>fdi</i>)	0.5744 (0.4402)	0.5420 (0.3385)	0.6353 (0.4500)	0.3643 (0.2960)
Constant	24.177*** (5.2038)	27.117*** (3.3677)	27.461*** (6.9947)	36.155*** (4.4594)
Net Effects	-	-	n.a.	-0.5033
Thresholds	-	-	n.a.	11.804
R-squared	0.7224	0.7859	0.7214	0.8031
Adjusted R-squared	0.6668	0.7430	0.6542	0.7556

Note: Values in brackets are standard errors; ***, **&* represent statistical significance level at 1%, 5% and 10% respectively (bold form). The bolded values indicate the significance of estimated parameters. n.a. implies not applicable due to insignificant marginal effects.

Source: Authors' computation (2020).

One of the most important information from the findings is that Diaspora remittance is a critical precipitating factor that incessantly drives industrial performance negatively. This means that Diaspora remittance flows into the country are not targeted towards industrialization. This

supports the findings of Adeoye *et al.* (2020) conducted for 46 African countries. Similarly, it follows the findings by Larrey, Mandelman, and Acosta (2008) for a panel of 109 developing countries that the prices of non-tradable goods are greatly affected by remittance inflows compared to tradable commodities. It negates the results of direct links between remittances and manufacturing outputs by Dzansi (2013) for a cross-section of 40 countries. Acosta, Larrey, and Mandelman (2009) also lend credence to a positive relationship. Another key important finding is that financial market development mainly through poor domestic credit provision to the private sector by banks is responsible for low industrialization process in the Nigerian economy. This does not follow the results of Adeoye *et al.* (2020) that financial development through the domestic credit to private sector influence industrialization positively. The findings from the financial deepening measure of financial market development on industrialization were not statistically relevant. What's more, the marginal and net effects of the interaction of Diaspora remittance and domestic credit to private on industrialization are negative. It means that the more developed the financial market becomes; additional remittance flows from migrants are not utilized in the most well-organized way to improve industrialization. This is related to the findings of Sobiech (2019) on the overall economic growth of 91 countries over the period 1970-2010. It, therefore, suggests that Diaspora remittance and financial market development are substitutes, which is in line with the results of Giuliano and Ruiz-Arranz (2009), Barajas *et al.* (2009), Sobiech (2019), Adeoye *et al.* (2020). Thus, the role of the financial market as a substitute for remittances in developing countries like Nigeria has not changed. This contradicts the findings by Nyamongo *et al.* (2012) that remittances and financial deepening are complements in African countries implying that the former repeatedly improves the direct impact of latter on growth instead of mitigating the links.

5. Concluding Remarks

This paper investigates the role of financial market development in the remittance-industrialization relations in Nigeria for the period 1981-2018. We probe the links between the three variables by finding whether Diaspora remittance and financial market development are substitute or complement. The FMOLS is employed and some of the key findings established are discussed as follows: (a) the unconditional influence of Diaspora remittance on industrialization is found to be negative and

statistically significant. (b) Poor financial market development has an unconditional negative impact on industrialization. Specifically, low domestic credit to the private sector by banks unrestrictedly affects industrialization. (c) The marginal effect of interactions between remittance and domestic credit to the private sector is statistically negative. (d) The corresponding net effects of the interactive term of remittance and domestic credit are in the same way negative on industrialization. This means that financial market development does not play a cooperative role in improving the links between Diaspora remittance and industrialization in Nigeria. This suggests that remittance and financial market development are substitute and not complement. (e) The study found that domestic credit to the private sector by banks to GDP will modulate a direct impact of Diaspora remittances on industrialization at the rate of 11.8%. (f) The amplifying effects of capital investment, trade openness and government consumption expenditure on industrialization are notable statistically. The economic implication of these findings is that the central authority must realize that laying emphasis on remittance inflows is not just sufficient but putting appropriate measures on how to make sure these transfers are put into productive use and ensure industrialization are equally necessary. One of these measures identified by Maimbo and Ratha (2005) is to ensure that there are clear policies and low corrupt practices. This also extends to the need for quality financial institutions in Nigeria such that transfers from migrants can be pooled into a productive investment which can lead to industrialization.

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Electricity Consumption and Economic Growth in Nigeria: A Causality Test Approach

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Abstract

Despite the important role of electricity in the growth process of an economy, deficiencies abound in the Nigeria electricity sectors which constitute a major concern. The study therefore examines the link between electricity consumption and economic growth in Nigeria collated within the period 1981-2019. Other cofounding variables included in the study are gross capital formation, labour force and government consumption expenditure. We used a vector autoregressive based on the Toda-Yamamoto approach to provide the framework for empirical analysis. The causality test result shows that a causal link runs from economic growth to electricity consumption but not the other way around. In terms of relative importance, the result shows that capital stock is more important in the economic growth process than electricity consumption. In summary, long-run causality runs from economic growth to electricity consumption thus confirming the conservation hypothesis for Nigeria. Going by the results, reducing distribution and transmission losses can improve electricity conservation in Nigeria.

Keywords: Electricity consumption, capital, labour, economic growth, causality.

JEL Classification: E22, E62, O11, Q41.

x

1. Introduction

A forage into relevant literatures reveals that economic growth as a concept has been of great importance to policy makers and economic researchers alike. The concept, aside from providing insight into productive activities, gives insight into the quantity of goods and services available for consumption and as such relates to the living standards of residents in a country (Palmer, 2012). Moreover, economic growth is closely related to major macroeconomic objectives including debt stabilization, employment growth, poverty reduction, and provision of necessary infrastructure through relevant fiscal policy. For example, an increase in economic growth implies a relatively more active economy which in turn implies the need for production inputs including labour increases such that there is a net increase in aggregate employment. Also, an increase in economic growth suggests that more goods are available for domestic consumption as well as for export given external demand. This translates on one hand to increases in standard of living domestically and on the other hand to increased export revenue.

Among the factors impacting on economic growth, energy particularly in the form of electricity has continued to receive close attention over the years. Historically, the prominence of energy is traceable to the high demand for wood and coal during the industrial revolution while the search for alternatives led to the discovery of oil, gas, and coal fired turbines. Evidently, breakthroughs in the production and use of energy accelerated the industrial revolution with the attendant exponential growth: a growth at speed that implied the doubling of output every half century which in turn radically transforms living standard particularly in the Western economies.

As an energy source, electricity has become a universal currency that continues to shape human societies following its discovery and subsequent development during the industrial revolution. In modern times, the demand for electricity has surged as humanity relies on it for both domestic and industrial purposes. Accordingly, the scale of electricity consumption per capita is seen as an important indicator of economic growth and level of modernization (Arouri et al., 2012). In general, countries that have higher per capita electricity consumption are considered more developed than those with low level of consumption (Onakoya *et al.*, 2013). Scholars argued that increased access to electricity contributes positively to capital, improves labour productivity, creates

employment opportunities, reduces poverty, and raises a country's export potentials (Narayan and Smyth, 2005; 2009). As one study of over 100 countries showed, there seems to exist a high correlation between electricity usage and the level of economic growth and development (Ferguson *et al.*, 2000). Thus, understanding the nature of causality between electricity consumption and economic growth has continued to be of concern to researchers in order to better inform the policy makers regarding sustainable energy provisions.

While studies on the economic growth – electricity consumption nexus populate the literature with established evidence of empirical relationship between both (Aqeel and Butt, 2001), consensus does not exist on the direction of relationship between them. While some of these studies focused on the developed countries (Stern, 2000; Altinay and Karagol, 2004), others have focused on developing countries (Cheng and Lai, 1997). Some others such as Squalli (2007) and Alper and Oguz (2016) have also considered a mixture of developed and developing countries. With respect to Nigeria, the bulk of these researches focused on the broader notion of energy consumption as it relates to economic growth with only few studies such as Akinlo (2009) and Ogundipe and Apata (2013) narrowing on the link between electricity consumption and economic growth. Further, while most of these studies established bi-directional causality from electricity consumption to growth, emerging trends in the Nigerian energy sector suggest increasing role of alternative energy sources such as solar, given the irregularity of electricity supply in the country.

Given these contemporary realities and the aggravating supply of electricity in the country, the argument arises as to whether the electricity-led growth phenomenon established by most extant literature on Nigeria continues to be valid. This research therefore, offers a re-examination of the relationship between electricity consumption and economic growth in Nigeria given emerging trends. In this regard, the objectives of this paper are twofolds; 1) to re-examine the nature of causality existing between economic growth and electricity consumption and 2) to examine the relative importance of electricity consumption in the economic growth process of Nigeria.

The rest of the paper is structured as follows: section 2 reviews the literature with respect to the relationship between economic growth and energy consumption. Section 3 develops the methodology in terms of the

adopted empirical model and data sources. In section 4, results of the empirical analysis and discussion of findings are presented. Concluding remarks and policy recommendations finalize the paper in section 5.

2. Literature Review

The question of whether a relationship exists between economic growth and energy consumption energy is not new. Among the first authors to brooch on the issue, Kraft and Kraft (1978) expressed concern about the implications of energy conservation policies on the US economy. Over time, theoretical propositions on the relationship between both variables have come to be grouped into four basic hypotheses with their respective policy implications. These include: 1) the energy-led growth hypothesis which suggests that causality runs from energy/electricity consumption to economic growth. This hypothesis implies that higher consumption of energy is to the long-run benefit of the economy so that conservation policies would be detrimental to growth. 2) The conservation hypothesis which suggests causality running from economic growth to energy/electricity consumption. The policy implication of this hypothesis is that energy conservation is beneficial since it does not hamper the process of economic development. 3) The feedback hypothesis which suggests that causality runs both ways. In this case, there seems to be a symbiotic relationship between economic growth and energy/electricity consumption such that energy conservation policies may hurt the growth process of the economy. 4) The neutrality hypothesis which suggests no causality in both ways such that energy conservation policies could be pursued without detriment to the economy.

Kraft and Kraft (1978), in their seminal paper found that the evidence of causality was from economic growth to energy consumption but not the other way thus establishing the conservation hypothesis for the US. Since then several studies have found evidence in support of the conservation hypothesis for different countries. With respect to Nigeria, Akinwale *et al.* (2013) utilized VAR, Error Correction Model, and Granger causality tests and found unidirectional causality from economic growth to electricity consumption. They rationalized the evidence of conservation hypothesis citing inadequate supply of electricity and recommended reduction in transmission wastages. Based on these findings, the authors suggested diversification of the energy mix in order to exploit the potentials of renewable energy sources.

Similar finding was earlier recorded by Sa'ad (2010) who used VECM and found that energy consumption Granger-caused economic growth without feedback. However, the result of the co-integration test conducted to examine the presence of long-run relationship between both variables showed that energy consumption and economic growth are not significantly related in the long-run. The author suggests that declining economic activities may be adverse on energy consumption in Nigeria. On the other hand, conservation policies could be pursued without substantial consequences on the Nigerian economy. The authors highlight rationing as one of such policies. In his study on 17 African countries, Wolde-Rufael (2006) found evidence to support the energy conservation hypothesis for Cameroon, Ghana, Nigeria, Senegal, Zambia, and Zimbabwe. Although these findings suggests that conservation policies can be implemented without jeopardizing growth, the author questions the viability of such policy option in view of the development status of the concerned countries. The author however, emphasized caution in interpreting the results since in Africa, electricity consumption constitutes only about 4 percent of total electricity consumption.

With respect to evidence on the growth-led hypothesis, among one of the earliest studies on Nigeria, Wolde-Rufael (2005) examined the nexus between economic growth and energy consumption in 19 African countries, Nigeria inclusive, using Toda-Yamamoto causality tests. Although the result of the study confirmed the existence of energy-led growth for Nigeria, the detected causality was negative, suggesting that rather than improve growth, higher energy demand retard growth for Nigeria. The author rationalized this finding on the grounds of “stolen resources”, referring to the broader notion of resource curse. In a similar study, Orhewere and Machame (2011) examined the relationship between economic growth and energy consumption in Nigeria using Vector Error Correction model and Granger causality approach. The authors found evidence of the energy-led growth for Nigeria using several measures of energy consumption. The result of the Granger causality tests showed that electricity consumption significantly increased economic growth in the short-run and in the long-run.

In terms of feedback between energy consumption and growth, the empirical evidence with respect to Nigeria is few. One notable study in this regard was conducted by Muse (2014) who questioned the nature of

relationship that exists between economic growth and energy consumption in Nigeria. He performed Error Correction and VAR analysis with the results pointing to bi-directional causality between energy consumption and economic growth in Nigeria. Another study by Ogundipe and Apata (2013), investigated the economic growth – electricity consumption nexus in Nigeria using co-integration, VECM, and Granger causality tests. The result of the Granger causality tests supported feedback between economic growth and electricity. The authors cautioned against excessive transmission losses as this could hamper long-run growth of the Nigerian economy.

Wolde-Rufael (2006) had undertaken to unravel the link between electricity consumption and growth for 17 African countries and found evidence of feedback in causality between both variables for Egypt, Gabon and Morocco. In an earlier study with an extended scope to cover 19 African countries, Wolde-Rufael (2005) focused on total energy consumption and reaffirmed the feedback hypothesis for Gabon for the relationship between total energy consumption and growth. This result was also found for Zambia.

Turning to the literature in support of the independence/neutrality hypothesis, there is sparse evidence in support of this hypothesis in the case of Nigeria. The existing evidence on neutrality hypothesis for Nigeria was recorded by Akinlo in a study on 11 sub-Saharan African countries. The same study also found evidence of neutrality between energy consumption and economic growth for Cote D'Ivoire, Kenya, and Togo. Earlier, evidence of the neutrality hypothesis for Togo and Kenya had been reported by Wolde-Rufael (2005) in a study on African countries which also confirmed neutrality for Benin Republic, the Republic of Congo, Senegal, South Africa, Sudan, and Tunisia. Shifting focus on electricity consumption rather than the broader context of energy, Wolde-Rufael (2006) reaffirms the neutrality hypothesis for the Republic of Congo, South Africa, and Sudan. The study also uncovered neutrality for the relationship between electricity consumption and economic growth for Kenya.

Moving away from Africa, much evidence in support for the neutrality hypothesis has been recorded by studies on the USA. In a notable study, Soytaş *et al.* (2007) examined the effect output and energy consumption on CO₂ emissions for the United States. They utilized Toda-Yamamoto based Granger causality tests and impulse response analysis and

discovered no causal relationship between energy consumption and output and between CO₂ emissions and output thereby confirming the neutrality hypothesis for the USA. A later study by Payne (2009) also using Toda-Yamamoto Granger causality tests reaffirmed the neutrality hypothesis for the USA in a study on the dynamics between renewable and non-renewable energy consumption and output. Further empirical evidence from Yildirim *et al.* (2012) using same methodology also reported neutrality between renewable energy consumption and economic growth.

3. Methodology

3.1 Data and Sources

Data for this research are obtained from the World Development Indicators (WDI) as found on the World Bank website as well as from the International Energy Agency (IEA), and Penn World Tables. The objective of this study is to examine the link between economic growth and electricity consumption in Nigeria. More so, some other variables commonly used in the literature are included to control for the part of economic growth not attributable to electricity consumption. These variables include gross capital formation (GCF) and labour force (LAB), and government expenditure (GCE). A summary description of the variables is presented in Table 1.

Table 1: Variables used for Analysis and Measurement

Variable	Measurement	Symbol
Economic Growth	Natural log of Real GDP	LGDP
Electricity Consumption	Natural log of Electricity Consumption	LELC
Capital Stock	Natural log of Real Gross Fixed Capital Formation	LGCF
Labour Stock	Natural log of Labour Force (proxied by employment)	LLAB
Government expenditure	Natural log of Government Consumption Expenditure	LGCE

3.2 Empirical Model and Estimation Approach

In line with the paper's objective, a causality analysis of the relationship between economic growth is conducted. Causality analyses commonly proceed from Vector Auto Regression (VAR) models in which all the variables in the regression are assumed to be endogenous such that causality runs from one variable to another for all included variables. Such a setup therefore, presents the opportunity to establish direction of causality between variables. Specifically, the empirical model is a Toda-Yamamoto VAR-X model of the following form:

$$\begin{aligned} LGDP_t = & a_1 + \sum_{i=1}^n \pi_{1i} LGDP_{t-i} + \sum_{j=n+1}^{n+d_{max}} \pi_{1j}^* LGDP_{t-j} + \\ & \sum_{i=1}^n \beta_{1i} LELC_{t-i} + \sum_{j=n+1}^{n+d_{max}} \beta_{1j}^* LELC_{t-j} + \sum_{i=1}^n \alpha_{1i} LGCF_{t-i} + \\ & \sum_{j=n+1}^{n+d_{max}} \alpha_{1j}^* LGCF_{t-j} + \sum_{i=0}^n \gamma_{1i} LLAB_{t-i} + \sum_{i=0}^n \eta_{1i} LGCE_{t-i} + e_{1t} \end{aligned} \quad (1)$$

$$\begin{aligned} LENC_t = & a_2 + \sum_{i=1}^n \pi_{2i} LGDP_{t-i} + \sum_{j=n+1}^{n+d_{max}} \pi_{2j}^* LGDP_{t-j} + \\ & \sum_{i=1}^n \beta_{2i} LELC_{t-i} + \sum_{j=n+1}^{n+d_{max}} \beta_{2j}^* LELC_{t-j} + \sum_{i=1}^n \alpha_{2i} LGCF_{t-i} + \\ & \sum_{j=n+1}^{n+d_{max}} \alpha_{2j}^* LGCF_{t-j} + \sum_{i=0}^n \gamma_{2i} LLAB_{t-i} + \sum_{i=0}^n \eta_{2i} LGCE_{t-i} + e_{2t} \end{aligned} \quad (2)$$

$$\begin{aligned} LGCF_t = & a_3 + \sum_{i=1}^n \pi_{3i} LGDP_{t-i} + \sum_{j=n+1}^{n+d_{max}} \pi_{3j}^* LGDP_{t-j} + \\ & \sum_{i=1}^n \beta_{3i} LELC_{t-i} + \sum_{j=n+1}^{n+d_{max}} \beta_{3j}^* LELC_{t-j} + \sum_{i=1}^n \alpha_{3i} LGCF_{t-i} + \\ & \sum_{j=n+1}^{n+d_{max}} \alpha_{3j}^* LGCF_{t-j} + \sum_{i=0}^n \gamma_{3i} LLAB_{t-i} + \sum_{i=0}^n \eta_{3i} LGCE_{t-i} + e_{3t} \end{aligned} \quad (3)$$

Where, n = the optimum lag length; and d_{max} = the highest order of integration in the model.

In the above model, we treat labour as exogenous which implies that we essentially consider a VAR-X (VAR with exogenous variable) model. Treating labour and government expenditure as exogenous variables is in line with the theoretical literature and has the advantage of providing higher degrees of freedom for inference. Looking at equation (1), the idea behind the causality test can be summarized thus: if *economic growth* can be predicted more accurately with past values of *electricity consumption* than without using such past values, all other terms remaining unchanged, then it must be the case that *electricity consumption* Granger causes *economic growth* and vice versa. Focusing again on the link between LGDP and LELC, the hypotheses of the Granger causality test can be formally stated as:

$H_01: \sum_{i=1}^n \beta_{1i} = 0$ which implies that electricity consumption does not Granger cause economic growth.

