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Journal of Progressive Research in Social Sciences
Vol 11, 1 - 2021
E-ISSN: 2395-6283

An Empirical Study of the Telecommunication and Economic Growth in Nigeria

Adejumo I. Olabisi.I[1], Bank-Ola R. Folake[2], & Adelakun O. Johnson[3]

[1]Department of Accounting, Lagos State University, Nigeria
[2, 3]Department of Economics, Adeleke University, Ede, Osun State, Nigeria
Corresponding Author: Adelakun.johnson@adelekeuniversity.edu.ng

Received: December 28, 2020; Accepted January 7, 2021; Published: April 3, 2021

Cite This Article:

Johnson, A., Olabisi.I, A., & Folake, B.-O. (2021). An Empirical Study of the Telecommunication and Economic Growth in Nigeria. Journal of Progressive Research in Social Sciences, 11(1), 7-21. Retrieved from http://scitecresearch.com/journals/index.php/jprss/article/view/2008

Abstract.

This study examines the impact of telecommunication on economic growth in Nigeria. The study's model is based on Solow's augmented growth theory where labor, capital and technology are the sole determinants of economic growth. Thus, economic growth is estimated through classical least squares and fully modified ordinary least squares techniques co integration and error correction model. The finding shows that labor employed, capital stock, real investment in telecommunication and electricity supply are statistically significant to economic growth in the short run equilibrium in Nigeria. Therefore, positive economic growth is attainable when efficient and well-coordinated policies are implemented on labor productivity, price management, investment promotion and constant electricity supply. The study used GDP as a proxy of economic growth. Secondary data from NBS, CBN and NCC which were corroborated with data from ITU, WTO and World Bank Development Indicators were used for the analysis. Based on established theories, existing empirical studies and available data, six independent variables (Telecommunications revenue, telecommunications Investments, Teledensity, Agriculture, Unemployment and Electricity consumption) were regressed on the dependent variable (GDP) using Multiple Regression Analysis. The study includes labor employed, capital stock, real investment in telecommunication and electricity supply to be the repressors and real economic growth to be the regress and using a time series data from 1999 – 2018.

Keywords: Economic Growth; Telecommunication; Nigeria, Capital Development and Technology.

Jel Code: D24; J23; J24; L96; O33; O47

1. Introduction

Telecommunication sector in many countries around the world witnessed exponential growth in the last three decades (Oladipo & Wynand, 2020; Leila, 2019; Amavilah, Asongu, Andrés, 2017). Effects of globalization on peace and stability: implications for governance and the knowledge economy of African countries. Shiu and Lam (2008) stated that the cause of the growth could be traced to market liberalization or privatization and advancement in technology. Telecommunications expansion has been observed to have both direct and indirect benefits to economic growth (WDI, 2018; Sajjad, 2017; NCC, 2014; Mohsin, Khan & Malik, 2012). Besides, there are plethora of empirics that explain the causal relationship between growth in the telecommunications sector and economic growth (Snežana, Zoran, & Zorana, 2019; Pradhan, Mallik, & Bagchi, 2018). Argument are that, the development of a modern nation to its full potential cannot be attained without adequate telecommunication infrastructure (Elena, Bogdan, Angela and Sorin, 2018; Tella et al., 2007; Osotimehin et al., 2010), which implies that telecommunication plays significant roles in economic growth and development (Mamoun & Talib, 2017; Ayse, Fatih, Hakan, Cevdet, Sadi, 2016). The world has become a global village with telecommunication being an indispensable tool in the

entire process of globalization. However, it is not in dispute that telecommunications and Information technology (IT) play essential roles in this process. Obviously, the development in this vital sector over the years has been phenomenal all over the world (Sajjad, 2017; Harald and Pantelis, 2011).

More so, Nigeria government considers telecommunications service to be so vital to national interest and economic development that it was placed directly under their control in most countries until fairly recently, when deregulation and competition were introduced (Akinwale, Sanusi, Surujlal, 2018; Mamoun & Talib, 2017; Lee, 2003). These recent advances in telecommunications technology have been an important vehicle in permitting information exchange to develop as a valuable commodity for moving the country into post-industrial and information driven economic growth. Given this development, the perspective on telecommunications development research concentrate on how best to increase and include telecommunication as an essential component of the economic development (Lloyd and Fenio, 2017; Mamoun el al., 2016).