$H_11: \sum_{i=1}^n \beta_{1i} \neq 0$ which implies that electricity consumption Granger causes economic growth

$H_02: \sum_{i=1}^n \pi_{2i} = 0$ which implies that economic growth does not Granger cause electricity consumption.

$H_12: \sum_{i=1}^n \pi_{2i} \neq 0$ which implies that economic growth Granger causes electricity consumption.

Given these hypotheses, four possible outcomes can be envisaged for the link between economic growth and energy consumption. 1) The rejection of H_01 and H_02 simultaneously which implies a bidirectional relationship between economic growth and electricity consumption, thus providing support for the feedback hypothesis. 2) A rejection of H_01 only which indicates a unidirectional relationship such that electricity consumption Granger causes economic growth but not vice versa. This scenario provides support for the energy-led growth hypothesis. 3) A rejection of H_02 only which implies that economic growth Granger causes electricity consumption but not vice versa. This scenario supports the conservation hypothesis. 4) An acceptance of H_01 and H_02 simultaneously which implies that economic growth and electricity consumption are independent. This last scenario supports the neutrality hypothesis (Alper and Oguz, 2016).

4. Data Analysis and Discussion

4.1 Descriptive Analysis

We begin with the result of the summary descriptive statistics of the variables in their original form reported in Table 2. In terms of range, figures from the table show that real GDP ranged from about ₦16.21 billion to about ₦72.09 billion with mean of ₦36.32 billion during the periods under analysis. Electricity consumption per capital ranged from about 51 kWh to 157 kWh with mean of about 107 kWh per capita approximately.

Table 2: Summary Statistics of Variables

Statistic	GDP (₦' Billion)	ELC (Per Capita kWh)	GCF (₦' Billion)	LAB (Millions)	GCE (₦' Billions)
Average	36325.25	106.84	34.36	41.55	1663.49
Median	25430.42	97.07	19.94	39.34	301.75
Maximum	72094.09	156.80	74.58	65.16	5053.15
Minimum	16211.49	50.90	9.57	26.94	219.67
Std. Dev.	19448.93	29.30	22.79	12.00	1837.89
Skewness	0.70	0.21	0.67	0.53	0.72
Kurtosis	1.93	1.76	1.77	2.05	1.77
Jarque-Bera	5.07	2.78	5.40	3.28	5.84
Probability	0.08	0.25	0.07	0.19	0.05
Observations	39	39	39	39	39

Source: Authors' computation (2020).

In the case of Gross Capital Formation, the variable had a mean of approximately ₦34.36 billion and ranged from ₦9.57 billion to ₦74.58 billion. Labour force, for the periods under review had a mean of 41.55 million and peaked at 65.16 million with lowest recorded being 26.94 million. With respect, to GCE, the variable ranged from ₦219.67 billion to ₦5053.15 billion within the analysis period. In terms of distribution, the skewness, kurtosis, and Jarque-Bera (JB) statistic show normal bell-shaped distribution for most of the variables except Government Consumption Expenditure.

4.2 Unit Root Tests

The inherent randomness associated with the realizations of economic time series data imply the possibility of spurious relationships when conducting time series analysis (Gujarati and Porter, 2009). In view of this, relevant tests of stationarity are traditionally conducted on the series in order to avoid spurious regressions. We adopt the ADF and PP tests for their relative simplicity and ease of interpretation. The test results are presented in Table 3. For thoroughness, the tests are conducted on the levels and first differences of each variable twice, with intercept only and including a trend component.

Table 3: Summary of Unit Root Test

Series	Test	ADF		PP		Conclusion
		Y	ΔY	Y	ΔY	
LGDP	Intercept Only	0.03	-3.86***	0.72	-3.86***	I(1)
	Intercept & Trend	-1.51	-3.76**	-3.15	-3.76**	I(1)
LELC	Intercept Only	-2.45	-8.56***	-2.44	-8.84***	I(1)
	Intercept & Trend	-3.64**	-8.36***	-3.84**	-8.64***	I(0)
LGCF	Intercept Only	-0.76	-4.04***	-1.13	-4.85***	I(1)
	Intercept & Trend	-1.95	-3.46*	-3.81**	-5.07***	I(0) PP
LLAB	Intercept Only	-1.24	-4.09***	-1.24	-4.05***	I(1)
	Intercept & Trend	-5.26***	-4.23***	-5.24***	-4.19***	I(0)
LGCE	Intercept Only	-0.69	-6.38***	-0.78	-6.38***	I(1)
	Intercept & Trend	-1.76	-6.29***	-1.98	-6.30***	I(1)

Note: ***, ** and * denote significance at 1%, 5%, and 10% respectively.

Y & ΔY denote levels and first difference of relevant variable respectively.

Source: Author's computation (2020).

The ADF and PP results confirm stationarity at first difference for LGDP whether or not a trend component is included in the test setup. For LELC, both tests support stationarity at levels only when a trend component is in the test setup. Without the trend component, LELC appears to be an I(1) series. The results with respect to LGCE are identical to those of LGDP while those of LLAB are identical to those of LELC. For LGCF, only the PP test supports stationarity at levels when a trend component is introduced into the test. Both versions of the ADF test identify LGCF as an I(1) series.

4.3 Causality Tests

The starting point of the non-causality tests is to determine the optimal lag length ideal for estimating the underlying VAR model as shown in Table 4. The Akaike Information Criterion (AIC), Final Prediction Error (FPE), and the Hannan-Quinn Criterion all suggest 5 lags are optimum whereas the Likelihood Ratio (LR) criterion specifies 4 lags. The Schwarz Criterion (SC), suggests 1 lags is optimum. The optimum lag implied by the SC is selected given sample size limitations.

Table 4: Lag Selection

Lag	LogL	LR	FPE	AIC	SC	HQ
0	92.3701	NA	1.49e-06	-4.9041	-4.5001	-4.7663
1	133.665	68.0151	2.25e-07	-6.8038	-5.9958*	-6.5282
2	139.449	8.50666	2.80e-07	-6.6147	-5.4026	-6.2013
3	148.124	11.2260	3.02e-07	-6.5955	-4.9794	-6.0444
4	169.759	24.1796*	1.59e-07	-7.3387	-5.3186	-6.6498
5	182.769	12.2458	1.48e-07*	-7.5747*	-5.1505	-6.7479*

Note:* denotes optimal lag selected based on respective criterion

Source: Authors' computation (2020).

With one optimum lags and order 1 as the highest order of integration going by the unit root test results, the TY-VAR model is augmented with the second lag of the endogenous variables (that is economic growth, electricity consumption, and Gross Capital Formation). A summary of the causality test results is reported in Table 5. The sum of lagged terms is reported along with the Granger causality result and this gives the direction of causality from the dependent to the independent variable in each equation (Wolde-Rufael, 2005).

Table 5: Summary of Causality Test

Null-Hypotheses	Test χ^2	Coefficient	DF	Decision
$LELC \nRightarrow LGDP$	2.219	-0.122	1	Accept
$LGCF \nRightarrow LGDP$	4.543**	-0.087	1	Reject
$ALL \nRightarrow LGDP$	5.735*	—	2	Accept
$LGDP \nRightarrow LELC$	9.889***	1.342	1	Reject
$LGCF \nRightarrow LELC$	2.503	-0.154	1	Accept
$ALL \nRightarrow LELC$	12.728***	—	2	Reject
$LGDP \nRightarrow LGCF$	3.029*	1.423	1	Accept
$LELC \nRightarrow LGCF$	5.492**	-0.837	1	Reject
$ALL \nRightarrow LGCF$	7.776**	—	1	Reject

Note: $\nRightarrow$ denotes non-causality from left to right

***, **, and * denote significance at 1%, 5%, & 10% respectively.

Source: Authors' computation (2020).

Starting with substantive results, we find that the null hypothesis of non-causality from electricity consumption to economic growth cannot be rejected at the usual levels of significance. Thus, the conclusion is that energy consumption does not cause significant changes in economic growth in the long-run for Nigeria. On the other hand, the hypothesis

that economic growth Granger causes electricity consumption is rejected at the 1 percent level of significance. The conclusion therefore, is that economic growth causes significant changes in electricity consumption in the long-run. Besides, the positive coefficient indicates that electricity consumption tends to increase with economic growth.

4.4 Relative Importance of Electricity Consumption in the Economic Growth Process

The relative importance of electricity consumption in the process of Nigeria's economic growth is examined through variance decomposition analysis. This gives the proportion of unexpected variation in an endogenous variable that results from own shocks and shocks from the other endogenous variables in the model. It also allows for assessing the relative importance of one endogenous variable on another (Andonova and Petkovska, 2011; Feasel *et al.*, 2017). A 10-period Cholesky decomposition of the forecast error variance of log GDP is presented in Table 6. Evidence from the table confirms strong endogeneity for economic growth in the system as its influence on itself is relatively stronger than the influence of other variables on it. Specifically, more than 80 percent of log GDP's forecast error variance is accounted for by own shocks for all the periods considered although this own-influence declines slowly into the long-run. Comparing the influence of electricity consumption and capital stock on LGDP, we find that capital stock has a stronger influence in evolution of economic growth relative to electricity consumption.[†] As own influence of LGDP declines, those of LELC and LGCF rise but the influence of LGCF is relatively more prominent. This shows that capital stock is relatively more important in the evolution of GDP as compared to electricity consumption.

[†]Following standard theoretical literature on growth, growth of labour is considered exogenously determined. LLAB (as well as government expenditure, GCE) were thus, entered as exogenous regressors in the TY-VAR model estimation. The variance decomposition analysis could therefore, not be performed with LLAB and LGCE as the analysis strictly covers endogenous variables only. In any case, the exclusion of LLAB and LGCE provide more of the much needed degrees of freedom for estimating a VAR model.

Table 6: 10-Period Variance Decomposition (%) of LGDP

Period	S.E.	LGDP	LELC	LGCF
1	0.035	100.000	0.000	0.000
2	0.057	93.398	1.227	5.375
3	0.072	90.266	0.829	8.904
4	0.084	88.045	0.637	11.318
5	0.094	86.398	0.594	13.008
6	0.102	85.170	0.607	14.223
7	0.110	84.245	0.634	15.122
8	0.116	83.533	0.662	15.805
9	0.122	82.975	0.686	16.339
10	0.128	82.528	0.707	16.765

Source: Author's computation (2020).

4.5 Discussion

The result of the causality tests conducted show that electricity consumption does not cause significant long-run changes in economic growth in Nigeria. On the other hand, it was found that economic growth causes significant long-run changes in electricity consumption. Thus, the findings provide support for the conservation hypothesis. The findings on the link between economic growth and electricity consumption corroborate the results of past research studies on Nigeria (e.g. Wolde-Rufae, 2006; Sa'ad, 2010; Akinwale *et al.*, 2013; Muse, 2014). It is also similar to those of some past foreign studies (e.g. Lise and Montfort, 2007; Joyeux and Ripple, 2011; Cowan *et al.*, 2014). Looking at the study's finding, it is possible that the inability of electricity consumption to significantly influence growth in the long-run is due to the epileptic nature of electricity supply in the country. Also, most productive activities in the country largely do not depend on national electricity supply for their operations due to the irregular supply. Thus, it is probable that very little of the electricity supply in the country is consumed by industrial activities which stimulate economic growth directly. Hence, a major chunk of electricity generated is consumed in residential activities, making it possible to expect non-causality from electricity consumption to economic growth in the long-run.

Relying on variance decomposition, the relative importance of the endogenous variables (i.e. electricity consumption and capital stock) on economic growth was considered. The findings showed that the response

of economic growth to own shocks is stronger compared to those of electricity consumption and capital stock. The own-shock effect is however, stronger in the short-run than in the long-run as a steady but slow decline in the proportion of forecast error variance attributable to own-shocks is observed. Specifically, approximately 93.4 percent of forecast error variance in log GDP is accounted for by own shocks in the first two years and hovers between 85 and 90 percent from the third to sixth year. Subsequently, the influence of log GDP on itself declines to about 82.5 percent as we move into the long-run.

Comparing the effects of electricity consumption and capital stock, the findings showed that as the proportion of forecast error variance in log GDP due to own shocks decline, more and more of this variance is accounted for by log capital stock. For instance, for the second and third periods, about 5 percent to 9 percent of the forecast error variance in log GDP is accounted for by log GCF as compared to just 1.2 percent to 0.83 percent by electricity consumption. For the fourth to sixth periods, the proportion of log GDP's forecast error variance accounted for by log GCF is increased by more than 4 percent points whereas, that accounted for by log ELC is decreased by about 0.2 percent points. As we move further into the future, the forecast error variance of log GDP attributable to log ELC hovers between 0.6 percent and 0.7 percent while that of log GCF ranges between 14 percent and 15 percent. These findings confirm the relative importance of capital stock in the determination of economic growth in Nigeria vis-à-vis electricity consumption.

5. Concluding Remarks

The paper examined the link between electricity consumption and economic growth in Nigeria. It specifically sought to uncover the nature of causality existing between both variables, and to assess the relative importance of electricity consumption in the economic growth process of Nigeria. The empirical results suggest economic growth precedes electricity consumption in the case of Nigeria. This implies that higher economic growth necessitates greater demand for electricity. It would imply therefore, that policy recommendations should favour conservation of electricity for greater efficiency without loss to economic growth. However, given the peculiarities of the Nigerian power sector, such policy is neither realistic nor is it desirable. Indeed, as figures from

the World Development Indicators show, as much as 45.6 percent of the Nigerian population still lacks access to electricity from the national grid. Therefore, a reduction of electricity consumption given that majority of Nigerians still lack access would not be a viable policy option. The realities of electricity generation and distribution in the country shows that the country is yet to attain that level on the energy ladder where electricity consumption can be reduced without detrimental social and economic consequences. In view of the realities of electricity consumption in Nigeria, the following policy measures are recommended:

1. An alternative approach to conservation of electricity should be through reduction of distribution and transmission losses by adopting more efficient methods.
2. The provision of electricity to end-users, especially to the productive sectors, should be improved in order to reduce reliance on non-environmentally friendly alternative electricity sources employed by most production processes in the country.
3. In line with the above, there should be committed efforts to improve the generation of electricity by exploring alternative sources of power generation and diversification away from hydroelectricity which constitutes a larger proportion of electricity generation in the country.
4. As the results confirm, capital plays a critical role in the growth process of the Nigerian economy. Hence, policies that stimulate capital accumulation should be pursued. Following theoretical propositions, such policies that increase savings would decrease interest rate and increase investment.

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Modeling the Growth Effects of Climate Change in Nigeria

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Abstract

This study empirically investigates the effect of climate change on economic growth in Nigeria due to the level of depletion experienced in the ozone layer and the activities of industrial sector in terms of their emissions to the environment using annual data between 1980 and 2017. The study utilizes the autoregressive distributed lag (ARDL) to evaluate the short run and long run impact of climate change (measured by annual average rainfall, forest depletion and carbon emission) on economic growth. The ARDL bounds test reveals that there exist a long run relationship between climate change and economic growth in Nigeria. In the short run, carbon emission and annual average rainfall have a significant positive relation with economic growth whereas forest depletion reported a significant negative impact on economic growth. Meanwhile, in the long-run, only forest depletion has an adverse effect on output growth while the statistical significance of carbon emission and annual average rainfall are not validated. Thus, the study suggests the use of bio-fuels and clean energy by subsidizing its use in the industrial sector in place of fossil fuels which adversely impacted the environment and depletes the ozone layers.

Keywords: Climate change, carbon emissions, economic growth, ARDL.

JEL Classification: O11, O44, Q30, Q54.

1. Introduction

Over the years, the world has been subjected to unprecedented changes in the atmospheric and climatic conditions which have induced fear and elicit a sense of urgency in order to forestall imminent danger. Climate change is the fluctuations in climatic and atmospheric conditions which causes departure from the natural occurrences and incidences of weather events (Batten, 2018). Climate change can be used to mean an alteration of the composition and conditions of the atmosphere that is beyond the level of discrepancies which can be caused by human and non-human activities (Mobolaji *et al.*, 2011).

Climate change is already beginning to transform life on earth and around the globe, seasons are fluctuating, temperatures are increasing and sea levels are rising. Climate change affects the whole world and the poorest people who contribute least to the change are the ones who suffer the most. Scientific research shows that the net climate resulting from the change will largely be driven by atmospheric greenhouse gases (Nkmedirim, 2003). Notably, climate change has been liable for the depletion of the ozone layer of the earth crust and its manifestation can be seen in the form of rising temperature, changes in the cycle of rainfall in term of duration and intensity which can result in the rising levels of water bodies, hence increasing the occurrences of such natural disasters like storms, floods and droughts. Consequently, climate change is at the topmost of all political and media agenda, this is because extreme weather events definitely will have spillover effects on various forms of economic activities which makes it a phenomenal example of externalities (Tol, 2009).

In the same vein, climate change implies an increase in average global temperatures. Natural events and human activities are suggested to be contributing to an increase in average global temperatures. This is caused primarily by increase in greenhouse gases such as Carbon Dioxide (CO₂). Nigeria is experiencing adverse climate conditions with negative impacts on the welfare of millions of people. Persistent droughts and flooding, off season rains and dry spells have sent growing seasons out of orbit, on a country dependent on a rain fed agriculture. Alarm smokes are beckoning with lakes drying up and a reduction in river flow in the arid and semi-arid region resulting in fewer water supplies for use in agriculture, hydro power generation and other users and their root cause can be traced to climate change. Scientific studies show snows are

disappearing rapidly. Climate Change has been confirmed following the release of the 4th IPCC Assessment report. Africa will be on the receiving end of the adverse effect of climate change with Nigeria inclusive (Intergovernmental Panel on Climate Change, 2017).

Accordingly, climate change has adversely affected the agricultural sector of Nigeria. The agricultural sector which contributes some percentage of the Nigerian Gross Domestic Product also employs majority of the rural populace (Alehile, 2020). Similarly, climate change negatively affect Nigerian economy and the living standards of its citizens ranging from increase in illness to morbidity and increase in mortality rate (Usman and Dije, 2013). More so, the energy sector will not be spared because climate change has impacted the hydropower plants which are source of electricity for the country. Likewise, many other sectors like the transportation, tourism and manufacturing sectors have all been affected which had generally affects the entire Nigerian economy and its gross domestic product. Studies conducted by Department for International Development (DFID) concludes that climate change will cost Nigeria between 6% and 30% of its GDP by 2050 worth \$100billion and \$460billion (Department for International Development, 2009).

This study therefore examines the effects of climate change on economic growth in Nigeria for the period, 1980-2017. This is because climatic change events can directly alter economic outcomes such as gross domestic product, investment, price level, quantity, pattern and composition of imports and exports thereby worsening social inequality. Hence, adequate understanding of the possible effects of climate change is now a necessity not just for policy formulation purposes by climate economists but for all professional involved in the economic planning for the Nigeria's economy. The empirical evidence on this debate is of much relevance to growth and environmental policies in the developing world, more so in Nigeria where income levels are below acceptable standards. Findings of this study will provide useful insights for policymakers and academics into climate change risk. For policymakers in Nigeria, this work becomes important because it provides empirical evidence to support the provision of adaptation efforts to moderate the impact of climate change which could affect shared growth. Therefore, the empirical verification of the moderating role of adaptive capacity to climate change impact on economic growth is critical. The outcome of the study lends support to the pursuit of adaptation strategies to be based

more on evidence than guesswork. Other parts of the study are divided into four. Section two present the review relevant studies while the methodology is discussed in part three. The result and discussion of analysis is presented in section four whereas the last section concludes and suggests policy options.

2. Literature Review

The relevant studies related to this research paper are reviewed in this section. Stern (2006) identified the channels of transmission from climate change to economic growth. Using a standard neoclassical growth theory as the basic framework of investigation, they identified capital accumulation and savings as the key dynamic channels through which climate change may impact on long-run growth. Since saving and hence investment is the present value of future consumption, climate impact on future consumption and households' welfare is implied. Another potential channel of transmission is the rate of human capital accumulation. Temperature increase slow down the rate of learning and also impact on health of the labour force adversely. The cumulative effect of these is to reduce labour productivity and long-run economic growth. Nordhaus (2008) examined the potential theoretical channels through which climate change may affect long-run economic growth. They maintain that the dichotomy between adaptation and growth on one hand, and mitigation and development on the other is clearly ambiguous. An important conclusion from the study is that the task of apportioning investment between productive capital and adaptation investments is a subtle one. Implicit in this finding then is that as an economy develops over time, it will automatically insulate itself from the perils of climate change. For instance, the structural changes that go with economic development will mean less dependent on the more sensitive sectors to climate change such as agriculture.

Thurlow, Zhu and Diao (2019) investigated three applications of the G-Econ data base¹ and reported some interesting findings. First, climate-output reversal was detected in the data. He found a negative relationship between temperature (a proxy for climate change) and output per capita but a strongly positive relationship between temperature and output per area (country size adjusted GDP). Another interesting finding reported by the study is that geographic factors account for much of the income differences between Africa and the rest of the world. The G-Econ data

base provided a better estimate of the economic impact of greenhouse warming than has been reported in previous studies. Karp and Zhang (2010) used annual data on the variations in temperature and precipitation over a period of 50 years at the global level to examine the effect of climate change on economic activity. Their study reported three primary findings. First, rising temperature significantly reduces economic growth in poor countries, but such effect is insignificant in developed countries. Second, higher temperatures appear to decrease growth rates in poor countries than just the level of output. Third, increase in temperature have wide-ranging effects on poor countries, reducing agricultural output, industrial output and aggregate investment and political instability. These findings reported by Karp and Zhang (2010) suggest that the effect of climate change at the aggregate level depends on a country's level of development, with the negative effect damped as the country moves up on the development ladder. This implication is consistent with the implications of the theoretical conclusion by Rezai, Foley and Taylor (2009) that economic development will automatically insulate countries from the perils of climate change and thus a separate adaptation investment from productive capital accumulation may not make much difference. With regard to precipitation, Onuoha (2009) concluded that precipitation does not have any significant effect on economic growth. This conclusion is independent of a country's level of development.

Harris and Roach (2007) empirically examined the impact of climate change on economic growth in Africa. Using annual data for 34 countries spanning the period 1961–2009, they found a negative impact of climate change on economic growth in Africa. Their study revealed that a 1^oC rise in temperature reduces economic growth by approximately 0.27 percentage points for the region. Considering a sub-sample in the time dimension over the period 1961–2000, they reported a greater negative effect of climate change on growth. Growth falls by 0.41 percentage points per degree celsius rise in temperature in Africa. The implication of this is that over time, the climate impact on growth is damped due to adaptation measures. This contradicts the popular view that the economic impact of climate change becomes worse as time elapses. Ison, Peake and Wall (2002), investigated the effects of temperature and rainfall on economic growth in Africa using annual data from 1962 to 2000 for 36 African countries. Using autoregressive distributed lag model

for panel data, he finds evidence of both short- and long-run relationship between temperature and per capita income growth. However, the impact of rainfall on growth has little support from the data. The important lesson of Gray (2009) is that African countries have not adapted well to weather shocks, and without proper intervention mechanisms to arrest the alarming effect of climate change growth may be hampered.

Martínez-Alier (2009) examined the streetlight effect in climate change research on Africa. The study employed panel data, which covered 54 sovereign countries including both Sub-Saharan and North African nations. All models were run using ordinary least-squares regression with Huber-White robust standard errors and robust regression and weighted average least squares regression. The result revealed that countries with greater exposure to the negative effects of climate change, and countries with less adaptive capacity do not receive more scholarly attention, hence, it is therefore suggested that both climate change research funders and researchers should place greater emphasis on grant proposals and projects addressing non-Anglophone, and where practical less politically open cases and the Anglophone bias might be partially addressed by funders providing resources for high-quality English translation of scholarly manuscripts and supporting materials. This would likely lead to greater coverage of Francophone, Lusophone and Arabic-speaking African countries, as well as Ethiopia and Eritrea. While the IPCC disseminates research in the six official United Nations languages (Arabic, Chinese, English, French, Russian and Spanish) and some IPCC synthesis reports and technical papers have been translated into non-UN languages, similar effort could be expended on translating primary research to inform IPCC assessments.

Lohmann (2010) explores the political economy of climate change in Africa with a focus on Nigeria. Though, it is believed that African countries contribute the least of any country to global warming, yet, they are relatively affected than any other continent. The research is anchored on the Marxian political economy paradigm or an explanatory tool for understanding the development of climate change issues and adaptation in Nigeria. It has found that the level of development of countries in terms of technology and other socio-economic various contributed to the management of climate change. The study suggested that adaptation policies should take care of the following challenges to enable the

funding have effect. They are mainstreaming climate change into economic frameworks and sectoral policies in order to ensure integrated adaptation responses; strengthening assessment of social and economic vulnerabilities to inform processes for identifying adaptation priorities; provisions of national adaptation policies that provide clear guidelines for integration and implementation of strategies, programmes and activities.

Martínez-Alier, Pascual, Vivien, and Zaccai (2010) examined the effect of climate change on the health of rural farmers in Offa, Kwara State, Nigeria. For the purpose of achieving the objectives of the study Ninety-eight (98) respondents were randomly sampled from ten wards. Data were collected through interview scheduled couple with a well-structured questionnaire. The data were analysed through the use of frequency count, simple percentages and Pearson product moment correlation (PPMC). The result of the study indicated that the mean age is 45.5%. 68.4% are male. 53.1% were married. 72.4% were literate with only 14.3% non-literate. The study further revealed a significant relationship between socio-economic characteristics of the respondents and their present health status ($r=0.344$, $p=0.001$ $\alpha=0.05$). The study also revealed a significant relationship between socio-economic characteristics of the respondents and their perceived effect of climate change on their health status ($r=0.381$, $p=0.001$, $\alpha=0.05$). More so, the major source of information of the respondents on climate change were through radio/television (mean=61.3), while only few (mean=36.3) heard from research institute, majority of the respondents health status were good (49.0%) they usually have deviation from normal health status as consequence of climate change. The common ailment they experienced is malaria (31.6%) while only few had headache and cholera (3.1%). It was concluded that their major source of information on climate change was through radio. More so it was deduced from the study that malaria is the most common and severe disease affecting the respondents with tuberculosis which is less severe. It was recommended that government should educate farmers through the mass media such as use of radio, newspaper and television on the need to plant trees to combat the effect of the ozone layers depletion which is also associated to climate change.

Intergovernmental Panel on Climate Change (2017) explores the emergence of a global climate change mitigation regime through an analysis of the language employed in international science-policy reports. The study assumed that, a global climate regime can only operate

effectively on the basis of a shared understanding of climate change which is itself based on a shared language of governance. The study therefore carried out an in-depth thematic and metaphor analysis of 63 policy documents published between 1992 and 2012. Results show that global climate science-policy discourses universalize the myriad impacts of a changing climate into a single dichotomous impacted/not-impacted scenario and aim to govern this world according to economic principles of cost–benefit analysis. These discourses use metaphors that draw on narrative structures prevalent in the wider culture to produce and legitimate a reductionist representation of climate change. This representation undermines public understanding of and engagement with climate change by marginalizing subordinate policy framings which do not align with the prevailing dichotomous framing. The types of documents the study analyzed in this paper represent important sources for journalists reporting on climate change. The study therefore suggests that any attempt to improve public communication of climate change should include revisions to organizational discourses.

Abidoye and Odusola (2015), also studied the effects of climate change on the socio-economic development of Nigeria, and finds that climate change and existing climatic variability will have harsh effects on the low-income and marginalized poor people in Nigeria and will, in addition, make the process of eradicating poverty more difficult because of the negative effects of climate change on economic growth, poor people's livelihoods and assets and the level of risks to which the people are exposed. The Nigerian's First National Communication (2003) studied the threat of climate changes to food security and livelihoods in selected states in Nigeria. The institution highlighted the implications of climate change-induced variability's on food security and livelihoods and recommended, that management issues raised by the study be translated into decision and policy making by stakeholders in order to ensure food security in northern Nigeria. Adesiji *et al.* (2013) examined the effects of climate change on food productivity in the Niger Delta. They find that climate change impacts significantly on all aspects of crop yields, availability of seeds, and access and utilization of foods. They noted that there were decreases in crop yields due to decreases in temperatures in the study areas and that most of the farmers had low level of awareness on the dangers of climate change. Edeh, Leo-Nnoli and Eme (2014) discovered a downward trend in rainy days per annum in Sokoto and

Kano, with Kaduna having only a slight reduction in its rain day per annum. This observed climate change induced variability was found to have a negative effect on annual crop yields. The study also found that a decrease in food crops availability occurred as rainfall and temperatures decreased in the study areas.

From the empirical review on the impact of climate change on economic growth, it is quite cleared that majority of the literature subjected climate change and economic growth to micro issues by sourcing information from individuals within a limited scope and use the result to evaluate the entire economy. This study employed macroeconomics variables that captured climate change and economic growth at its fullest. Also, sophisticated analyses were employed to determine the impact of climate change on economic growth in Nigeria, as only a handful of studies have estimated the short-run and long-run implications of climate change on economic growth in Nigeria.

3. Methodology

3.1 Data

The study employs a secondary data to empirically investigate the impact of climate change on the economic growth in Nigeria between 1980 and 2017. The variables employed to proxy climate change are carbon emission, forest depletion and average total annual rainfall, while gross domestic product growth rate was used to capture economic growth. The data was sourced from the World Development Indicators (WDI, 2019), and Food and Agriculture Organization (FAO, 2019).

3.2 Model and A’priori Expectation

The study adapts and modifies the empirical study of Ogbuabor and Egwuchukwu (2017) to investigate the effect of climate change on economic growth in Nigeria. The modified model can be specified thus:

$$GDPgr_t = f(CO_{2t}, FRD_t, AAR_t, FDI_t, GFCF_t, POP_t) \quad (1)$$

Where: *GDPgr* represents gross domestic product growth rate; *CO₂* carbon dioxide emissions proxy for climate change; *FRD* represents forest depletion; *AAR* represents average total annual rainfall; *FDI* represents foreign direct investment; *GFCF* represents gross fixed capital

formation and *POP* represents population. Hence, the econometric model is specified as:

$$GDPgr_t = \varphi_0 + \varphi_1 CO_{2t} + \varphi_2 FRD_t + \varphi_3 AAR_t + \varphi_4 FDI_t + \varphi_5 GFCF_t + \varphi_6 POP_t + e_t \quad (2)$$

The variables are the same as earlier stated. φ_0, φ_{1-6} are parameters, e represents error term and t represents time dimension. The theoretical expectation indicate that carbon dioxide emissions proxy for climate change, forest depletion, average total annual rainfall are expected to show a negative relationship with gross domestic product growth rate while foreign direct investment and gross fixed capital formation are expected to show a positive relationship with gross domestic product growth rate. This can be represented symbolically as: $\varphi_1, \varphi_2, \varphi_6 < 0$ and $\varphi_3, \varphi_4, \varphi_5 > 0$.

3.3 Estimation Methods

Given the results of the unit root test, the study employed ARDL developed by Pesaran and Shin (1999). ARDL was preferred to other techniques because ARDL estimation yields consistent estimates of the parameters when some are $I(0)$ and $I(1)$ and a long run relationship exists⁵. This means that the ARDL approach avoids the pretesting problems associated with standard co-integration, which requires that the variables be already classified into $I(1)$ or $I(0)$ (Pesaran and Shin, 1999). According to Pesaran and Shin (1999), the ARDL approach requires two steps. In the first step, the existence of long term relationship among the variables is determined using F-test. The second step of the analysis estimates the coefficients of the long run relationship and determines their values, followed by the estimation of the short run elasticity of the variables with the error correction representation of the ARDL model. The second step also determines the appropriate lag length selection of the independent variables.

Equation (2) represents only the long run equilibrium relationship among the variables. However, the short run adjustment of inflation rate to changes in monetary policy instruments is crucial for further estimation in the dynamic error correction model. The error correction model is shown as:

$$\Delta Y_t = \alpha_0 + \sum_{i=1}^{p-1} \alpha_i \Delta Y_{t-i} + \sum_{j=0}^{q-1} \beta_j \Delta X_{t-j} + \gamma ECM_{t-1} + U_t \quad (3)$$

Where Δ represents the first difference operator and ECM_{t-1} represents the error correction term estimated from the equation (4). γ represents the speed of adjustment from the short run to the long run so as to obtain equilibrium in the case of shock on the system. Y_t is the dependent variable, Y_{t-1} is the lag value of dependent variable, $\sum$ represents summation, X_t represents the explanatory variables, β is the coefficient and U_t is the error term. The first part represents the short run estimates of the model while the second part is the long-run relationship between the variables. Based on equation on the ECM specification, equation (3) can be re-represented as:

$$\begin{aligned} \Delta GDPgr_t = & \delta_0 + \sum_{t=1}^{p-1} \delta_1 \Delta GDPgr_{t-1} + \sum_{t=0}^{q-1} \delta_2 \Delta CO_{2t-1} + \\ & \sum_{t=0}^{q-2} \delta_3 \Delta FRD_{t-1} + \sum_{t=0}^{q-3} \delta_4 \Delta AAR_{t-1} + \sum_{t=0}^{q-4} \delta_5 \Delta FDI_{t-1} + \\ & \sum_{t=0}^{q-5} \delta_6 \Delta GFCF_{t-1} + \sum_{t=0}^{q-6} \delta_7 \Delta POP_{t-1} + \gamma ECM_{t-1} + e_t \end{aligned} \quad (4)$$

When estimating ARDL, there it is vital to determine whether the variables are co-integrated or not. This is done by restricting all the estimated coefficients of the lagged level variables to be equal to zero (0). Hence, the null hypothesis of no co-integration is given as:

$$H_0: \delta_1 = \delta_2 = \delta_3 = \delta_4 = \delta_5 = \delta_6 = 0 \quad (5)$$

The above null hypothesis is tested against the alternative hypothesis that is the presence of co-integration among the variables:

$$H_0: \delta_1 \neq \delta_2 \neq \delta_3 \neq \delta_4 \neq \delta_5 \neq \delta_6 \neq 0 \quad (6)$$

This test is carried out by the means of F-statistics (Bound test) of ARDL and asymptotic non-standard distribution variables to determine whether the variables are $I(0)$ or otherwise. If the computed F-statistics lies above the upper bound, then the null hypothesis is rejected and if otherwise, the null hypothesis is accepted. The hypothesis indicates that there is no long run relationship between dependent and the explanatory variables. Furthermore, in order to establish the causal relationship among the series, the model to be estimated can be written as:

$$\begin{aligned} GDPgr_p = & \tau_0 + \sum_{j=1}^p \tau_{1j} GDPgr_{t-j} + \sum_{j=0}^{q_1} \tau_{2j} CO_{2t-j} + \\ & \sum_{j=0}^{q_2} \tau_{3j} FRD_{t-j} + \sum_{j=0}^{q_3} \tau_{4j} AAR_{t-j} + \sum_{j=0}^{q_4} \tau_{5j} FDI_{t-j} + \\ & \sum_{j=0}^{q_5} \tau_{6j} GFCF_{t-j} + \sum_{j=0}^{q_6} \tau_{7j} POP_{t-j} + e_t \end{aligned} \quad (7)$$

All variables are as previously defined, other diagnostic tests such as serial correlation and heteroskedasticity tests were conducted to validate the result obtained from the ARDL estimation.

4. Data Analysis and Discussion of Findings

4.1 Descriptive Statistics

The summary of descriptive statistics of gross domestic product growth rate (GDPgr), carbon dioxide emissions (CO₂), forest depletion (FRD), average annual rainfall (AAR), foreign direct investment (FDI), gross fixed capital formation (GFCF) and population (POP) are presented in Table 1. Importantly, the summary of the descriptive statistics assist to know whether the variables are normally distributed or not which is done through the Jarque-Bera statistic with the null hypothesis of normal distribution, satisfying zero skewness and the excess kurtosis is zero against the alternative hypothesis of non-normal distribution. Hence, if the p-value of the Jarque-Bera statistic exceeds 5% ($p > 0.05$), then the null hypothesis is accepted, otherwise the null hypothesis of normal distribution is rejected.

Table 1: Descriptive Analysis of Variables

	GDPGR	CO₂	FRD	AAR	FDI	GFCF	POP
Mean	3.470848	0.376199	1.776532	10.16421	2.793916	3.036677	2.588164
Maximum	33.73578	0.648670	4.740000	12.47000	10.83256	59.38751	2.857502
Minimum	-13.12788	0.193185	0.000000	5.590000	-1.150856	-35.99681	2.488183
Std. Dev.	7.417955	0.141885	1.250563	2.553983	2.315934	22.85858	0.080671
Skewness	1.267732	0.479039	0.824795	-0.994078	1.587482	0.553977	0.889932
Kurtosis	9.149892	1.826220	3.016411	2.518912	6.083617	2.880960	4.307322
Jarque-Bera	70.06211	3.634816	4.308909	6.624995	31.01605	1.966076	7.721928
Probability	0.000000	0.162446	0.115966	0.036425	0.000000	0.374173	0.021048
Observations	38	38	38	38	38	38	38

Source: Authors' computation (2020).

The table shows that GDP growth rate (GDPGR) averaged approximately 3.47% with a minimum and maximum value of -13.13% and 33.74%, while its standard deviation stood at approximately 7.42%. For carbon emission (CO₂), forest depletion (FRD) and annual average rainfall (AAR), the mean values are 0.3762, 1.7765 and 10.16 respectively.

The negative Skewness suggests in GDPGR that the growth in AAR has been below its mean value for most of the period under review. The result here indicates significant fluctuation on the path of GDP Growth Rate series as denoted by the high standard deviation value. In addition, the Jarque-Bera results depict that carbon emission, forest depletion and gross fixed capital formation series were normally distributed during the period of investigation. The direction of skewness is negative only for annual average rainfall (AAR) while it is positive for the all other variables. The Skewness statistics indicates that annual average rainfall (AAR) has on the overall, been declining for most of the period which the study covers. Similar, interpretation can also be given to other variables with similar Skewness statistics as those explained.