According to World Bank (1995), late starters in the telecommunications, "will risk exclusion from the global economy and face severe comparative disadvantage on their goods and services". Tele-density improved from 0.37% in 1996 to 8.5% in 2004, several towns and cities estimated at 48% of the population and 18% of the land mass have potential access, grown from one player (monopoly) to hundreds of the active players, and exceeded minimum International Telecommunications Union (ITU) recommended teledensity of 1% to 24.18% in 2006 (Lechman, & Marszk, 2015; Sesan, 2007). The number of telephone lines in cell phone (fixed) has been on the increase from 702,000 in 2002 to 1,673,000 in 2006 but dropped steadily to 1,307,000 in 2008. Telephone line in cell phone (mobile) increased from 1,569,000 in 2002 to 62,988,000 in 2008 (Tchamyou, 2017; NCC, 2011). The teledensity rose from 45.93% in 2008 to 63.11% by 2010 which reflects the increase in index of the population to telecommunication devices as a result of increase in investment in the telecommunications sector in Nigeria (ITU, 2011; Ijewere and Gbandi, 2012; Sajjad, 2017). As the telecommunications grow in Nigeria the economy measured GDP grow thereby. This research seeks to measure the impact of the telecommunication sector on the growth of the economy using GDP as a proxy.

The need to expand and improve services provides the rationale for privatizing the telecommunication sector in both developed and developing countries. It has become so painful to policy-makers that an efficient communication sector is vital to a well-functioning modern economy, and that constructing such as system requires capital investment spending on a scale that few governments can either achieve or effectively manage (Leila, 2019; Roeller and Waverman, 2001). When the level of private investment is high, the technological spillover on the entire economy is greater and that leads to a greater effect on economic growth. The World Bank (2003) report of private participation of infrastructure in developing countries demonstrated the role of high telecommunication private investment by stating "in many cases the biggest gains from private provision come through increased investments to meet increasing demands and serve previously unattended consumers". The World Bank report says that the results have been particularly impressive in telecommunication, especially, where competitive regimes have been established (Leila, 2019; Wellenius, 1997; Ranamurti, 1996; Ros, 1999). Nevertheless, Nigerian economy is yet to attain that status to achieve the desired level of economic growth. Capital investments in mobile networks and operations since 2001 have accounted for 80% of total telecommunications foreign capital investments, yet this did not translate into sustainable economic growth in the Nigerian economy (NCC, 2014; WDI, 2018).

Generally, the study examines the impact of telecommunication sector on economic growth in Nigeria. The specific objectives include: determining the contribution of teledensity to economic growth in Nigeria, to ascertain the relationship between telecommunication sector revenue and economic growth, to examine the impact of investment in telecommunication sector on economic growth in Nigeria. This empirical research attempts to use 19years (1999-2018) time series data to investigate the impact of telecommunication and economic growth in Nigeria. The choice of 1999 as the base year is due to the fact that investigate the impact of telecommunication sector on economic growth during the period of Structural Adjustment Programme (SAP) in Nigeria. According figures published by the National Bureau of Statistics, in the first quarter of 2017 showed that telecommunication sector contributed N1.45 trillion to the GDP and in the second quarter, the figure rose to N1.549 trillion (Akinwale, Sanusi, Surujlal, 2018). This particular study seeks to identify the impact of telecommunication on economic growth in Nigeria. This work will be of great importance to the general public, the government and its agencies in the telecommunication sector.

The rest of the paper is structured as follows. Section 2 shows evidence of telecommunication on economic growth in Nigeria. Section 3 describes the research methodology for the study. Section 4 displays the quantitative results, policy implications and illustrates the contributions of telecommunication to economic growth in Nigeria. Section 5 concludes and highlights important recommendation.

2. Literature Review

2.0 Typology of telecommunications

2.1 Telecommunications and the Nigeria Economy

The telecommunications industry is a major direct contributor to Nigeria economic activity. The mobile cellular subscription (per 100 people) in Nigeria increased from 0.03 per 100 people in 2000 to 83 per 100 people in 2016, and mobile cellular subscriptions rose from 30000 subscribers to an outrageous154.3 million subscribers by 2016 (World Bank Development Indicators, 2018). Moreover, the individuals using the internet also increased from 0.06% in 2000 to 25.7% in 2016. The Executive Vice-chairman of NCC, Prof Umar Danbatta, disclosed that investment in the information and communication technology (ICT) sector has reached 70 billion dollars in 2017, and the mobile broadband penetration has increased within the space of one year from less than 10% in 2015 to 21% in 2016, although the target is 30% by year 2018 (Danbatta, 2017), and communications hardware (0.4 percent) categories that are narrower than the broad definition of telecommunications offered above. At 3 percent, telecommunications thus represented more than a third of the total fraction of GDI spent on information technology (IT; 7.9 percent of GDI) in 2003. In fact, the fraction attributable to telecommunications is probably larger relative to that of IT than these figures suggest, given that much of the GDI from IT hardware (particularly semiconductors) could apply to any of several industries (computing, telecommunications, media, and electronics, for example).

Global System for Mobile Communications (GSM) helps the nation in the growth of her economy as it makes available an easy and efficient way of satisfying the communication needs required to promote and enhance trade between Nigeria and her international partners It also plays an important role locally in advocating the several government communication initiatives thereby connecting all the sectors of the nation's economy together so as to attain a mutual aim. Most importantly, it supports investment which promotes employment opportunities in the long haul. At the nation's micro economy, the GSM sector had an incredible contribution of 53% in 2003 to the nation's Gross Domestic Product (GDP). In the year 2015, the GSM Market alongside other parts of the telecommunications sector contributed 1, 645, 82 billion naira to the GDP of the nation in the final quarter of the year, that is, 8.8%.

Ijewere and Gbandi (2012) contended that the first telecommunication facilities in Nigeria were established in 1886. Furthermore, Chieme and Obiora (2014) admitted that between 1960 and 1985 the telecommunication sector consists of the department of Post and Telecommunication (P & T) in charge of the internal network and a limited liability company, the Nigerian External Telecommunication (NET) limited, responsible for the external telecommunication provided the gateway to the outside world. The installed switching capacity at the end of 1985 was about 200,000 lines as against the planned target of about 460,000. All the exchanges were analogue with 1 phone line to 440 inhabitants, well below the target of 1 phone line to 100 inhabitants recommended by the International Telecommunication Union (ITU) for developing countries. Telecommunication is a major driver of any economy and a vehicle for improved economic growth.

According to Ajiboye et al. (2007), the Nigerian telecommunication sector was grossly under-developed before the sector was deregulated under the military regime in 1992 with the establishment of a regulatory body, the Nigerian Communication Commission (NCC). Since then, the NCC has issued various licenses to private telephone operators. These licenses allowed Private Telephone Operators (PTOs) to roll out both fixed wireless telephone lines and analogue mobile phones. The return to democracy in 1999 necessitated the granting of licenses to three GSM service providers: MTN, V-MOBILE and MTEL in 2001. This was followed by the licensing of the Second National Operator (SNO), in 2003; that is, Globalcom and Universal Access Service licenses of 2006 which include fixed telephony, VSAT and internet service providers. Also, in March 2008, the NCC gave license to another GSM operator known as Etisalat (Aigbinode, 2008). Admittedly, the transition to democratic rule in Nigeria on 29th May, 1999 saw the burning need to overhaul the then near-moribund and sole telecommunication sector (NITEL) in Nigeria for rapid national economic development. Therefore, the Federal Government of Nigeria, under the leadership of President Olusegun Obasanjo, thought it wise to deregulate the sector by granting license to GSM service providers and subsequently privatized NITEL with a view to improving socioeconomic life/status of many Nigerians both in the rural and urban areas.

2.2 Reforms in Nigeria Telecommunications Sector

Development of the Nigeria telecommunications sector started in 1999 when the National Telecommunications Policy (NTP, 1999) was approved by the Federal Government of Nigeria. Apart from the five GSM licenses, other licenses were sold to private operators in other segments of the market such as the Code Division Multiple Access (CDMA) and Fixed/Fixed wireless segments. Six CDMA operators and sixteen Fixed/Fixed wireless operators were licensed between 2001 and 2010 (NCC bulletins). However, the combined capacities of the CDMA and Fixed line/Fixed wireless operators is less than 5% of activities in the sector; therefore, GSM operations constituted the bulk of activities in Nigeria telecommunications sector. Invariably, the growth and development witnessed in the sector was achieved majorly through mobile telecommunications related activities.