4.2 Correlation Analysis

The correlation analysis shows the degree of linear association among the variables which can either be positive or negative. The correlation coefficient lies between -1 and 1 (i.e. $-1 \leq r \leq 1$). Also, the correlation analysis is meant to offer a glimpse at the nature of relationship among the variables in the model and thus be able to observe if there could be any multicollinearity problem among the variables. Hence, Table 2 presents the relationship among the variables.

Table 2: Correlation Matrix

Variables	GDPGR	CO ₂	FRD	AAR	FDI	GFCF
CO ₂	-0.197971	1				
FRD	0.106196	-0.212334	1			
AAR	0.498902	-0.700036	0.262849	1		
FDI	0.082992	-0.232812	0.723675	0.254571	1	
GFCF	0.217441	-0.175260	0.076608	0.378393	0.147566	1
POP	-0.028086	-0.044893	-0.646512	-0.039485	-0.46476	0.177815

Source: Authors' Computation, (2020).

It is revealed from the table above that the different correlation between the variables can be seen and interpreted by the coefficient of correlation of each variable in the table. Interestingly, a quick view of the table reveals that carbon emission (CO₂) and population growth (POP) are negatively correlated with economic growth (values of -0.198 and -0.028 respectively). Similarly, on the other hand, forest depletion (FRD), annual

average rainfall (AAR), foreign direct investment (FDI) and gross fixed capital formation (GFCF) are positively correlated with economic growth. The correlation coefficient between GDPGR and AAR is highest and standing at 0.499. This relatively high value gives some preliminary and intuitive information that AAR is strongly and directly correlated with economic growth. Surprisingly, it turns out that the correlation between POP and GDPGR is relatively poor thus suggesting that both variables are inversely linked.

4.3 Unit Root Test

The unit root test methods utilized for the purpose of evaluating the stationarity property of the series employed for this study are those that have been widely employed in empirical analysis. Specifically, Augmented Dickey Fuller (ADF) is the basic criterion that is being used in this study because of its widespread application in previous empirical studies. The result of the unit root test based on the Augmented Dickey Fuller (ADF) is presented Table 3.

Table 3: Unit Root Test

Variables	Augmented Dickey-Fuller (ADF) test		Order of Integration
	Level	1st diff.	
GDPGR	-4.610936**	-	I(0)
CO ₂	-1.402121	-6.043997**	I(1)
FRD	-2.021680	-8.762324**	I(1)
AAR	-1.628193	-6.168916**	I(1)
FDI	-3.667886**	-	I(0)
POP	-3.039933**	-	I(0)
GFCF	-5.086443**	-	I(0)

Note: ** implies 5% significance level.

Source: Authors' Computation (2020).

From Table 3, the Augmented Dickey-Fuller (ADF) unit root test was employed in order to examine the stationarity of the variables. It reveals that gross domestic product growth rate, foreign direct investment, population and gross fixed capital formation are stationary at their level form that is I(0) while carbon dioxide emissions, forest depletion and

average annual rainfall become stationary at first differencing that is $I(1)$. Since there are mixtures of $I(0)$ and $I(1)$ variables, the underlying assumption of utilizing an autoregressive distributed lag (ARDL) is justified.

4.4 ARDL Bounds Test

The autoregressive distributed lag (ARDL) bounds test by Pesaran, Shin and Smith (2001) is carried out to examine the long run relationship among the variables as it is essential that cointegrating relationship exist among the variables. Hence, if the F-statistics is greater than the upper bound $I(1)$, the null hypothesis is rejected while if the F-statistics is less than the upper bound $I(1)$, the null hypothesis is accepted, that is no cointegration among the series and if the value of F-statistics lies between the lower bound $I(0)$ and upper bound $I(1)$, the result is said to be inconclusive.

Table 4: Bounds Test

Test Statistics	Critical Value		Decision
	$I(0)$	$I(1)$	
F-Statistics = 7.873			Co-integrated
10%	2.12	3.23	
5%	2.45	3.61	
2.5%	2.75	3.99	
1%	3.15	4.43	

Source: Authors' computation (2020).

From the result presented in Table 4, the F-Statistic value is greater than the upper bounds values at different significance levels. Hence, we reject the null hypothesis of no cointegration among variables in the long run.

Table 5: ARDL Short-run and Long-run Estimates

Variables	Coefficients	t-Statistic	Prob.
Short-run Estimate of the Model			
ΔCO_2	16.42091	103.2014	0.0000
ΔFRD	-1.000193	-43.54903	0.0000
ΔAAR	2.447295	249.6608	0.0000
ΔFDI	0.109104	10.89965	0.0000
ΔGFCF	0.005914	7.599790	0.0000
ΔPOP	-25.24830	-74.16167	0.0000
ECM(-1)	-0.9091	382.9039	0.0000
Long-run Estimate of the Model			
CO_2	0.000510	0.459009	0.6498
FRD	-0.050928	2.297196	0.0293
AAR	-0.000611	-0.216790	0.8299
FDI	0.011632	3.819549	0.0007
GFCF	0.000710	0.669315	0.5088
POP	0.001121	3.398658	0.0020

Source: Authors' computation (2020).

4.5 Long-run and Short-run Estimates

Table 5 presents the long run and short run equations of the model. From the result in the short run, it shows that climate change proxied by carbon emissions has a significant impact on economic growth. In the short run, carbon emission (CO_2) has a significant positive relation with Economic growth. 1% point increase in carbon emission (CO_2) leads to 16.42% increase in gross domestic product proxy for economic growth in Nigeria. This result does not conform to apriori expectation and this could be as a result of over reliance on the using of fossil fuel for productive activities. It is quite cleared that carbon emission is an important determinants of economic growth in the long run although not significant.

Also, forest depletion (FRD) has a significant negative relation with economic growth in the short and long run. The result also conforms to apriori expectation. However, 1% point increase in forest depletion will lead to 1.00% decrease in gross domestic product proxy for economic

growth in Nigeria. Hence, it becomes clear that forest depletion is an important variable determining economic growth in the short and long term.

More so, annual average rainfall is also an important determinant of economic growth in Nigeria. From the result, 1% increase in annual average rainfall will bring about a 2.45% increase in economic growth in the short run. The result also conforms to apriori expectation and it is significant at 5% level of significance. Hence, it becomes clear that annual average rainfall is an important determinant. While in the long run, annual average rainfall has non-significant negative impact on gross domestic product in Nigeria. This result depicts that Nigerian relied on annual average rainfall for her endowed agricultural activities since the sector accounting for more than 60% of her GDP.

Likewise, foreign direct investment that captured the foreign investment in the economy depicts a direct relationship with economic growth in both short run and long run. From the result, 1% increase in foreign direct investment (FDI) will lead to about 0.11% increase in Economic Growth and such relation is significant in the long run. Furthermore, gross fixed capital formation (GFCF) and population growth (POP) show that they are important determinants affecting economic growth in the short run. From the result, 1% point increase in gross fixed capital formation will lead to about 0.6 % increase in economic growth in the short run. Also, Population depicts an inverse relation with economic growth in the short run although it shows a positive significant impact in the long run. Hence, this result justifies the reality of Malthusian theory of population in Nigeria in the short run.

Importantly, the ECM result for the short run situation indicates that the error correction estimates (ECM) is properly signed and significant at 1% level of significance which implies that about 90.9% of the disequilibrium caused by previous year's shock converged back to long run equilibrium in the current year.

4.6 Post Estimation Tests

The study conducted post estimation tests (serial correlation and heteroskedasticity) on the impact of climate change on economic growth in Nigeria.

Serial Correlation Test

The Breusch-Godfrey Serial Correlation LM test will be used to test the null hypothesis that states that there is no serial correlation in the model. Hence, the study rejects the null hypothesis if the p-value is significant at 5% critical value.

Table 6: Breusch-Godfrey Serial Correlation LM Test

F-statistic	2.689177	Prob. F(2,24)	0.0883
Obs*R-squared	6.773664	Prob. Chi-Square(2)	0.0338

Source: Authors' computation (2020).

From Table 6, the value of the Chi-Square (0.0338) is statistically significant at 5% which implies that the null hypothesis is rejected.

Heteroscedasticity Test

One of the underlying assumptions of linear regression is constant variance of the model (Homoscedasticity) violation of this assumption can lead to bias estimation of the model parameters. To validate this assumption, this study checked the heteroscedasticity of the model using the Breusch-Pagan-Godfrey approach and the result is presented in Table 7.

Table 7: Heteroskedasticity Test: Breusch-Pagan-Godfrey

F-statistic	1.944270	Prob. F(16,19)	0.0838
Obs*R-squared	22.34957	Prob. Chi-Square(16)	0.1323
Scaled explained SS	3.618313	Prob. Chi-Square(16)	0.9994

Source: Authors' computation (2020).

From the above table, the value of the Chi-Square (0.1323) is not significant at 5% which implies that the null hypothesis that states that there is no heteroscedasticity is accepted.

4.7 Discussion of Results

The outcome of this study revealed that annual average rainfall, forest depletion and carbon emission proxy for climate change have significant effect on economic growth in the short run. In the long run, the empirical results obtained from this study show some interesting empirical regularities and resemblance with previous studies. Specifically, the results here in some aspects support that of previous studies in this subject. The study conducted the ARDL bounds test in order to examine

the long run relationship between the variables. The result reveals a long run relationship exist among the variables in Nigeria which implies that there is a co-movement of the variables in the long run.

More so, the ARDL estimation result reveals the short run and long run estimate of the effect of climate change on economic growth in Nigeria. In the short run, carbon emission has a significant positive relation with economic growth. 1% point increase in carbon emission leads to 16.42% increase in economic growth in Nigeria although it has a positive non-significant impact in the long run. This result does not conform to apriori expectation and this could be as a result of over reliance on the using of fossil fuel for productive activities. It is quite cleared that carbon emission is an important determinants of economic growth in the long run. Also, forest depletion has a significant negative relation with economic growth in the short run and long run. The result also conforms to apriori expectation. However, 1% point increase in forest depletion will lead to 1.00% decrease in economic growth. Hence, it becomes clear that forest depletion in an important variable determining economic growth in the long run, and as the economy continues to embark on deforestation, it reduces the availability of agro raw materials which are essential for the manufacturing sector. Likewise, annual average rainfall shows a positive significant impact on economic growth in the short run but negative non-significant impact on economic growth in the long run. This is attributable to the contribution of rainfall in improving the watering of the farmlands which results into improved harvest in the short term. However, in the long term continuous rainfall can destroy the crops due through flooding of the farmlands leading to decrease in crop production.

Furthermore, the study tested the links between climate change and economic growth in Nigeria. The Granger causality establishes a neutral hypothesis that is there is no causal relationship between climate change proxied by carbon emissions and economic growth proxied by gross domestic product growth rate in Nigeria. Recent empirical studies in this strand of the literature have noted that the climate change in an important variable influencing economic growth in Nigeria. This result is contrary to the findings of Ogbuabor and Egwuchukwu, (2017) who found that climate change has a significant adverse impact on economic growth.

5. Conclusion

This study empirically examined the impact of climate change on economic growth in Nigeria between 1980 and 2017 by employing the autoregressive distributed lag (ARDL) approach. The result shows that an increase in forest depletion has a negative impact on economic growth measured by growth rate of gross domestic product. On the other hand, since Nigerians depends on rain-fed agriculture which comprises a huge share of GDP, a decline in rain fall reduces an economic growth measured by GDP growth rate. The reduction in economic growth will also result in increasing poverty. Thus, control of climate change is not only important for economic growth issue, but also crucial for poverty alleviation. The result asserts that if climate change is not controlled, the economic growth will be reduced (an increase in forest depletion dangers a lot) considerably in the long run. However, Nigeria alone can do very little with regard to controlling climate change as its share of Green House Gas emissions in comparison to developed countries is small. Although the developing countries like Nigeria contribute the least to causing climate change, they are the most affected by this phenomenon. This is due to their dependency on agriculture and their inability to pay for the resources necessary to combat climate change via adopting the preventive measures (mitigation) and adaptation techniques.

Following the results from this study, the following policy options suggested are: (i) The government should encourage the use of bio-fuels and clean energy by subsidizing its use in the industrial sector in place of fossil fuels which may adversely impact the environment and depletes the ozone layers; (ii) Government and non-governmental organisation should give high priority to environmental safety education through training and public awareness; and (iii) The central authority should evolve policies that embolden afforestation and reinforce stiffer sanctions on individuals or organisations engaged in unwholesome deforestation, bush burning and desert encroachment.

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Government Expenditure and Private Consumption in Nigeria: Further Empirical Evidence

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Abstract

The study investigates the effect of government expenditure on private consumption in Nigeria from the period of 1980 and 2018. Using Autoregressive Distributed Lag (ARDL), the result of short-run parameters shows that government expenditure, foreign direct consumption and population have positive and significant relation with private consumption while import has negative and significant relation with private consumption. Concerning the long-run parameters, total investment and export have a significant positive relation with private consumption while import exerts a negative significant effect on private consumption. Thus, there is a need for efficient and effective policy that will encourage foreign investment to increase government revenue. This supports the Wagner's Law that growth of national income raises the size of the public sector.

Keywords: Government expenditure, private consumption, FDI, real GDP, ARDL.

JEL Classification: E21, H50, O47, P45.

1. Introduction

The impact of government spending on private consumption and economic growth is one of the controversial issues in both theory and experience. On the theoretical ground, there are different schools of thoughts on the issue. The Keynesian theory of absolute income hypothesis suggests that household current consumption is a function of their current disposable income. Thus, an increase in government spending leads to increased output, employment and income, which further increases private consumption and generates thus crowding in effect. On the contrary, the standard real business cycle model, under the framework of neoclassical theory, predicts that a rise in government spending reduces private consumption. Generally, government can use different sources of financing its spending. The increase in government spending through taxes lowers household permanent income. This negative wealth effect decreases household consumption. Reacting to the increase in taxes, households increase labor supply by working more, which is called substitute on effect. Under the standard real business cycle model, the negative wealth effect dominates the substitution effect. As a result, household consumption decreases. This phenomenon is known as crowding out effect or “substitutability hypothesis” between public and private consumption. A number of studies introduced specific modifications in standard real business cycle model to generate crowding in effect (Linnemann, 2006; Abu and Abdullahi, 2010). Finally, full Ricardian equivalence argues that an increase in government spending, regardless the way of financing, has no impact on household consumption. This holds because households have perfect foresight and knowledge about the economy. Therefore, they internalize government’s budget constraint into their own lifetime budget constraints (Keho, 2019).

On the experience ground, there is no clear evidence on the impact of government spending on private consumption. A number of empirical studies found a positive impact of government spending on private consumption (Bouakez and Rebei, 2007). On the opposite side, other studies found support for the substitutability between government spending and private consumption (Auteri and Costantini, 2010; Dawood and Francois, 2018). Since private consumption constitutes the largest component of gross domestic product and aggregate demand, it is

important to understand the impact of government spending on private consumption.

The statistics on public expenditure in Nigeria revealed a major problem which shows that more emphasis has been placed on recurrent expenditure as opposed to capital expenditure which is expected to foster development. Meanwhile, there are challenges of mismanagement and misappropriation of public expenditure in the economy. This is manifested in the inability to maximize the benefits associated with economic booms. Nigeria currency was overvalued; as such export was discouraged while import was encouraged, with these are also poor business environment, neglect and decay of infrastructure, corrupt practices, and huge expenditure on maintenance of democratic institutions. Moreover, Nigeria has not fared well in the last couple of years as manifested in fiscal imbalance running into large fiscal deficits (Onoh, 2007).

Despite the rising government expenditure in Nigeria, the problem of translating this to a meaningful growth and development of the country has been daunting over the years. This is evident by high rates of unemployment, illiteracy rate, and the number of its citizens who continue to wallow in abject poverty, while more than 65% of its people live on less than US\$1 per day. As high as 70% of Nigerians also still lack medical care, do not have access to clean and portable water and basic needs of life-WHO. Macro-economic indicators do not favor Nigeria, for instance, indicators like balance of payments, import obligations (US\$35.2 billion), inflation rate (15.7%), exchange rate (₦304.7/US\$1), unemployment (14.2%) and national savings (13.1% of GDP) reveals that Nigeria had not fared well in the last four decade despite being the largest economy in Africa with an estimated GDP of US\$510 billion-World Bank (Onoh, 2007).

In view of the importance of government expenditures in the transformation of an economy, especially that of Nigeria which is public sector driven, it is imperative that there is a need to determine the actual impact of government expenditure on the Nigeria economy, whether high public expenditure are responsible for the lack of development and the sectors that government needs to curtail or increase expenditure as the case may be. It is also evident that increasing government expenditure has not yielded the desired growth and development in Nigeria.

Thus, it is quite unfortunate that the quantity and quality of government expenditure has not translated to meaningful development or improvement in the welfare of the citizens. The standard of living of majority of Nigerians is low; many are still in abject poverty, while more than 50 percent live on less than US\$2 per day. Nigeria is among the poorest countries in the world despite the amount of public spending made by the government. Giving the existing problems, it is therefore significant to investigate into the nature and effect capital and recurrent expenditure on private consumption so as to proffer solution to existing problem. Therefore, the attempt in this study is to empirically examine the impact or effects of public expenditure on private consumption in Nigeria. The study is presented in five parts. Section one provide the introduction, section two depicts the literature review, section three presents methodology, and sections four and five present discussion of results and conclusion respectively.

2. Literature Review

This section reveals relevant studies on the relationship between government expenditure and private consumption. Specifically, Dada (2013) addressed the effects of macroeconomic volatility on Government Consumption Expenditure in Nigeria as well as the burdens and challenges it has been imposing on public welfare. The Structural Vector Auto-Regression process including, the government consumption expenditure, real exchange rate, general price level (inflation rate), unemployment rate and debt service obligation, was estimated over the period 1980-2008. They found that, the government consumption expenditure response to one structural innovation appears to be greater in inflation than other endogenous and exogenous variables, that is, an economic shock to inflation effect is stronger on the government consumption expenditure at longer horizon. Also, inflation innovations played a larger role in explaining government consumption expenditure forecast error variance in the short run than they did in the long-run, and this generates negative net effects on public welfare in the short-run than long-run. The estimates revealed that, variability in exchange rate appears to be less sensitive to shocks than other variables and it appears not to be very important in explaining government consumption expenditure in either the short or long run, because the magnitude of the coefficient is considered to be relatively too small. In summary, the principal findings

of this study is that government consumption expenditure appeared to be less sensitive to one innovation or shock of unemployment and debt service obligations than inflation.

Lewis and Winkler (2017) empirically examined the crowd in puzzle between government spending, entry and consumption. The study reports that net firm entry robustly rises after a U.S. government spending expansion. The study uses this new finding to test the empirical validity of various model features that have been proposed to generate consumption crowding-in after positive expenditure shocks. Endogenous-entry models typically fail to generate the observed joint increase in consumption and entry. Model feature that dampens the wealth effect, such as rule-of-thumb households or complementarity between labor and consumption in preferences, tend to reduce entry. The study shows that utility- or productivity-enhancing public spending can reconcile the model with our documented fact and performs well empirically.