The ideology of economic growth has had a long history, since the eighteenth century when Adam Smith published his Wealth of Nations, which centers on the pursuit of growth. Economic growth is an increase in the monetary value of goods and services of a country over a given period, as indicated by G.D.P. Early work on economic growth and development highlighted the necessity of adequate infrastructure as a basis for development. Hirschman (1958) recognized the importance of social over-head capital, which he defined as those services without which primary, secondary and tertiary production activities cannot function. The social over-head capital includes all public services from law and order through education and public health to transportation, communications, power and water supply.

2.3 Telecommunication Effect on Economic Growth

Macro Environment and Telecommunications (2004) came up with the six ways in which telecommunication development can influence economic growth: Diffusion of new ideas and knowledge; Reduction of regional infrastructure and development gap; Telecommunication as an input to economic production process; Market efficiency effect; Spill over and externality effect; Coordination of economic activity; Global telecommunication connections; Rural and urban development.

2.4 Theoretical Review

The modern conception of economic growth began with the critique of Mercantilism, especially by the physiocrats and with the Scottish Enlightenment thinkers such as David Hume and Adam Smith, and the foundation of the discipline of modern political economy. Stemming from the Recardian principle of diminishing returns to capital, economies will eventually reach a point at which any increase in capital will no longer create economic growth. This point is called a "steady state". The model also notes that countries can overcome this steady state and continue growing by inventing new technology. Solow (1994) explained three waves of interest in growth theory during the past 50 years, the first was associated with the work of Domar (1947) and Harrod (1948), while the second wave was the development of the neoclassical model (Solow, 1956) and the third began as a reaction to omissions and deficiencies in the neoclassical model. Some of these theories are Classical, Neoclassical, Exogenous and Endogenous growth theories. However, several other variants of these theories have been developed by various researchers' overtime.

De Long and Summers (1991) from their empirical studies on endogenous growth found that machinery and equipment investment has a strong association with GDP growth. That of Röller-Waverman (1997) found an endogenous relationship between telecommunications and growth in a more rigorous economic and econometric context. Romer (1986) argued that the rate of investment and the rate of return on capital may increase rather than decrease with a rise in the capital stock because of the intrinsic extremities. This research work is situated in the endogenous growth theory which believes that government policies can raise a country's growth rate if they lead to more intense competition in markets and help to stimulate products and processes (Riley, 2012).

The Solow (1957) approach of the growth accounting equation can be used to capture the factors that account for the growth in total output. According to Solow's growth accounting concept, the growth rate of total output depends on the growth rate of capital and labour weighted by their shares of income plus the level of technological progress. The equation below (in Cobb-Douglas form) represents total output(Y) as a function of total-factor productivity (A), capital input (K), labor input (L), while α and α-1 represent income shares of capital and labour respectively.

$$\mathbf{Y = A \times K^{\alpha} \times L^{\alpha-1}}$$

The growth accounting equation, as presented in equation above, stated briefly the contribution of growth in inputs and improved productivity to the growth of output. Capital and labour each contribute an amount equal to the share of their income multiplied by their growth rates. The residual in the growth accounting equation, total factor productivity (TFP), is the technological level. Increase in TFP comes from improvement in the method of production which increases the efficiency of factor inputs; hence, more output is produced. Solow found that the growth in output outpaced the weighted average of increase in capital and labour inputs. This difference has often been termed the Solow residual.

Charles Jonscher in his economics dissertation at Harvard University raised the question that if we can measure the microeconomic impact of ICT on firm productivity, we should also be able to link, at the macroeconomic level, the growth in informational occupations and the adoption of technology to improve their productivity. This is what we label first the causality effect depicted in Figure1. According to this causality framework, economic growth leads to increasing complexity in production processes. Complexity in production processes results in the growing fragmentation of value chains and increases functional complexity within firms. The first response to this effect is the specialisation of the workforce and the resulting emergence of workers whose Primary function is the manipulation of information for purposes of organising the production of goods: these are the "information workers

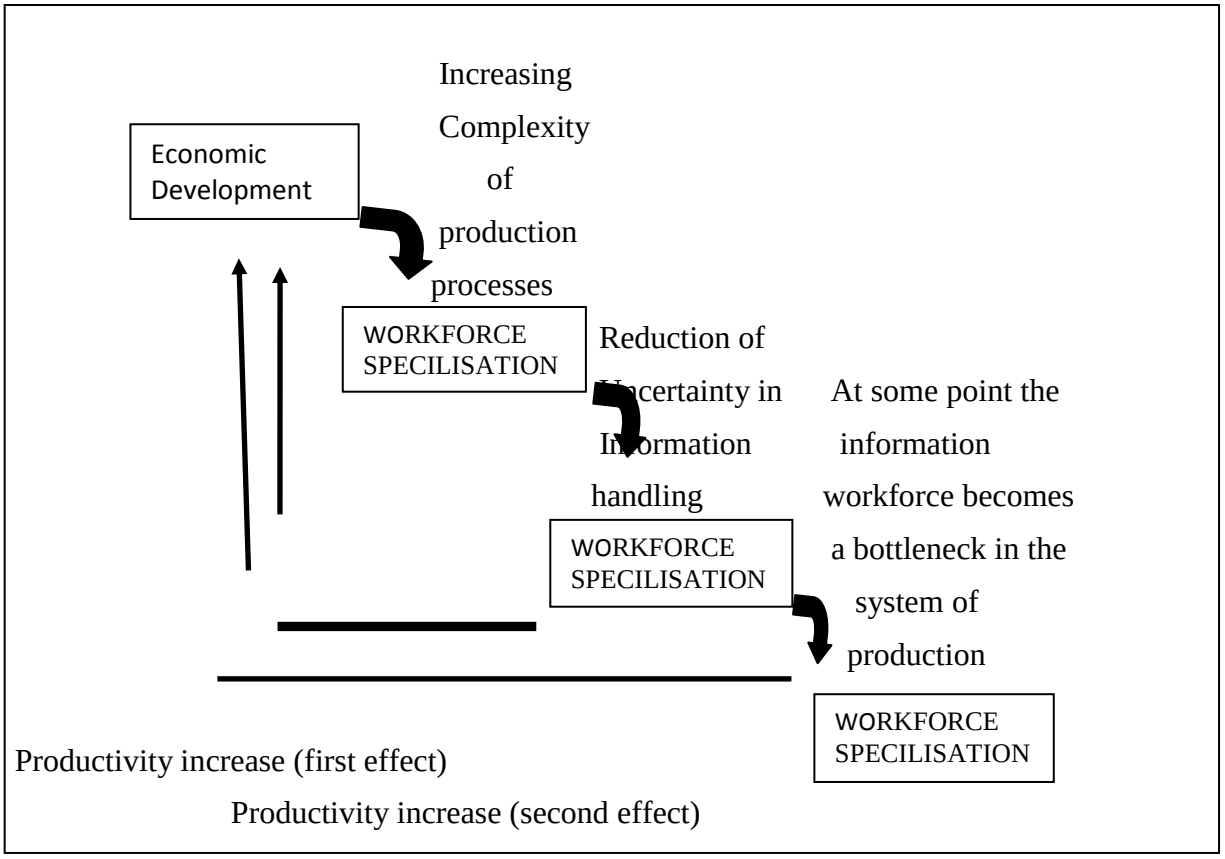


Figure 1: First Causality Model: ICT Innovation and Diffusion is Driven by the Growth of the Information Workforce

This is why economists have found that ICT is directly linked to economic growth. Independently of the issues raised around the direction of causality, every study attempting to link economic growth and ICT has concluded that technology adoption has an impact on economic growth. In particular, ICT has been found to have a direct influence on the economy at four levels including: Improvement of total factor productivity; creation on of enterprises; employment opportunities and Economic growth. According to Jorgenson et al., rising productivity in the later period was driven by a combination of structural and transitory factors (e.g. flexible labour markets). However, this lag could also be explained by another set of firm-related factors. Having studied how technology is adopted by individual firms and how it can actually have an impact on the firm's productivity, management science could contribute to the identification of such factors.

2.5 Empirical Review

Jha and Khaleja (2008) in a study on the perspective of determining the significance of telecommunication on economic development argued that telecommunication has a crucial impact on the development of the economy. In Nigeria, Tella et al. (2007) and Tiruneh, Wamboye, & Sergi, (2017) investigated the simultaneous relationship between telecommunications and economic growth. Their findings revealed that fixed lines and mobile phone penetration have significant effects on economic growth.