Keho (2019) examined the effect of government expenditure on economic growth in Nigeria using time series data spanning from 1986 to 2018. Using the Ordinary Least Squared Regression technique, it was found that government capital expenditure and government recurrent expenditure has a positive and significant impact on economic growth. Government expenditure drives economic growth in Nigeria and the study recommends that more of government's resources should be directed to especially capital expenditure and recurrent expenditure in terms of income to increase aggregate demand.

Akpan and Atan (2020) empirically examined the effect of government expenditure on private consumption in Nigeria using Auto Regressive Distributed Lag (ARDL) approach for the period 1981 to 2018. The study employed time series data of government expenditure components (recurrent and capital) and private consumption in order to establish the short and long relationship of the model. The unit root and cointegration tests were conducted on all the variables and the results revealed the existence of stationarity and long run equilibrium relationship respectively. The empirical results of the long run model showed recurrent expenditure as having a significant relationship with private consumption in Nigeria, while capital expenditure revealed an insignificant relationship. The results further indicated a positive and significant relationship between private consumption and Gross

Domestic Product in Nigeria both in the short and in the long run. The results of the short run analysis revealed a positive but insignificant relationship between private consumption and government expenditure (recurrent and capital expenditure) in Nigeria. This positive relationship between recurrent expenditure of government and private consumption confirms the current position of government that is aimed at increasing recurrent spending in order to boost the economy out of the current recession.

Kraipornsak (2010) examined the impact of government spending on private consumption and on the economy of Thailand. Government spending is categorized into consumption spending and capital spending. Three categories of private consumption are used: food consumption, non-food consumption, and services consumption. The estimated model indicates substitution effects of government consumption spending on budget shares of private non-food consumption and of government capital spending on budget share of private food consumption. However, the results do not indicate whether the negative effects of changes in the budget shares of the non-food and the food consumption equates to reduced total private consumption. The concept of aggregate demand comprising consumption, investment, government spending (consumption spending and capital spending), export, and import are used to estimate their relationship by using the Vector Error Correction Mechanism. The study found no effect of government capital spending on either the private consumption or the growth of GDP while the government consumption spending has negative effect on the growth of GDP.

Adedeji and Adegboye (2013) examined the factors that determine the private consumption spending in Nigeria. The framework of the model specified assess the relative contribution of income, and other factors that affect savings to the dynamics of private consumption spending in Nigeria using time-series data spanning between 1981 and 2010. Using an error correction mechanism (ECM) after testing for the stationarity of the data, the study revealed that except for real interest rate in current year which was not statistically significant in all experimental runs, all other explanatory variables were statistically significant. Precisely, the old-age dependency ratio, inflation rate, GDP per capita and disposable income have significantly positive effect on private consumption spending, while real GDP growth, foreign direct investment, public

spending and change in real effective exchange rate had negative impact. This implies that public consumption was crowding out private consumption even back up to one year period and private consumption spending was an increasing function of income as hypothesized by Keynes.

Ambler, Bouakez and Cardia (2017) utilized vector autoregressions (VARs) which showed that public spending shocks crowd in private consumption has been seen as evidence against standard neoclassical models of the business cycle. It showed that a standard real business cycle model in which all agents, including the government optimize is compatible with the results from the empirical literature. A VAR estimated using artificial data simulated from the model indicates that, under standard assumptions to identify public spending shocks, an increase in public spending is associated with an increase in private consumption and the real wage. The implied impulse responses are qualitatively and quantitatively similar to those in the empirical literature. Recent empirical work finds out that government spending shocks cause aggregate consumption to increase over the business cycle, contrary to the predictions of Neoclassical and New Keynesian models.

Murphy (2013) proposed mechanism to account for the consumption increase that builds on the framework of imperfect information. In this model, owners of firms targeted by an increase in government spending perceived an increase in their permanent income relative to their future tax liabilities. Owners of firms not targeted remain unaware of the implicit increase in future tax liabilities, causing aggregate consumption to increase. A testable implication of the proposed model is that the value of firms should increase, implying all else equal an increase in aggregate stock returns. This prediction of the model is shown to be consistent with empirical evidence.

Awode (2019) examined whether government expenditure in Nigeria has had any influence on growth in the economy. The study focuses primarily on capital and recurrent types of government expenditure, and these were regressed against the real gross domestic product. Secondary time series data ranging from 1981 to 2016 obtained from the CBN Statistical Bulletin were used. Having established that the series were co-integrated in the long run through the co-integration technique of Johansen, the study then used the error correction and Granger causality techniques to achieve its objectives. Results indicated that recurrent expenditure exerts

a significant positive influence on real GDP, while the influence of capital expenditure on real GDP turned out negative. The Granger causality test revealed that both capital and recurrent expenditures Granger cause real GDP.

Gukat and Ogboru (2017) examined the impact of government expenditure on economic growth in Nigeria for the period 1981–2016. Specifically, the impacts of government recurrent and capital expenditures were tested using two separate models. The stationarity of the variables was tested to determine the stochastic properties of the series. Also, the co-integration result indicates that the two models each have one co integrating equation. An ordinary least square technique with error correction specifications was used to analyze the data. The result for the model indicated that the coefficients of social and economic services were negative while administration was positive and significant. The result for the model indicates that coefficients of administration and social services were negative and insignificant while economic services were positive but insignificant. The study therefore concluded that government expenditure has not translated into meaningful economic growth.

Ojong, Nkamare and Anthony (2016) examined the effect of recurrent expenditure on the growth of Nigeria economy and to examine the link between capital expenditure and the growth of Nigeria economy. In line with these objectives, secondary data were sourced from the CBN statistical bulletin and other relevant publication using the desk survey method. The exploratory and ex-post facto designs were used for the study. The data collected were analyzed using the ordinary least square multiple regression technique. Findings from the analysis revealed that recurrent expenditure had a significant relationship on the growth and development of Nigeria economy; capital expenditure had a significant effect on the growth and development of Nigeria economy and finally, aggregate expenditure had a positive impact on the growth of Nigerian economy. On the basis of these findings, it was recommended that government should spend more on security as this will promote investment; also, government should increase its expenditure on economic services such as agriculture, construction, transport, communication, electricity and other economic services and finally, government should increase its spending on transfers such as pensions, gratuities, bursaries and grants etc.

Ogundipe and Oluwatobi (2013) investigate the impact of both government recurrent and capital expenditure on growth performance using an econometric analysis based on Johansen technique for the period of 1970-2009. The study found the component of total expenditure impacting negatively (except education and health) and insignificantly on growth rate; further diagnosis test reveals capital expenditure may likely induce significant impact on growth rate in the long-run. Notable recommendations include, proper management of capital and recurrent expenditure, proper surveillance and quantification of capital spending in order to boost social and human capital, and development of sound institutions void of political influences.

Nduka, Ananwude and Osakwe (2019) re-examined how the standard of living of the citizens are affected by the expenditure pattern of the Federal Government of Nigeria from 1981 to 2018. The outcome of the study based on data applied revealed that government expenditure has significant effect on the standard of living of her citizens. They argued that this is not the reality on ground as the level of poverty in country is high as the rich are getting richer, whereas the poor are getting poorer. There are deaths of basic infrastructures coupled with abandoned capital projects by past administrations. Those at the helm of affairs are interested in personal and political interest at the detriment of the welfare of the citizens. With the high volatility in inflation rate in the macro economy, we urge the government to increase salaries and wages of workers to cushion its devastating effect on purchasing power. There is overwhelming need for the government to continue channeling resources to the social sector within its life betterment programme such as pension, social security etc. to significantly reduce poverty to improve per capita income because reduction in poverty translates to higher per capita income thus better standard of living.

The related literatures reviewed above point towards the importance of the relationship between government spending and private consumption, however, this area of research is relatively understudied for Nigeria. Therefore, this study will investigate whether government spending generates “crowding-out” or “crowding-in” effects on the private sector in Nigeria. From the methodological perspective, this study uses a more efficient and less restrictive econometric approach which improves the findings on the subject not only for Nigeria but for overall empirical literature on the nexus between government expenditure and private

consumption. More precisely, the study uses Autoregressive Distributed Lag (ARDL) which deals with both slope heterogeneity and cross-sectional dependence. Most of existing studies using data employed earlier regression methods that impose cross-sectional homogeneity and independence in the error terms. The cross-sectional homogeneity assumption is likely to be violated given the heterogeneity of economies with respect to trade policy, economic conditions and institutional developments.

3. Methodology

3.1 Theoretical Model

To analyze the impact of government expenditure on private consumption, two types of approaches are most widely used, that is, Keynesian Government Intervention approach and Absolute Income approach. In the Keynesian Government Intervention, the theory holds that increase in government expenditure leads to increase in economic activities and higher economic growth. The Keynesian theory asserts that government expenditure especially deficit financing could provide short - term stimulus to help halt a recession or depression. This analysis holds that public spending measures have a direct impact on aggregate demand, which will stimulate the economy. The theory postulates that:

$$Y_t = C_t + I_t + G_t + (X_t - M_t) + \varepsilon_{1t} \quad (1)$$

In Absolute income Hypothesis, theory postulates that real consumption is a stable function of real income i.e. $C/P = f(Y/P)$

$$C_t = \alpha_t + \beta(Y_t - T_t) + \varepsilon_{2t} \quad (2)$$

Keynes developed these postulates on a priori premise but later on backed them up with some statistical evidence.

Equation 1 and 2 can therefore be solved using simultaneous model.

$$C_t = \pi_0 + \pi_1 I_t + \pi_2 G_t + \pi_3 X_t - \pi_4 M_t + V_t \quad (3)$$

Where π_0 is $\frac{\alpha}{1-\beta}$; π_1 , π_2 , π_3 and π_4 is $\frac{\beta}{1-\beta}$; and V_t is $\frac{\beta\varepsilon_1 + \varepsilon_2}{1-\beta}$. C is private consumption, I is investment, G is government expenditure, X is export, and M is import.

3.2 Model Specification and Data Measurements

The study uses secondary time series dataset which poses some challenges. The presence of non-stationary macroeconomic variable and variables with long time dimension subject the regression to spurious results and according to Hernandez-Leal *et al.* (2017), the presence of non-stationary variables abounds. The presence of non-stationarity makes forecasting and predicting difficult. The extension of time series data helps deal with issues of non-stationarity and co-integration (Zhao, Gou and Li, 2019). In the analysis for co-integration, the study checked for unit root and co-integration and then estimated the long run and short run relationship.

The data is fitted to an autoregressive model on the premise that (i) the current values of the dependent variable could depend on a linear combination of its past values as well as (ii) the past values are distributed across time in the past. Following from the aforementioned, the study therefore uses Autoregressive Distributed lag model which allows the study to include the lagged values of both the dependent (PRC) and independent variable(s) (i.e. GOVEXP, INV, GDPPC, X and M). The ARDL model allows for flexibility which makes it possible to use variables integrated of different order (either I(0) or I(1)) except for order two(2) (Altaee, Al-Jafari, and Khalid, 2016). Autoregressive distributed lag (ARDL) models:

$$\begin{aligned}
 PRC_t = & \beta_0 + \beta_1 PRC_{t-1} + \beta_2 GOVEXP_{t-1} + \beta_3 INV_{t-1} + \\
 & \beta_4 GDPPC_{t-1} + \beta_5 X_{t-1} + \beta_6 M_{t-1} + \gamma_1 \sum_{j=1}^q PRC_t + \\
 & \sum_{j=1}^p \gamma_2 GOVEXP_t + \sum_{j=1}^p \gamma_3 INV_t + \sum_{j=1}^p \gamma_4 GDPPC_t \\
 & + \sum_{j=1}^p \gamma_5 X_t + \sum_{j=1}^p \gamma_6 M_t + \alpha_t + \varepsilon_t
 \end{aligned} \tag{4}$$

PRC_t is the dependent variable denoting private consumption. The explanatory variables are government expenditure (GOVEXP), total investment (INV), gross domestic product per capita (GDPPC), export (X) and import (M) respectively. The following are control variables that have the potential of augmenting growth: *FDI* is the foreign direct investment measured by FDI inflows as a percentage of GDP; *POP* is the population outcome measured by the population of age 15-64 as a percentage of total population; α_t is time fixed effects and ε_t is the disturbance term of the equation.

The data is sourced from the World Development Indicators (WDI) and Central Bank of Nigeria Statistical Bulletin of various Years. The data collected are annual data for a 28-year period from 1990 to 2017.

4. Analysis and Discussion of Results

4.1 Descriptive Statistics

Table 1 presents the summary statistics of series for the model. The statistics have the mean with their corresponding maximum, minimum and standard deviation. The distributional properties are also examined through their skewness and kurtosis, while the Jarque-Bera test statistic is used to test for normality in the distribution. The table shows that the weighted average value of private consumption was 30.764 with its positive minimum value of 30.017 and positive maximum value of 31.492. The mean of rate of government expenditure over the period of study was 13.557 having a minimum value of 10.622 and maximum value of 15.249. The mean value of total investment was 28.956; its minimum and maximum ranges between 28.262 and 29.995 respectively. Furthermore, gross domestic product per capita on the average was 12.405 and its minimum was 12.104 while its maximum was 12.856. Also, export mean was 29.649 with 29.036 for minimum and 30.501 for maximum while import means was 28.774 with 27.463 and 29.897 for both minimum and maximum respectively. The weighted average value of foreign direct investment was 3.454 with its positive minimum value of 0.650 and positive maximum value of 10.833. The mean of population over the period of study was 53.128 having a minimum value of 52.001 and maximum value of 53.696.

Table 1: Descriptive statistics

	PRC	GOVEXP	INV	GDPPC	X	M	FDI	POP
Mean	30.78	13.56	28.96	12.41	29.65	28.77	3.45	53.13
Maximum	31.49	15.23	29.99	12.86	30.50	29.90	10.83	53.70
Minimum	30.02	10.62	28.26	12.10	29.04	27.46	0.65	52.01
Std. Dev.	0.56	1.38	0.60	0.28	0.50	0.73	2.31	0.52
Skewness	-0.02	-0.71	0.65	0.45	0.52	0.05	1.63	-0.88
Kurtosis	1.33	2.30	1.81	1.45	1.78	1.70	5.60	2.54
Jarque-Bera	3.24	2.93	3.59	3.75	2.99	1.99	20.32	3.83
Probability	0.20	0.23	0.17	0.15	0.22	0.37	0.00	0.15
Observations	28	28	28	28	28	28	28	28

Source: Authors' computation (2020).

As shown in the table, all the series exhibit positive average values. Consequently, population has the highest yearly mean value of 53.13 while foreign direct investment has the lowest yearly mean value of 3.454. Given the standard deviation values of the eight series under consideration, foreign direct investment seems to be more volatile while gross domestic product per capita appears to be least volatile. This finding is however, in agreement with the statistical properties of the series. With respect to the statistical distribution of the variables, all the series are positively skewed except for private consumption and population who are negatively skewed. Private consumption, government expenditure, total investment, gross domestic product per capita, export, import and population were platykurtic (<3) while only foreign direct investment was leptokurtic in nature (>3).

4.2 Pairwise Correlation Analysis

The study presents the direction (i.e. sign) and magnitude of correlation between the variables in the model. The correlation analysis is meant to offer a glimpse at the nature of relationship among the variables in the model and thus be able to observe if there could be any multi-collinearity problem among the variables. The result for the exercise of correlation analysis is reported in Table 2 in the form of a correlation matrix. The different correlation between the variables can be seen and interpreted by the coefficient of correlation of each variable in the table. Interestingly, a quick view of the table reveals that foreign direct investment was negatively correlated with private consumption (values of -0.417).

Similarly, on the other hand, government expenditure, total investment, gross domestic product per capita, export, import and population are positively correlated with private consumption (values of 0.900, 0.853, 0.914, 0.888, 0.933 and 0.649 respectively).

Table 2: Correlation Matrix for the Variables

	PRC	GOVEXP	INV	GDPPC	X	M	FDI	POP
PRC	1							
GOVEXP	0.900	1						
INV	0.853	0.712	1					
GDPPC	0.914	0.757	0.941	1				
X	0.888	0.737	0.929	0.948	1			
M	0.933	0.880	0.874	0.888	0.868	1		
FDI	-0.417	-0.349	-0.399	-0.428	-0.430	-0.347	1	
POP	0.649	0.850	0.295	0.365	0.385	0.593	-0.255	1

Source: Authors' computation, (2020).

The result from the correlation analysis presented in tables 4.2 above provides a glance into the possible effects or impacts which may be derived in the subsequent sections on regression and impact estimations. However, theoretically, the coefficient of correlation between each of the variable cannot be interpreted or used to infer the effects in the model.

4.3 Unit Root Test

The unit root test methods utilized for the purpose of evaluating the stationarity property of the series employed for this study are those that have been widely employed in empirical analysis such as ours. Specifically, Augmented Dickey Fuller (ADF) and Phillip Perron (PP) are the basic criteria that have been used in this study because of their widespread application in previous empirical studies. The result of the unit root test based on the ADF and the PP methods is presented in Table 3.

Table 3: Unit Root Test

Variables	Augmented Dickey-Fuller		Phillip-Perron		Order of Integration	
	Levels	1st Diff.	Levels	1st Diff.	Levels I(0)	1st Diff. I(1)
PRC	-0.763(0.813)	-6.707(0.000)	-0.718(0.826)	-6.707(0.000)	No	Yes
GOVEXP	-2.514(0.124)	-6.364(0.000)	-4.090(0.004)	-	Yes	Yes
INV	-0.846(0.993)	-2.129(0.006)	-0.469(0.982)	-6.877(0.000)	No	Yes
GDPPC	-0.217(0.969)	-4.163(0.003)	-0.131(0.962)	-4.163(0.003)	No	Yes
X	-0.120(0.937)	-7.602(0.000)	-0.534(0.860)	-8.789(0.000)	No	Yes
M	-1.748(0.397)	-5.547(0.000)	-1.745(0.398)	-5.715(0.000)	No	Yes
FDI	-3.396(0.020)	-	-3.396(0.020)	-	Yes	-
POP	-2.348(0.166)	-2.040(0.069)	-2.503(0.126)	-2.011(0.080)	No	Yes

Source: Authors' Computation (2020).

The unit root test is carried out with constant and trend specifications for the respective series. The lag-selection was based on the default selection of the Akaike-Information Criterion (AIC). The table contains the ADF and the PP test statistic at levels and first difference of the time series. The numbers in the brackets represent the probability values of the estimate test statistic of the ADF and PP tests. The unit root test results from the ADF and PP methods show that the order of integrations mixed with some of the variables being stationary at levels and first difference at the same time. In particular, the stationarity of the general unit root process for the set of time series data for the variables shows that they are all significant at least at the 5 percent level for the first difference of all the variables and thus the null hypothesis of unit root in the data cannot be upheld.