In the same vein, Osotimehin et al. (2010) conducted a study on the effects of investment in telecommunication infrastructure on economic growth and found that telecommunication infrastructure measured by teledensity and telecommunications employment is both statistically significant and positively correlated with economic growth (See also Tchamyou, 2017; Salahuddin, & Gow, 2016). But the research conducted by Onakoya (2013) from his study of the impact of economic reform on the telecommunications sector concluded that Telecommunications sector is statistically insignificant to explain GDP growth and the impact of investment in telecommunications was found to be an insignificant predictor of GDP even when the investment was lagged by one year. While that of Oji-Okoro (2010) and Costello, & Donnellan, (2016) on the relationship between FDI and Telecommunications growth in Nigeria shows a negative relationship between FDI and GDP. This was corroborated by the findings of Gold (2008) which shows a negative relationship between teledensity and GDP growth from his aggregate analysis of the impacts of telecommunication infrastructural development on Nigeria economy. By the conduction of Garnger-

Sims causality test with a 50 years' time series data of United State of America, Beil et al. (2005) proved that there is casual relationship between telecommunication investment and economic growth. Based on another extensive study with the data of 105 countries Shiu and Lam (2007) strongly argued that telecommunication development is significantly related to the economic development.

However, Gruber and Koutroumpis (2010) found significant positive effects of mobile telecommunications diffusion on GDP and productivity growth using data from 192 countries for the 1990 to 2007 period. Vu (2013) using econometrics and growth accounting, find that the intensity of ICT use in Singapore has a significant positive link with value-added and economic growth, especially in the manufacturing sector. In the study conducted by Commander, Harrison, and Menezes-Filho (2011), the results showed a positive relationship between ICT capital and the productivity of firms in Brazil and India. According to Cardona et al. (2013), ICT acts as GPT (general purpose technology), which is an enabling technology for further innovations that affect economic growth and productivity beyond the effect of regular capital goods. Bertschek et al. (2015) by means of survey analysis used broadband internet to proxy telecommunication, and the results revealed a positive relationship between broadband internet and economic growth.

William et al. (2011) observed that revenue generated from the telecommunication services has a significant impact on the GDP in the economy of the Ghana. On the other hand, Stiglitz (1998) argued that the revenue of the telecommunication industry has significant influence over the economic growth of the developing countries. From another empirical research Ovum (2006) proved that in India mobile industry has a contribution of 313 billion RS equivalent to 7.8 billion dollars towards the gross domestic product (GDP). By the conduction of a comprehensive study Mcknisey (2007) claimed that telecommunication industry particularly including the mobile operators they have a significant contribution towards the growth of the GDP which is two times larger than any other industry in China. The mobile economy GSMA technology (2015) reported that the telecommunication revenue has a greater variation based on the region to region. In developing markets such as Sub-Saharan Africa, Asia Pacific region the revenue growth is tremendous but the Europe it is slowing down only because of the subscriptions rate. They also reported that the forecasted revenue growth rate will be declined by 3.1 percent per annum until 2020. Based on an empirical study in Egypt, Saudi Arabia and India, Graber & Venkata (2013) and Niebel, (2018) suggested that the revenue of telecommunication industry which generated from providing various services is accountable for two or three percent of total GDP.

Badran et al., (2012) in a study on telecommunication industry and economic growth argued that in many emerging countries telecom industry is the one of most important source of revenue for national treasury. Based on an empirical study in Egypt, Saudi Arabia and India; Graber and Venkata (2013) suggested that the revenue of telecommunication industry which generated from providing various services is accountable for two or three percent of total GDP.

Zhang (2013), Bowles (2012) both of them argued that the presence of internet continuously transforms the economy of Australia as the internet user was increased from 73 percent in 2007 to 87 percent in 2009. In another study based on the internet consumption model Zhang (2013) and Song, (2015). found that internet diffusion has a strong positive correlation with GDP per capita.

World bank (2013) in a study on the teledensity and its impact on the economy, reported that as the world wide teledensity (density of telephone users) is increased by 10 percent, the world wide Gross Domestic Product (GDP) also increased by 6 percent. In a similar study but only based on Young and Earnest (2013) and Bhattacharyya, & Hodler, (2014), study on the teledensity and its impact on the economy strongly emphasized that because of the higher growth of teledensity, the GDP of India had been growing faster than ever.