4.4 ARDL Bounds Test

ARDL bounds test for co-integration was used to confirm the long-run co-integration and result from the bounds test co-integration is presented in Table 4. The result revealed that computed F-Statistics for Wald test was 5.171. The value exceeds both the upper bounds and lower bounds critical values for all level of significance. Therefore, the statistics test yields evidence of long-run relationship between private consumption and its determinants at 5% and 10% levels of significance.

Table 4: Bounds Testing

Computed Wald F-statistic: 5.505; K = 7		
Bounds Level	Lower Bound	Upper Bound
1% critical bounds value	2.96	4.26
5% critical bounds value	2.32	3.5
10% critical bounds value	2.03	3.13

Source: Authors' Computation (2020).

Note: *, ** & *** implies 1%, 5% & 10% respectively.

4.5 Long-run and Short-run Estimates

Having established the fact that the explanatory variables in the model have long-run relationship with the dependent variable, it is pertinent to also examine the direction of and magnitude impact of the relationship between government expenditure and private consumption. ARDL is employed for the estimation. The estimator is a long-run parameter estimation method in which the steady state converging relationship are evaluated and examined based on the parameter estimates obtained from the estimation exercise. The regression results are reported in Table 5. The table contains the parameter estimates obtained from the ARDL estimation approach. The variables are estimated in their growth form for purpose of data demeaning and to avoid outliers which can lead to heteroscedasticity problems.

From the short run parameters, it shows that government expenditure, foreign direct investment and population have positive and significant relation with private consumption while import has negative and significant relation with private consumption. The result indicated that a percentage increase in government expenditure will bring about 0.259% increase in private consumption indicating as government spend more into the economy, there will be too much money in the circulation and this will lead to increase in consumption. Import exerts a negative significant effect on private consumption indicating that a percentage increase in import brings about 0.118% in private consumption. Therefore, import discourages private consumption within the period

considered in this study while foreign direct investment exerts a positive significant effect on private consumption. Therefore, a percentage increase in foreign direct investment brings about 0.018% increase in private consumption. The more the investment from abroad by Nigerian citizen in Diaspora, the more will be the private consumption. Also, increase in population will lead to an increase in private consumption in Nigeria. Therefore, a percentage increase in population will bring about 0.586% increase in private consumption. The result shows an ECM value of -0.216 which is otherwise referred to as the speed of adjustment. The speed of adjustment is significant at 10% percent level considering its standard error. Approximately 21.6% of disequilibrium from the previous year's shock converges back to the long-run equilibrium in the current year.

Table 5: Long-run and Short-run Estimates

Regressors	ARDL	
	Long Run	Short Run
D(GOVEXP)	1.200(0.352)	0.259(0.006)***
D(INV)	0.398(0.003)***	0.047(0.742)
D(GDPPC)	3.521(0.243)	-0.220(0.616)
D(X)	0.469(0.023)**	-0.169(0.230)
D(M)	-0.549(0.008)***	-0.118(0.008)***
D(FDI)	0.083(0.381)	0.018(0.090)*
D(POP)	2.714(0.289)	0.586(0.001)***
C	-158.98(0.324)	-
ECM(-1)	-	-0.216(0.083)*
R-squared	0.9846	Akaike info criterion -1.682
Adjusted R-squared	0.973	Schwarz criterion -1.106
F-statistic	86.372	Hannan-Quinn criter -1.511
Prob(F-statistic)	0.000	Durbin-Watson-stat 2.037

Note: ***, ** and * denotes asymptotic significance at 1%, 5% and 10% respectively. Values in parenthesis are the p-values of the parameter estimate.

Source: Authors' computation (2020).

In the long run, total investment and export have a significant positive relation with private consumption while import exerts a negative significant effect on private consumption. In magnitude, a percentage

point increase in total investment leads to 0.398% increase in private consumption in Nigeria while a percentage point increase in export bring about 0.469% increase in private consumption. Also, import exhibit a negative significant effect on private consumption in Nigeria indicating that a percentage point increase in import of goods and services will bring about 0.549% decrease in private consumption. The adjusted R-squared value of 0.973 showed that 97.3% of the dependent variable is explained by the independent variables. Also, the Durbin Watson value of 2.037 is approximately 2, this shows that there is no auto-correlation in the model. More so, the F-statistic of 86.372 [$P < .01$] implied that the overall model is significant.

4.6 Stability Test

After the ARDL estimation, the study conducted stability test for the empirical model using the CUSUM test presented in Figure 1. The results confirm stability of the model at 5% significance level.

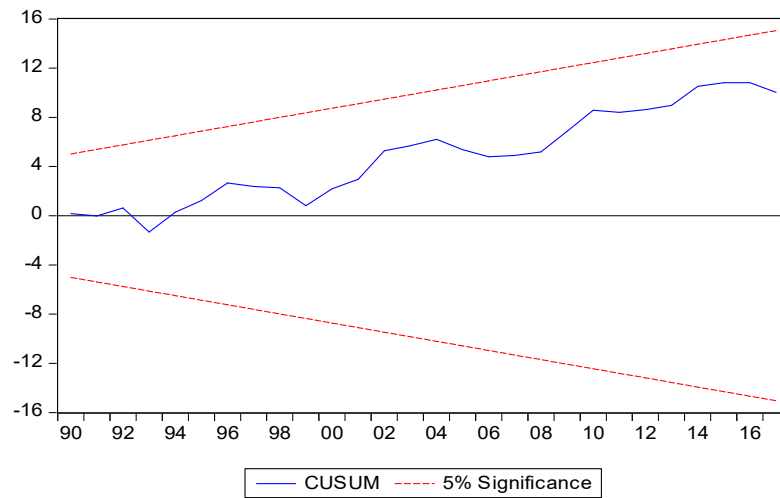


Figure 1: Stability test

Source: Authors' computation (2020).

4.7 Discussion of Empirical Results

The outcome of this study revealed that government expenditure, foreign direct investment and population have positive and significant relation with private consumption while import has negative and significant relation with private consumption in the short run. In the long run, total investment and export have a significant positive relation with private

consumption while import exerts a negative significant effect on private consumption. The empirical results obtained from this study show some interesting empirical regularities and resemblance with previous studies. Specifically, the results here in some aspects support that of previous studies in this subject. Recent empirical studies in this strand of the literature have noted that the government expenditure, foreign direct investment, total investment, export, population and import are important determinant of private consumption in Nigeria. This result is in line with the findings of Ukwueze (2015), Nyambe and Kanyeumbo (2015), and Keho (2019) whose findings revealed that government expenditure, foreign direct investment, total investment, export, population and import played a complimentary role on private consumption.

5. Conclusion

The study investigated the effect of government expenditure on private consumption in Nigeria between 1990 and 2017. Using the autoregressive distributed lag (ARDL), the result of the short run parameters shows that government expenditure, foreign direct investment and population have positive and significant relation with private consumption while import has negative and significant relation with private consumption. In the long run, total investment and export have a significant positive relation with private consumption while import exerts a negative significant effect on private consumption. The study suggests the following policy recommendations: (i) There is a need for efficient and effective policy that will encourage foreign investment to increase government revenue. This supports the Wagner's Law that growth of national income raises the size of the public sector; (ii) Government should embark on the policies that will boost the disposable income of the citizen to promote the welfare of her citizens. Payment of new minimum wages and tax reduction strategies were favourable policies that will have a crowding out effects on the private consumption of average Nigerians; and (iii) Government needs to demonstrate high level of transparency and prudence in the budgetary allocation and execution to ensure an effective management of public funds and prevent leakages as a result of contracts inflation and looting of treasury which are the symptoms of high level of corruption and ineptitude characterizing most developing countries.

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Estimating the Impacts of Population Dynamics on Economic Performance in Nigeria

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Abstract

The study appraised the impact of population dynamics on economic performance in Nigeria within the period 1980-2018. Economic performance measured by real output growth was regressed on three indicators of population dynamics which include birth rate, death rate, and net migration. Using the autoregressive distributed lag approach, the results revealed mixed relationship between population dynamics and economic performance in Nigeria. Exclusively, the findings showed that death rate and net migration influenced economic performance negatively, while birth rate has a direct impact on economic growth. The study suggests the need to regularize the unbridle influx of foreigners into the country in order to reduce pressure on Nigeria's available output. Also, measures should be taken to check the crude death rate of Nigeria as it affects economic growth negatively.

Keywords: Birth rate, death rate, net migration, population, output growth.

JEL Classification: F22, J61, O47, R23.

1. Introduction

The empirical debates on the intertemporal research into growth rate of population determinants have been topical research issues in most of the less developing economies (Atanda, Aminu and Alimi, 2012). Debates on population have not really attracted much concentration and concern in the developing economies. Reasons for this inadequate focus on population related research in the developing nations is partly blamed on the unavailability of favorable environment that enables such task (Pitchford, 2018). However, right from the Malthusian days, population boom have been a thing of serious concern. Malthus in 1798 was the first to raise this concern, stipulating that natural resources become inadequate when population growth exceeds production growth.

In Nigeria, the study of population and its day-to-day interaction within its immediate environment cannot be overemphasized. This is because it gives clear understanding of all situations, both economic, politically, socially, legally among others occurring within the society. Nigeria has an annual population growth rate of 2.8%. The Nigeria's population was also estimated at 193 million by the year 2016. This number is even expected to double in 44 years (National Population Commission, 2016). In the human development aspect (HDI) which is a statistic composite index of life expectancy, education and per capita income indicators. It comprises health, decent living standard and knowledge, which Nigeria ranks 142nd out of 174 countries. In recent times, the Nigerian populations have grown beyond these estimates even though there is yet to be any fresh population census from which we can get the current true population size of the country.

Some of the recent problems and challenges especially food crises, land grabbing, tribal discriminations among others have shown that the nation's resources can no longer cope with its population. This forms a major reason for the current wave of crises all around the country; from the Boko-Haram dominance in the northern part of the country, to the militant struggle for resource control in the South. Studies have attested to the reason that persistent increase in population without a corresponding increase in resources, could result into poor economic performance, which is a major source of the various forms of crisis as it is been experienced today, while some other studies believe that productivity growth without population growth is almost impossible (Galor and Weil, 2016). This is because the human factor as a source of

labour supply is highly necessary to enhance output and general economic prosperity (Drèze and Murthi, 2017).

The negative implication of population growth on a country's economic emancipation is traceable to the Malthusian theory of population. The Malthusian theory (which is an idea that population growth is potentially exponential while the growth of the food supply is linear) posited that any increase in population growth along with the presence of diminishing returns will lead to a decline in output per capita (Payne and Bradley, 2017). More so, any increase in population growth diverts resources from investment in capital to consumption. The increase in consumption lowers the level of savings which also reduces investment spending thereby hampering capital formation and resulting into lower economic growth.

On the other hand, the positive effects of population growth on a country's economic growth arise from the possible economies of scale in production. A greater population results into greater labour force. An improvement in the labour force through training and manpower development enhances results into specialization and division of labour along with the possibility of technological change, all of which increase economic growth (Yujie, 2017). Thus, it is seen that there exists a viable relationship between population growth and economic growth. An increase in population does not necessarily lead into poor economic growth, but a population that keeps increasing without making meaningful productive contribution to the economy could negate economic growth in the long run (Inyang, 2013). In reference to Malthus, natural resources become depleted when the people who depends on its use grows more than the rate of production. Technological development plays a major role in the process of smoothening the population growth and economic growth interrelationship (Peterson, 2017). Even, the Malthusian and the Post-Malthusian regimes are been differentiated by the pace of technological progress in the post Malthusian era (Galor and Weil, 2016). Also, technology have aided the growth of population in different ways, while at the same time aiding the development of resources to cater for this population, but this dual role of technology is not at equal rate.

In exploring the effect of population on economic growth, and in determining whether the interrelationship is positive or negative as it is been done in various studies, it would not be sufficiently determined if

the main components of population were not examined as they contribute or restrict economic growth. Thus, the two major constituents of population are the rates of birth and death, better identified as the fertility and mortality rates; and these two factors have a way of influencing productivity in any economy (Flegg, 2014). Also, the developing economies which seem to be less productive have a high fertility rate when compared with most other developed economies. Hence, they are more densely populated than the developed economies but majorly, lack basic resources to support their population (Flegg, 2018). An instance is the Nigerian fertility rate of 5.8 children per woman while 2.1 children per woman are obtainable in the developed world (Fang, 2018).

Population dynamics are intrinsically linked to patterns of economic and social convergence as well as, more broadly, to territorial cohesion across globe (World Bank, 2015). The relationship between population growth and growth of economic output has been studied extensively. Many analysts believe that economic growth in high-income countries is likely to be relatively slow in coming years in part because population growth in these countries is predicted to slow considerably (Huang and Xie, 2013). Others argue that population growth has been and will continue to be problematic as more people inevitably use more of the finite resources available on earth, thereby reducing long-term potential growth (Payne and Bradley 2017; Yujie, 2017). Population growth affects many phenomena such as the age structure of a country's population, international migration, economic inequality, and the size of a country's work force. These factors both affect and are affected by overall economic growth.

The relationship between population growth and economic growth is controversial. The links between population growth, growth in per capita output, and overall economic growth over the past 200 years were examined and the results revealed that low population growth in high-income countries is likely to create social and economic problems while high population growth in low-income countries may slow their development. International migration could help to adjust these imbalances but is opposed by many. Drawing on economic analyses of inequality, it appears that lower population growth and limited migration may contribute to increased national and global economic inequality. This study therefore investigates the impacts of population dynamics on

the economic performance of the Nigerian economy from 1980 to 2018. Other sections are divided into four parts. Sections two and three present the literature review and methodology correspondingly. The fourth and fifth section presents the analysis and discussion of empirical results, and concluding remarks respectively.

2. Literature Review

Empirical studies of the cross-national relationship between the rates of economic development and population growth may reasonably be interpreted as providing consistently strong evidence of the absence of a negative causal effect of the latter upon the former. The most important positive effects of additional people--improvement of productivity through the contribution of new ideas and the learning-by-doing resulting from increased production volume--appear in the long run and are cumulative. Together with this positive long-term effect, the absence of an observed negative medium-term effect upon economic growth is adduced as sufficient evidence that, in the very long run, more people have a positive net effect.

Chang-Hsing (2011) investigate the empirical modelling of population and employment growth in the United States, relates the empirical equilibrium relationship to the dynamic process of population and employment growth using a lagged adjustment model. The study used a simultaneous system with spatial autocorrelation in its analysis and found that population agglomeration creates a general need for productivity while generating employment in the process.

Chenavaz and Octavio (2015) argued that greater productivity can only be enhanced through the interaction between the ancient and modern population - economic growth relationship in the developed economies. The study based its analysis on the new economic growth theory and found that the Humean-Malthusian view of population-economic growth interaction can be linked to the differing modes of family structure in developed economies as against what is obtainable in the developing economies and this accounts for the differences in incomes and the fertility rate they face.

Fang (2018) discovered using a population projection matrix which as a function of the level of per capita income and gross national product per capita, was found to have contributed five percent growth rate of GNP per year. The author argued that this is sufficient to bring down the rate

of population explosion comparable to the ones obtainable in the developed economies. However, the five percent population increase rate is so large that it might not be accommodated if not regulated within the developing economies.

Frimpong and Adu (2014) noted that population migration is a major tool for promoting economic development not only in developing nations but also in advanced countries of the world. The study, through an empirical examination of the relationship among economic growth, population migration and consumer welfare maximization in China, concluded that migration of human capital, economic growth and consumer welfare maximization together have general positive interaction. The study employed methodology on the human capital theory and also itemized the various ways through which investments can be made in human capital to foster improved productivity and further emphasized the important role human capital plays in fostering economic growth and development.

Inyang (2013) revealed that there are a number of identified consequences of ageing societies and they include the need to sustain public spending on pensions and health care versus the need to reduce budget deficits. Following both economic and social implications of ageing societies, the study therefore recommend promotion of longer working lives through life long training, education and skills updating, and the provision of appropriate working environments for older workers. It further suggests that ensuring private household transfers are integrated into old-age security systems as soon as possible and provide access to education across the life course to ensure that all individuals are prepared physically, mentally, socially to adapt with increasing individual responsibility for old age.

In a similar study, Liao and Qin (2014) found that GDP per capita, illiteracy rates and daily visits to physicians for checks were the core determinants of life expectancy. During the course of examining the effects of population health status on economic growth in Chinese provinces, the study further showed that income and daily visits to physicians are positively linked to life expectancy while the illiteracy rate reduces life expectancy production.

Morudu (2016) investigates the relationship between population and economic growth by aiming at resolving analytical issues bordering on

short and long run phenomena which were found to have established both negative and positive effects between the variables in the short run on one side and insignificant influence of the former on the latter in the long run. It was also revealed that the reverse relations running from economic growth to population growth are weak in both the short and long run, regardless of economic development conditions.

The correlation between savings, economic growth and demographic change was investigated by Pitchford (2018) and the results revealed that a rapidly growing population requires increasing investment to maintain the labour to capital ratio. Therefore, the labor productivity increases. Besides this simple relationship between population growth, savings and economic growth, the increase of human capital, institutional and restructuring problems also play an important role.

Drèze and Murthi (2017) examine the role of demographic factors in explaining the boom in economic growth rates in East Asia during the period 1999-2016. As the authors stress, the realization of the demographic dividend in East Asia was made possible due to effective social, economic and political institutions and policies. In that study they have estimated growth using an econometric model. The World Bank database used for this econometric analysis contains statistics of 78 (Asian and non-Asian) countries, covering the time period from 1999 to 2016. The dependent variable is the growth rate of real GDP per capita in 1965-90 in purchasing power parity.

Atanda, Aminu and Alimi (2012) investigate the comparative trend review of population growth determinants between developing countries (Bangladesh, Ethiopia, Indonesia, Mexico and Nigeria) and developed nations (Germany and United States). The findings from trend analysis showed that fertility rate, crude death rate, birth rate, mortality rate, and life expectancy are the key factor determining rapid population growth rate. Likewise, youth dependency ratio of young people below age 15 has been credited as a leading cause of population growth and growth threat in developing countries. On the other hand, the results revealed that excluding Mexico from the Upper Middle Income group, developed economies (comprising United States and Germany) with large population size have a higher real economic well-being (using the real per GNI capita as a measurement), compared with selected developing economies in the world.

Vasudeva and Okunade (2014) studied the level at which the health of the population can affect their contribution to the general economic performance became a topical issue in recent literature especially in sub-Saharan Africa. With the theoretical model taking its root from the Solow growth model, it was revealed that the population health has not significantly contributed to improvement in economic performance. The study also found that economic growth contributes to life expectancy increase in the sub-Saharan Africa region.

Mesagan, Alimi and Adebisi (2018) investigate the links between population growth, energy consumption and economic growth in Nigeria for the period 1981 to 2015. Using the autoregressive distributed lag (ARDL) model, the finding showed that the country experienced a tremendous increase in population from 1981 till the present time periods and population growth and energy consumption have a direct and significant impact on real income growth. Also, oil price has positive and stable effects on the real gross domestic product in Nigeria under studied.

Bezruchka (2019) noted that the rate of growth in population was found to have outpaced that of food production in Nigeria through an empirical interaction among population, environment and food provision of the most populous country in Africa. The author thereafter expressed concern over the low food production rate, and recommended proper land management to provide more arable and settlement re-organization to help prevent environmental degradation, as well as planting exotic crops to boost food production for the Nigerian populace.

The reviewed literature showed that most of the past studies on population and economic growth were focused on population dividend, population and technology among several other areas focusing more on the developed and a conglomeration of developing economies. The role of human capital accumulation necessitated by the impact of fertility and mortality rates as well as net migration on economic growth has not been given adequate attention in Development Economics literature, especially in Nigeria. Also, studies have expressed divergent views on the impact of various aspects of population on economic growth. While some emphasized a strong negative relationship (Tung, 2014; Winegarden, 2018 etc.), some emphasized the positive interaction (Prettner, 2013; Wanjun, Kinugasa, and Hamori, 2013 among others), while others are

neutral (Galor and Weil, 2016; Lee, 2019 etc.). Thus, further research into this relationship is therefore of immense importance.

3. Methodology

3.1 Theoretical Modeling

The theoretical model of this study is premised on the endogenous growth model of the neoclassical school of thought. In neoclassical growth models, the economy is assumed to reach a steady state in which all macroeconomic variables grow at the same rate and in the absence of technological progress, per capita growth of these macroeconomic variables will eventually cease. The neoclassical prepositions resemble the philosophical theories found in Ricardo and Malthus. The basic underlying assumption of neoclassical philosophy is that there are diminishing returns to capital in the production process (Blanchet, 1988). During the mid-1980s a new growth theory was launched by Paul Romer in 1986, where the scholar explains the growth process in a different manner. Thus the dissatisfaction with neoclassical models motivated the construction of new growth theories where the key determinations are endogenous in the model; long run growth is not determined by exogenous factors but by endogenous factors in such models (Agarwal, 2017).

The simplest version of an endogenous model is the AK model which assumes constant exogenous saving rate and fixed level of technology. The stickiest assumption of this model is that the production function does not include diminishing returns to capital. This assumption means the model can lead to endogenous growth. The AK model production function is a special case of a Cobb–Douglas function with constant returns to scale.

$$Y = AK^{\alpha-1}L^{\alpha} \quad (1)$$

This equation shows a Cobb–Douglas function where Y represents the total production in an economy, A represents total factor productivity, K is capital, L is labour, and the parameter measures the output elasticity of capital is α . For the special case in which $\alpha + \beta = 1$, the production function becomes linear in labour and it becomes labour-augmented production function as follows:

$$Y = AL \quad (2)$$

In the above equation Y is the level of output, A is the level of technical progress that can enhance effective labour and L represents labour. Thus, AL represents labour-augmented which is grossly dependent on the dynamics of population determinants in the country (Galor and Weil, 2016). Thus, the above equation is rewritten as:

$$GDP = f (POP) \quad (3)$$

Where, POP stands as population, and GDP represents gross domestic product.

Mathematically, the equation is written as:

$$GDP_t = \alpha_0 + \beta_1 BTR_t + \beta_2 DTR_t + \beta_3 NMIG_t + \varepsilon_t \quad (4)$$

Where, GDP is output level measured by economic growth; BTR is birth rate; DTR is death rate; $NMIG$ is net migration; α is the slope; β_{1-3} represents the coefficients of the variables; and ε is stochastic error term.

3.2 Data Sources, Measurements and Estimation Approaches

The study used an annual time series data sourced from Central Bank of Nigeria statistical bulletin (2018) and World Development Indicator (WDI, 2018). Also, the data covers the period of 1980-2018. Furthermore, this research study employed the Autoregressive Distributed Lag (ARDL) estimator to evaluate the coefficients of the empirical model. Before the parameter estimation, the stationarity level of the variables is tested using the Augmented Dickey Fuller and Phillips Perron tests and the ARDL approach to cointegration test.

4. Analysis and Discussion of Findings

4.1 Descriptive Statistics

The descriptive characteristics of all the variables in the model are presented in Table 1. The results indicated that the mean value of GDP was 1100.45 and the mean values of birth rate, death rate and net migrant are 6.0892, 102.24 and -199339. The results of the standard deviation further revealed that net migration is the most volatile variable among the variables in the model. Also, the descriptive statistics revealed that GDP and BRT are positively skewed while DRT and $NMIG$ are negatively skewed.

Table 1: Descriptive Statistics

Variable	Mean	Std. Dev.	Min.	Max.	Skewness
GDP	1100.5	1085.3	153.65	3221.7	0.9037
BTR	6.0892	0.3047	5.5910	6.6640	0.2393
DTR	102.24	21.644	66.900	126.20	-0.2775
NMIG	-199339	96708.	-300000.	-91407.	-0.0060

Source: Authors' computation (2020).

4.2 Correlation Analysis

Table 2 presents the correlation analysis of the variables in the model. From the table, the birth rate and death rate have negative relationship with GDP while only net migration maintains a positive relationship with GDP. The correlation coefficients of the relationships among the variables are also reported in the table.

Table 2: Correlation Matrix

	GDP	BTR	DTR	NMIG
GDP	1			
BTR	-0.4662	1		
DTR	-0.0291	-0.3373	1	
NMIG	0.0882	0.0642	0.00014	1

Source: Authors' computation (2020).

4.3 Unit Root Tests

The results of unit root tests are reported in Table 3. The study employed two unit root tests in order to have robust analysis. From the results of Augmented Dickey-Fuller (ADF) test, it was revealed that birth rate was stationary at levels and at 1% level of significance while gross domestic product and net migration were stationary at first difference and at 1% level of significance. Also, death rate was equally stationary at first difference but at 10% level of significance. Similarly, the results of Philips-Perron (PP) test showed that gross domestic product, birth rate and net migration were stationary at first difference and at 1% level of significance. Death rate was also stationary at first difference but at 5% level of significance. Since the results revealed that all the variables are stationary either at levels or at first difference but at different levels of

significance, it becomes econometrically reasonable to conduct the co-integration test.

Table 3: Unit Root Test Results

Variables	Augmented Dickey-Fuller (ADF) Test			Philips-Perron (PP) Test		
	Level	1st Difference	Status	Level	1st Difference	Status
GDP	0.847077	-5.593236*	I(1)	0.780021	-5.607499*	I(1)
BTR	-3.168513*	-0.248508	I(0)	-1.995930	-5.533858*	I(1)
DTR	-0.241762	-1.691480***	I(1)	-2.303125	-2.541952**	I(1)
NMIG	2.025809	-4.358029*	I(1)	1.612119	-4.289108*	I(1)
Critical values	Level	1st Difference	Critical values	Level	1st Difference	
1%	-2.628961	-2.630762	1%	-2.627238	-2.628961	
5%	-1.950117	-1.950394	5%	-1.949856	-1.950117	
10%	-1.611339	-1.611202	10%	-1.611469	-1.611339	

Note: *, ** and *** represent significance at 1%, 5% and 10% respectively.

ADF: automatic maximum lag length is based on Akaike Information Criterion (AIC)

PP: automatic maximum lag length is based on Newey-West Bandwidth

Source: Authors' computation (2020).

4.4 Bounds Test

The bound test reports the cointegration test results (see Table 4) of population growth indices and economic growth in Nigeria. The result of ARDL bounds test revealed that F-test is 3.0187. The value of the estimated F-statistic of the model is greater than the upper bound critical values at 5% level of significance. It is apparent from the results that there exists a long-run relationship among the variables. This implies that the series are related and can be combined in a linear fashion, even if there are shocks in the short-run, which may affect the movement in the individual series, they would converge with time (in the long-run). Therefore, both the long-run and short-run models were estimated.

Table 4: Bounds Test for Co-integration

F- Statistics	5.018716	
Number of independent variables – k	3	
Critical values	Lower bound	Upper bound
10%	2.72	3.77
5%	3.23	4.35
2.5%	3.69	4.89
1%	4.29	5.61

Source: Authors' computation (2020).

4.5 Short-run and Long-run Estimates of Population Indices and Economic Growth

The short-run estimates of the relationship between population growth and economic growth are presented in Table 5. The short-run analysis revealed that the coefficient of the birth rate is positive, which implies that it contributed positively to the economic growth in Nigeria. However, death rate and net migration rate have a negative and significant impact on economic growth.

Table 5: Short-run Estimates

Dependent Variable: $\Delta(\text{GDP})$				
Method: Autoregressive Distributed Lags (ARDL)				
Variables	Coefficient	Std. Error	t-Statistics	Prob.
$\Delta(\text{BTR})$	43.1283	20.2880	2.1258	0.0281
$\Delta(\text{DTR})$	-24.5710	12.0223	-2.0438	0.0305
$\Delta(\text{NMIG})$	-0.00610	0.00351	-1.7429	0.0927
ECT(-1)	-0.31271	0.17720	-1.7647	0.0889

Source: Authors' computation (2020).

The sign of lagged error correction term is negative and statistically significant at 10% level. Also, the value of ECT coefficient is -0.3127 which signifies the extent to which any disequilibrium in the lagged error

correction term affects any resulting adjustment in the level of economic output. It is the feedback or adjustment effect which shows that 31.3% of the disequilibrium converges back to the long-term equilibrium.

Table 6: Long-run Estimates

Dependent Variable: GDP				
Method: Autoregressive Distributed Lags (ARDL)				
Variables	Coefficient	Std. Error	t-Statistics	Prob.
BTR	13.7917	5.15635	2.6747	0.0044
DTR	-78.5751	33.9403	-2.3151	0.0284
NMIG	-0.00195	0.00064	-3.0469	0.0007
C	1327.46	9134.67	0.1453	0.8039

Source: Authors' computation (2020).

The results of the long-run analysis are similar to the short-run analysis in Table 6. Following the results in the table, the coefficient of birth rate was found to be positive while the parameters of death rate and net migration were negative. In magnitude terms, the results showed that a unit increase in death rate and net migration in the economy results in 78.57% and 0.002% decrease in economic growth. The implication of this is that a continuous influx of people in the country which is expected to enhance the level of human capital in the economy put more pressure on the level of aggregate output. This is line with the findings of the study that the pressure on food supplies, resources, employment opportunities, and social services necessitated by population explosion (as result of rise in the number of immigrants) continued to further aggravate the fragile socio-economic structure and promote additional political instability in the region. However, the results showed that a unit increase in birth rate in the economy leads to 13.79% increase in economic growth.

5. Conclusion

The study examines the relationship between population indices and economic performance in Nigeria between 1980 and 2018. Using the autoregressive distributed lag (ARDL) technique, the results revealed mixed relationship between population determinants and economic

growth in Nigeria. The results revealed that death rate and net migration have negative coefficients while birth rate reported positive parameters. The finding found that death rate and net migration influenced economic growth negatively, whereas birth rate has a direct impact on economic growth. The result conform with the findings of Atanda, Aminu and Alimi (2012) that birth rate, death rate and net migration are major determinants of economic growth in developing economies. Based on the findings emanated from this study, there is need to regularize the unbridle influx of foreigners into the country in order to reduce pressure on Nigeria's available output. More so, measures should be taken to check the crude death rate of Nigeria as it affects economic growth negatively.

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Workforce Employability and Skill Development for the Fourth Industrial Revolution

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Abstract

The beginning of the twenty-first century represents the beginning of the Fourth Industrial Revolution, which, unlike its predecessors, is characterized by a fusion of technologies that is blurring the lines between the physical, digital and biological spheres. These characteristics have generated many changes in the way work is performed. In order to meet these challenges, employees must increase their flexibility in the way they perceive work time, wages, tasks, workspace and so on. And, in an era of technology and digitalization, employees must keep their skills and knowledge, related to new technology, up to date. Several other aspects related to employability will be discussed in this article.

Keywords: Fourth Industrial Revolution, flexibility, digitalization, employability, workforce.

JEL Classification: J24, L51, N37, O15, O32.

1. Introduction

The world of work has started to witness significant difference in operations of workplace. It is therefore, pertinent for government and the private sector to understand the major shifts occurring as a result of the exponential pace of change that is disrupting every industry in every country (and) impacting every aspect of how we work and live, leading to threats and opportunities (Morgan, 2016). As a result of these, government, industry bodies and other policy makers must rethink the skills strategies that are failing to prepare the current and future workforce for the Fourth Industrial Revolution (4IR).

Since these disruptions will not affect all industries and occupations to the same extent or at the same pace, ignoring the impact of the Fourth Industrial Revolution (4IR) is as short-sighted as believing five years ago that the internet and electronic communication would have little impact on our work and lives.

In recent times the industries are changing radically, more people are working virtually in multiple locations and job loss in many establishments is increasing as a result of numerous influences. In some instance, job loss is blamed on trade imbalances, and assumed causes are said to be due to recent recession, technology, or globalization. Of in fact, the new technologies are now changing how we work and whom we work with in a changing global workplace as well as specific job tasks to be performed. It should not be a surprise if the knowledge, skills and abilities required by employers during the Fourth Industrial Revolution are different compared to the knowledge, skills and abilities required by the other three industrial revolution periods. It is believed that many jobs in the near future will be delegated to artificial intelligence (AI) or become automated (Frey & Osborne, 2017). As a consequence to the changes that are expected, it is estimated that about 35% of today's children, when adults, will have job types that exist today; the rest will have job types that do not yet exist (World Economic Forum, 2016). In the context of the Fourth Industrial Revolution, dominated by massive changes in the way people work (World Economic Forum, 2018).

The major features of the Fourth Industrial Revolution are embodied in accelerating digitalization, artificial intelligence (AI), cloud computing, robotics, and 3D printing with definite implications for education, employment, and the future of work. This will influence to a large extent,

the skills that are needed in the labour market. All over the world, demand is moving toward adaptable social, behavioral, and non-repetitive cognitive skills, and away from routine tasks and narrow skills tied to specific jobs. For instance in Africa, demand for software engineers, marketing specialists, writers, and financial advisers is rising, whereas demand for mechanical technicians, administrative assistants, and accountants is falling (Hanan Morsy, 2020).

This revolution is fully with us now, while companies and corporate leaders are busy adjusting to the new reality, is the education sector doing enough to prepare students to step into a new world where robotics, automation and big data analytics are transforming how we live and work?

In order to meet the demands of future workforce, students must be equipped with 21st century skills that would help them thrive in the future of work. Many have argued that education has been slow to adapt to rapid technological advancements, which mean that students are ill-prepared for the world they will soon inherit. Skills, such as, critical thinking, problem solving and creativity are important, but many of the current education systems do not properly take care of these skills. So, it becomes pertinent to ask the question “what can educators and schools do to prepare students for the Fourth Industrial Revolution (4IR)?”

The aim of this paper therefore, is to raise awareness of the Fourth Industrial Revolution and the skills requirements to prepare the workforce for the changes that we are to experience in the next ten years. The paper is structured into five sections. Section one introduces the paper and the second section examines the transition of industrial revolution from the first to fourth one. While section three discusses the drivers of the fourth industrial revolution, section four looks at the requirements for employability and skill development. The last section discusses the ways forward for workforce in Nigeria in particular and Africa at large.

2. Industrial Revolutions in Historical Perspective

The history of technology is particularly broad and is concerned with the process of invention, construction and use of objects, as well as the exploration of the social, economic, political and ethical implications of

the application of technology in our lives. Technology is seen as an application of scientific knowledge and a prerequisite of science. Technology as in use today did not emanate until the end of the 18th century. The technology on ground then was one embodied in the technique, a set of arts and skills which was transmitted by the craftsman to the apprentice.

2.1 First Industrial Revolution (Late 18th – Early 19th Century)

The end of the 18th century is linked to the First Industrial Revolution. The term First Industrial Revolution was originally used to describe what happened in England from 1760 to 1830. The First Industrial Revolution covers the period between 1780 and 1840 (Hobsbawm, 1999). Some of the key factors that led to the inroad of this revolution were immigration and demographic profiles. The basic technological dimensions of this revolution were:

- the mechanization of fabric production and the subsequent development of the textile industry;
- the development of the steel industry; and
- the great incursion into transportation through the creation of steam engine.

There was a new power source, steam, an element that points to the wider dimensions of the industrial revolution. The first industrial revolution was linked to the development of the capitalist system and to changes in social, economic and cultural structures within the society. This also manifested in the significant change in the nature of human resources required in the world of work. People are starting to move away from the farm to the industry. In this new workplace, workers need to work on a strict and guided schedule. The tasks performed were usually monotonous and require high level of discipline and education. The First Industrial Revolution used water and steam power as its mechanical devise for production.

2.2 Second Industrial Revolution (Late 19th – Mid 20th Century)

The Second Industrial Revolution covers the period between 1850 and 1914 and this is linked to the demographic development in western countries, urbanization and technological advances in communications. The urbanization is characterized by construction of railroads, creation of

new cities, and industrial centers, growth in the populations of the harbours, and the introduction of internal-combustion engines (cars, buses, and trucks). Forms of energy increasingly used were electricity, gas and oil. New ideologies emerged called Marxism, when workers came together to protest against employers demanding for better working conditions (Gaganakis, 1999). During the Second Industrial Revolution, electric power was used to create mass production.

2.3 Third Industrial Revolution (Mid 20th – Early 21st Century)

The Third Industrial Revolution took off in the second half of the 20th century and it led to the development of technology and renewable energy sources, improved communication and increased productivity. The predominant form of energy during this period is nuclear, and the major development are in the areas of electrical appliances and computers. During this period the development and dissemination of digital skills became important issues in many national and international policies on education and training of human resources. Workers started to see the need for more specialised knowledge, which increases their opportunities for information, communication and dialogue (OECD, 2015; Zinnbauer, 2007). However, despite the fact that 3,2 billion people worldwide use the internet, only 7% of households in the less developed countries have access to the Internet (International Telecommunication Union, 2015).

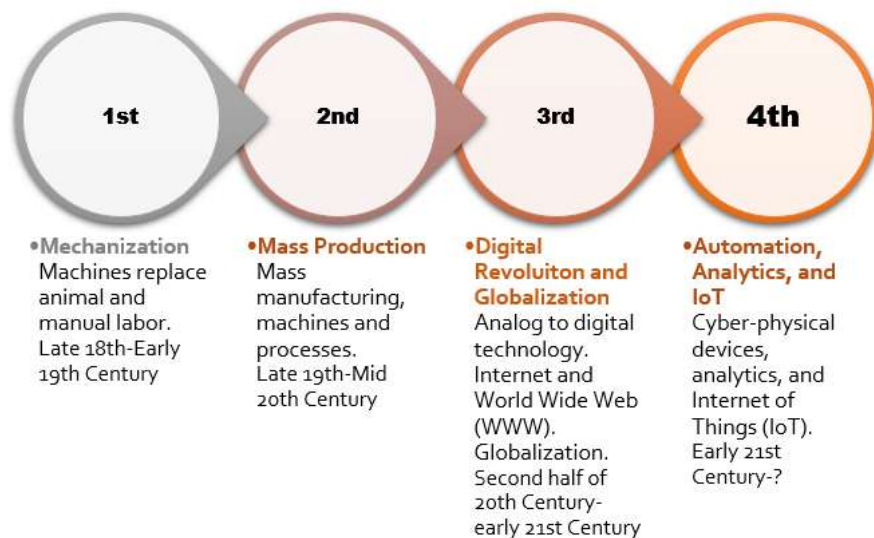
The Third Industrial Revolution (also referred to as digital revolution) used electronics and information technology to automate production.