Literature Gaps

One limitation of the previous works done on this study is the unresolved debate on neoclassical model-theory of economic growth and that improvement in telecommunications infrastructure alone is not sufficient to stimulate GDP growth. Before turning to the data, therefore, let us consider some possible theoretical objections one might lodge against the neoclassical growth model (Zhang, & Li, 2018; Vu, 2017). One might object to the model on the grounds that it does not, in the end, shed light on economic growth. In the steady state of the neoclassical model, all growth is due to advances in technology, but technological progress is taken as exogenous. It seems that the model unravels the mystery of economic growth simply by assuming that there is economic growth. Indeed, this critique helped to motivate the recent theories of endogenous growth. The persuasiveness of this objection to the neoclassical model depends on the purpose of growth theory. If the goal is to explain why standards of living are higher today than a century ago, then the neoclassical model is not very illuminating. A more challenging goal is to explain the variation in economic growth that we observe in Nigeria. For this purpose, the neoclassical model's assumption of constant, exogenous technological change need not be a problem.

Other complementary factors like increased per capital income, low inflation rate, a robust energy sector and adequate security of lives and properties across the country in which telecommunications services plays very vital roles will ensure that the multiplier effects of telecommunications services impact National economic growth positively. Thus, the review of this empirical study suggests that liberalisation of other sectors of Nigeria economy is equally important for a robust economic growth to accrue from the telecommunications sector. GDP measurement also ignores quality of life and it underestimates activities of informal markets. Improved quality of life such as easy access to information, quality education, physical and mental health etc. It is also observed that a gap exists because majority of the previous literatures on this study stopped their analyses using 2013-time series data but it is the aim of this research work to fill this gap by extending the period of analysis to 2018 in other to capture the recent trends on the impact of telecommunication sector on economic growth in Nigeria.

3. Research Methodology

The research utilizes a quantitative approach to empirically investigate the "Impact of Telecommunication Sector on Economic Growth in Nigeria". Gross Domestic Product is used as a proxy for Economic Growth in Nigeria. While the independent variables shall be Teledensity, Telecommunication Sector Revenue and Investment in Telecommunication Sector. Secondary data were employed to conduct this empirical analysis. The data were sourced from National Bureau of Statistic (NBS), Central Bank of Nigeria (CBN), Statistical Bulletin, Nigeria Communication Commission (NCC) and corroborated by data from World Trade Organisation (WTO) and World Bank Development Indicator.

3.0 Theoretical Framework

As mentioned above, we employ the endogenous growth theoretical framework an augmented Robert Solow growth model, developed in Estache et al. (2005) and cited by Prof. Risikat O.S. Dauda, 2019 inaugural lecture, as the theoretical framework to organize our analysis of the impact of telecommunication on economic growth in Nigeria context. The model builds on that proposed by Solow (1957) and further developed by Mankiw, Romer and Weil (1992), and includes the accumulation of human as well as physical capital to explain the impact of telecommunication on economic in Nigeria. In addition, the model introduces an infrastructure index (Inf Inx hereafter) in the production function. As in the Estache et al. (2005) paper, the Solow growth model used here relies on a Cobb-Douglas production function with labor augmenting technological progress, human capital and the infrastructure index.

The Solow (1957) approach of the growth accounting equation can be used to capture the factors that account for the growth in total output. According to Solow's growth accounting concept, the growth rate of total output depends on the growth rate of capital and labour weighted by their shares of income plus the level of technological progress. Robert Solow provided the most basic version of the neoclassical theory of growth. The center piece of the model is the production function

$$Y = F(K, AL), \text{ ----------} (3.1)$$

where Y is output, K is capital, L is labor, and A is a measure of the level of technology. AL can be seen as the labor force measured in efficiency units, which incorporates both the amount of labor and the productivity of labor as determined by the available technology. If we assume that the production function has constant returns to scale, we can write the production function as

$$y = f(k), \text{ ----------} (3.2)$$

Where y = YIAL, k = K/AL, and f(k) = F(k, 1). This production function relates output per efficiency unit of labor to the amount of capital per efficiency unit of labor. The equation below (in Cobb-Douglas form) represents total output(Y) as a function of total factor productivity respectively.