2.4 Fourth Industrial Revolution (As from Early 21st Century)

The Fourth Industrial Revolution (4IR) takes off from the technological and digital developments of the third industrial revolution which has caused rapid changes in administration, management, governance and production systems . During this dispensation, many people are exposed to the use of mobile phones, processing power, storage capacity, access to knowledge. It came with robotics, the Internet of Things, autonomous vehicles, artificial intelligence, 3-D printing, biotechnology, energy storage, nanotechnology. In addition, transport and communication costs will drop, new ecosystems, such as Environmental Informatics will develop, citizens will be empowered by using technology. It is admitted that 4IR will have great impact on business, government and people.

According to Klaus Schwab (2015), new ways of serving existing needs will be created. Well- established incumbents will be ousted by innovative competitors who have access to global digital platforms for research, development, marketing, sales, and distribution. Besides, major shifts will also occur, as growing transparency, consumer engagement, and new patterns of consumer behavior force companies to adapt the way they design, market, and deliver products and services. Physical products and services will be enhanced with digital capabilities. The citizens will have the opportunity to engage with public authorities more directly, as they will voice their opinions, coordinate their efforts and even supervise governments. While governments will increase their control over populations, their central role of conducting policy will diminish because of redistribution and decentralization of power. Governments' survival will depend on the levels of transparency, effectiveness and efficiency they present. Regarding the impact on people, it is regarded that the fourth industrial revolution will change not only what we do but also who we are. There will be significant changes regarding identity, privacy, ownership, work hours, leisure time, relationships, skills, consumption patterns, values, beliefs, moral and ethical boundaries (World Economic Forum, 2016).

Figure 1: The 4 Industrial Revolutions



Source: Adapted from Pat. Shank (2016).

3. Technological Drivers of Fourth Industrial Revolution

The developments of digital, physical, and biological technologies are three fundamental technological drivers of the Fourth Industrial Revolution driven by new breakthroughs in these three areas and with a great fusion with each other. These three technological drivers can be summarized in Table 1. While the major technological drivers for the Third Industrial Revolutions came from the hardware field, technological drivers for the Fourth Industrial Revolution mainly originate from the software field.

3.1 Digital Technology

Digital technology is the fundamental driving force for the Fourth Industrial Revolution and the innovations and advances coming up are made possible through digital power (Schwab, 2016). This technology cluster is making the whole world a digitally connected one. Digital technology is mainly manifested in four fields of the Internet of Things, artificial intelligence and machine learning, big data and cloud computing, and digital platforms. The basic idea of the Internet of Things (IoT) is to make pervasive presence of things around us communicate with each other to achieve common goals. The major features of Internet of Things are the integration of various identifications and tracking technologies, such as wired and wireless sensors and actuator networks, enhanced communication protocols, and distributed intelligence for smart objects (Atzori *et al.*, 2010). The Internet of Things technology can identify, locate, track as well as monitor subjects; it can even trigger the corresponding event autonomously and in real-time (Sarma and Girão, 2009). Now the products of Internet of Things play an increasingly important role in smartphones, traffic logistics, environmental protection, public security, intelligent fire control, industrial monitoring, personal health and other fields. Accompanying the advances of calculation speed, the expansion of storage capacity and the progress of network technology, artificial intelligence (AI) has developed tremendously. AI is a technology that has been used to simulate the thinking and behaving process such as studying, reasoning, thinking and planning of human beings (Pfeifer and Scheier, 2001). To enable the computer to achieve high-level application, it manufactures intelligent machines or systems that are similar with the human brain. This technology starts in the 1990s, but not until recently does it gain rapid progress. Machine learning is one of the most active niche within the AI

field. Machine learning provides the computer with the ability to find hidden insights without exactly being programmed beforehand. Using algorithms that can iteratively learn from existing data, machine learning enables computers to adapt and make reliable, repeatable decisions when exposed to new data. Nowadays, machine learning has been widely applied to text-based sentiment analysis, biometric identification, security market analysis and image recognition, etc. Big data and cloud computing is the third aspect of digital technology. With the development of sensors, the improvement of storage capacity, and the progress of machine learning, the volume of data is soaring. The most widespread definition of big data is the '4V' theory: big data comes from a variety of resources and contains a great volume of data; that big data streams in at a high rate and must be handled timely implies its velocity; big data comes in a variety of formats; big data has to be cleaned to ensure the veracity (Fernández et al., 2014). While big data analysis may entail a huge commitment of hardware using the old hardware storage method, the emergence of cloud computing offers a promise to make it small (Purcell, 2014). Except for big data analysis, cloud computing can also allow leasing of IT capabilities, whether they are infrastructure, platform, or software applications, to provide subscription-oriented services in a pay-as-you-go model (Buyya and Sukumar, 2011). Except for the aspects discussed above, a significant innovation enabled by the network effects of digitization is the platform. On a global scale, technology-enabled platforms make what is now called the on-demand economy (referred by some as the sharing economy) possible. Digital platforms have dramatically reduced the transaction and friction costs incurred when individuals or organizations share the use of an asset or provide a service. These platforms, which are easy to use on a smartphone, convene people, assets, and data, creating entirely new ways of consuming goods and services. As is known to all, Uber, the world's largest taxi company, owns no vehicles; Facebook, the world's most popular media owner, creates no content; Alibaba, the most valuable retailer, has no inventory. These platforms are rapidly multiplying to offer new services ranging from laundry to shopping, from chores to parking, from home-stays to long-distance rides. These platforms work as information brokers to match supply and demand in a very accessible (low cost) way, provide consumers with diverse goods, and allow both parties to interact and give feedback.

3.2 Physical Technology

Physical technology, which has visible achievements, rapid applications, and broad prospects, is probably the best-known technology drivers of the Fourth Industrial Revolution, since it has the most direct impacts on daily lives. There are two primary physical manifestations: autonomous vehicles and 3D printing. The invention of autonomous (also called self-driving, driverless, or robotic) vehicles make it possible for cars to operate without manual manipulations. It uses traditional vehicle production techniques along with advanced sensors, adaptive cruise control, active steering, brake by wire, GPS navigation, lasers and radar. AVs have the potential to fundamentally alter transportation systems by averting deadly crashes, providing critical mobility to the elderly and disabled, increasing road capacity, saving fuel, and lowering emissions (Fagnant and Kockelman, 2015). Also, autonomous vehicles, as one of the most innovating fields in industry production, will lead to economic growth. According to estimation, Economic benefits brought by autonomous vehicles will accelerate over time to over $\pounds 51 \times 10^9$ in 2030 in UK (KPMG, 2015). 3D printing, or additive manufacturing, is a technology that creates a physical object into a three-dimensional shape by printing layer upon layer from a digital 3D drawing or model, while the existing subtractive manufacturing technology produces a desired shape by removing layer by layer from a piece of material. The realization of 3D printing starts with a 3D model, which is a virtual design of the object that you want to make. 3D technology encourages innovations with an unprecedented design freedom. There is no need for any specific machines for manufacturing, which avoids extra costs and leads times (3D Printing Industry, 2014). For the moment, applications are confined mainly in the auto motive, aerospace and medical industries. However, it is stretching to more fields like arts, sculptures, design and architecture. One interesting example is 3D printing food, like chocolate and sugar. Now people are even experimenting on 3D printing of meat at the cellular protein level (3D Printing Industry, 2014).

3.3 Biological Technology

Major breakthroughs in the field of biological technological advancement of the Fourth Industrial Revolution are found in the areas of genetic technology and neurotechnologies. Genetic study is one of the vital branches of biological research that has brought, considerable progress in reducing the cost, increasing the ease and efficiency in genetic

sequencing, activating and editing. It took more than ten years, at a cost of 2.7×10^9 USD to complete the Human Genome Project. Today, a genome can be sequenced in a few hours with less than 1000 USD (Ho, 2000). On the treatment side, IBM's Watson supercomputer system can make personalized treatment plans for cancer patients by comparing the past data of patients, treatments and genetic information with update medical knowledge in just a few minutes. Also, progress in genetic engineering helps people obtain higher agricultural yields through enhancing the robustness, effectiveness and productiveness of crop breeding.

Neurotechnology can help us monitor brain activity and look at how the brain changes and interacts with the outside world. The goal of neurotechnology is to confer the performance edge of animal systems on robotic machines (Ayers et al., 2002). It is estimated that by 2008, the neurotechnology industry would have reached a value over 144×10^9 USD (MaRS Advisory Services, 2009). With the efforts of research institutions and the combination of information and artificial intelligence technology, applications in brain sciences have been increased gradually. There are more and more neuroimaging and neurostimulation devices coming into the market; though in its relative infancy, neurotechnology is enhancing education, communication, intelligence, cognitive ability, disease treatments, and the military (Potomac Institute, 2014). For individual users, neurotechnology application can now help paralyzed people control prosthetic limbs or wheelchairs 'with their minds' (Hochberg et al., 2012). Neurofeedback, the technology to monitor brain activity in real time, offers countless opportunities to help fight addictions, regulate food behavior, and improve performances ranging from sports to the classroom. As for medical treatment, being able to collect, process, store and compare large amounts of brain activity-related data allow us to improve diagnosis and treatment efficiency of brain disorders and mental health-related issues. In addition, the next generation of computers, whose design has been triggered by brain science, are able to reason, predict and react just like the human cortex.

Table 1: Technological drivers for the Fourth Industrial Revolution

Technology drivers	Fields
Digital Technology	Internet of things (IOT) Artificial intelligence and machine learning Big data and cloud computing Digital platform
Physical Technology	Autonomous Cars 3D printing
Biological Technology	Genetic Engineering Neurotechnology

Source: Compiled by the Author (2020).

4. Employability during Fourth Industrial Revolution

It is found from the preceding section that the fourth industrial revolution has brought in new ways of doing things. Hence, the rearrangement of jobs, occupations and careers will require a rethinking of the types of skills needed in this rapidly changing work environment. Consequent to these changes, the following skills will be required for the workforce during fourth industrial revolution globally.

4.1 Workforce Readiness

The basic set of skills needed to get into the workforce and be successful, are in the areas of attendance, time management and personal presentation. These skills are Literacy, numeracy, digital literacy, resume/CV writing, self-presentation, time management, professionalism, etiquette, social norms.

4.2 Soft Skills

These are skills embodied in the abilities to interact, communicate and collaborate with a range of people - including colleagues, customers and management. As humans increasingly work alongside robots, uniquely human skills such as creativity, complex problem-solving, emotional intelligence and critical thinking will be irreplaceable by machines. The skills include Communication, critical thinking, creative thinking, collaboration, adaptability, initiative, leadership, social emotional learning, teamwork, self-confidence, empathy, growth mindset, cultural awareness.

4.3 Technical Skills

These are the knowledge and capabilities to perform tasks specific to a job. New employment opportunities are being created through technology, so jobs often require industry-specific technical skills and targeted training. Skills in this category include computer programming, coding, project management, financial management, mechanical functions, scientific tasks, technology-based skills, and other job-specific skills such as nursing, farming, legal etc.

4.4. Entrepreneurship

This is the knowledge and abilities to create and build a work opportunity or idea which include setting up a business, starting freelance work or developing as a self-starter within a work environment. As the gig economy grows, young people's ability to be innovative, creative and take initiative to launch new ventures will serve them well in the fourth industrial revolution. These skills will include Initiative, innovation, creativity, industriousness, resourcefulness, resilience, ingenuity, curiosity, optimism, risk-taking, courage, business acumen, business execution.

4.5 Preparing the Workforce for the New World of Work

The governments, employers and educational institutions must make their workforce skills to be adaptable to the demands of new world of work. This will equip the workforce to be relevant and productive in the fourth industrial revolution. In preparing the workforce for the new world of work, the following issues need to be well addressed:

- The need to know the jobs that will be required in each industry in 2020 to 2030 and those that will disappear or altered;
- The full-time and temporary workers the organisations will need in 2020 and beyond and the range of skills they should have;
- We should know how to prepare the workforce for productive partnerships with machines;
- We must understand the assumptions about work, jobs and skills development that are likely to prevent us from preparing the workforce for the workplace and that will be disrupted by new technology;

- The need to reconceptualise training for occupations if many occupations will disappear or changed by the time students will graduate;
- There will be the need to prepare the workforce for multiple career changes that cut across occupational boundaries;
- We should know how to equip people with the skills they will need to use technology that hasn't even been conceptualised now; and
- We need to know what to do differently to create more entrepreneurs for a world of declining formal employment.

5. Road to Employability

According to The Institute for the Future (2011) the need for workers of the future to be adaptable, lifelong learners and be successful in the next decade, individuals will need to demonstrate foresight in navigating the shifting landscape of organizational forms and skill requirements. They will increasingly be called upon to continually reassess the skills they need, and quickly put together the right resources to develop and update these.

In the words of Josh Bersin (in Deloitte: 68-69) people should be prepared and guided throughout their working lives and cycle through career stages many times. We should think about our careers as series of waves from post-education to pre-retirement, in which we continuously reinvent ourselves.

Therefore, for Nigeria to fully reap the benefits of Fourth Industrial Revolution there must be a future agenda to promote digital transformation as well as address policies relating to Education, Entrepreneurship, E-commerce and infrastructure. It must adopt national strategies for education and skills development, focusing not only on youth but also on adult workers, dropouts, informal-economy workers, and those from economically and socially disadvantaged groups.

According to AfDB research findings close to half of employed African youth consider their skills to be mismatched to their jobs, and that two-thirds are either over- or under-educated, leading to depressed wages and job satisfaction (Hanan Morsy, 2020). It is by tackling these skills and

education mismatches that African countries and Nigeria in particular can build an adaptable and flexible workforce that will be ready for the Fourth Industrial Revolution. This will require a new educational philosophy that places importance on soft skills as well as investing in basic and digital infrastructure.

5.1 Education

To reduce dropout rates, attendance incentives and access to schools in remote areas must be enhanced, and junior secondary school, at a minimum, should be made mandatory.

Demand-driven education must be pursued to reduce labour market mismatches and make education more attractive to students and more relevant to employers

New dynamic information systems should be adopted to track current and future labor-market needs in the economy. It will make it easier for youth to learn about job openings, apply for jobs, and meet their skill requirements.

An overhauled education system that would translate into increased productivity and output for the continent as a whole should be adopted.

The key to unlocking Nigeria's potential is a better educated and more highly-skilled workforce. This requires systemic changes from kindergarten onwards. The essential ingredients include

- greater access to early childhood education;
- an emphasis on ICT skills and critical thinking from primary level onwards;
- much higher participation in STEM;
- much higher participation in upgraded technical and vocational education and training (TVET);
- investing in well-paid teachers trained to work with modified curricula to prepare students for the new world of work; and
- Teachers need training to provide gender-sensitive pedagogy to keep girls in schools.

Nigeria should continue to work towards the African Union Agenda 2063 target of 70 percent of high-school graduates entering tertiary education, with 70 percent of them graduating in science and technology related subjects (compared with the current SSA average of 8 percent). This means raising the quality of early STEM teaching and the number of teachers, and expanding access to cost-effective online learning where ICT can deliver STEM subjects through virtual laboratories and simulations, instead of resource intensive, on-site labs (Hanan Morsy, 2020).

5.2 Technical, Vocational Education and Training

TVET reform is also critically important, not as a standalone, but as part of a wider economic strategy that focuses on priority sectors and needs, with clear implementation plans that include monitoring and evaluation. Efforts should be made to improve TVET in Nigeria and Africa in general in terms of modern facilities, better pedagogical skills and more practical experience among TVET trainers. Private sector engagement in designing and delivering TVET is crucial for quality and relevance. TVET must be demand-driven and responsive to market situations. Besides industrial attachments and apprenticeships, students need entrepreneurship training and business literacy. Governments are also looking to the private sector to help fund TVET costs through taxes and levies. The goal is to prepare better-educated youth for productive, formal and informal self-employment, especially along the agribusiness value chain.

Nigeria and African nations in general have been advised to attain universal lower secondary education, then, prioritise the quality and relevance of upper secondary and TVET, before gradually expanding uptake to meet labour demand.

There must be total overhauling of the educational curriculum in response to increasing need for technical and Science, Technology, Engineering and Mathematics (STEM) skills required for the jobs of tomorrow.

5.3 STEM Education

STEM (Science, Technology, Engineering and Mathematics) is relevant to nearly every aspect of our lives. Hence, highly skilled workforce is needed in this field to keep up with the world's future requirements. It

is important because the development of economies rely on this field, which is crucial in preparing graduates for STEM-related career. In the article of Hans Vestberg for the World Economic Forum (WEF), as quoted by Study International Staff that “As technology evolves, it is becoming increasingly clear that our education systems are not preparing people for the opportunities that 5G and other Fourth Industrial Revolution breakthroughs will present. Educators, policy-makers, non-profits and the business community need to confront this fact even if it means questioning long-standing practices and trendy assumptions.” He adds that it is important to instill quality STEM skills to meet the needs of our “ever-more-technological society”, and that “our society must significantly improve its STEM education across all income levels and age groups and among both genders” (Study International Staff, 2019).

5.4 Encouragement of Continuous Learning

This tech-driven era calls for continuous learning and upskilling to meet the ever-changing needs of the workforce. Hence, the idea that our formal education should end at 22 or 25 is now outdated. As technology changes rapidly, the need for flexible, responsive schooling and training models become imperative. Students can no longer be complacent with what they were taught or have learned, instead, they must be encouraged by both parents and teachers to continuously upskill themselves through all available resources, such as online courses.

5.5 Promotion of School Makerspaces

Schools need to provide students with a platform to “practice their curiosity, problem-solving skills, inquisitiveness and the iterations of failure, schools need to provide learning environment that will enable students to be creators using a wide variety of physical and digital tools. A makerspace is a place where people work on projects and network. In schools, these facilities help students develop their skills and creativity, inspiring young learners to engage in the STEAM agenda (Science, Technology, Engineering, Mathematics and the Arts). This makerspace will promote and equip the children with the love of learning that will allow them to make sense of their world through hands-on experiences that will come in through emphasis on collaboration and creativity.

5.6 Entrepreneurial Skill

Since Nigerian entrepreneur will no longer compete locally but globally, it should be of uppermost interest of the policy makers to come up with 4IR-compatible policies that will promote entrepreneurial development of technological driven enterprises.

6. Conclusions

Current employees and future employees need to take into consideration that work arrangements are much more diverse and that working in a standardised form may no longer be dominant in the future. Working from home, from other continents, with multiple employers at once, project work, just for a limited time, using online platforms etc. are increasingly common. Employees must also invest in the development of specific skills that will be harder to be replaced by artificial intelligence such as social skills, creative thinking, cross-cultural competencies, etc. In the digital era with hyper connectivity and machine/human interactions, employees need to constantly keep up to date with their knowledge and develop new skills related to using new technology.

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