The growth accounting equation, as presented in equation above, stated briefly the contribution of growth in inputs and improved productivity to the growth of output. Capital and labour each contribute an amount equal to the share of their income multiplied by their growth rates. The residual in the growth accounting equation, total factor productivity (TFP), is the technological level. Increase in TFP comes from improvement in the method of production which increases the efficiency of factor inputs; hence, more output is produced. Solow found that the growth in output outpaced the weighted average of increase in capital and labour inputs. This difference has often been termed the Solow residual.

3.1 Model Specification

In building the model for this study, the Ordinary Least Square (OLS) Method of regression analysis shall be used.

This is given as $Y=\beta_o + \beta_1X_1+ \beta_2X_2 + \beta_3X_3 +...+ \beta_nX_n$ ---------- (3.3)

Where; Y= Dependent variable

$\beta_o - \beta_n$ = Parameters to be estimated

X_1-X_n = Independent variables

3.2 Model

Multiple Linear Regression Analysis model was constructed to explain the relationship between the dependent variable and the independent Variables using econometrics model as statistical tool. The model built for the regression analysis is stated below.

$$\mathbf{GDP_t = \alpha+\beta_1 telrev_t +\beta_2 telinv_t + \beta_3 Telden_t + B_4 Agric_t + \beta_5 unemp_{t+} \beta_6 Ec_t +\mu} \quad \text{---------- (3.4)}$$

$\mathbf{GDP_t}$ is the dependent variable. $\mathbf{\beta_1 telrev_t + \beta_2 telinv_t + \beta_3 Telden_t}$ are the explanatory variables, while $\mathbf{\beta_4 Agric_t + B_5}$Unemp + $\mathbf{B_6}$Ec are the control variables. Growth figures (i.e. percentage growth) were used to measure the relationships between the dependent and the independent variables. The **μ** (error term) encapsulates all other unobserved variables not directly included in the regression equation that could influence the dependent variable**.** Several economic interactions have capacity to influence GDP Growth in any economy. It is however not feasible to incorporate all these interactions in one regression equation. Thus, the error term was included to capture the effect of the unobserved interactions.

The underlying theoretical assumption of the research is that, after the liberalisation of the telecommunications sector, substantial investments were attracted into the sector (Telinv) which helped to galvanize telephone usage (Teledensity). As the numbers of telephone usage increases together with other externalities also increases. These increases are therefore expected to influence growth in the economy (GDP growth).

4 Results and Discussion

4.0 Summary of the Ordinary Least Square Regression Result

From the regression result, Economic Growth was the dependent variable proxy by Gross Domestic Product while Teledensity (TELD), Telecommunication Sector Revenue (TSR) and Investment in Telecommunication Sector (INVT) Agricultural sector, unemployment and Electricity Consumption were the independent variables. The regression results obtained were presented in the table below.

Table 1: Dependent variable: GDP

Variable	Coefficient	Standard error	t-statistic	Probability
C	9266.593	2857.515	3.242885	0.0031
TELD	140.0973	107.8694	1.298767	0.2050
TSR	14.65944	8.587348	1.707097	0.0993
INVT	1008.747	233.2914	4.323977	0.0002
R^2 = 0.882541, F-Statistic =67.62246, Adjusted R^2= 0.869490, Prob.(F-Statistic) =0.000000 D.W Statistic=1.543241				

Source: Author's Computation

The interception of the regression equation presented on table 4.1 above is 9266.593 All things being equal, it represents the value of Gross Domestic Product (GDP) if Teledensity (TELD) is zero holding Telecommunication Sector Revenue (TSR) and Investment in Telecommunication (INVT) constant. The regression coefficient of Teledensity (TELD) is 140.0973. It shows that a unit increase in Teledensity (TELD) will bring about 140.0973 units increase in Gross Domestic Product (GDP) in Nigeria. It is positive showing a direct relationship between Teledensity (TELD) and Gross Domestic Product (GDP) in Nigeria. Hence, the increase in Gross Domestic Product (GDP) led to increase in economic growth in Nigeria. The regression coefficient of Telecommunication Sector Revenue (TSR) is 14.65944. It shows that a unit increase in Telecommunication Sector Revenue (TSR) will bring about 14.65944 units increase in Gross Domestic Product (GDP) in Nigeria. It is positive showing a direct relationship between Telecommunication Sector Revenue (TSR) and Gross Domestic Product (GDP) in Nigeria.

Hence, the increase in Gross Domestic Product (GDP) also led to increase in economic growth in Nigeria within the study period.

The regression coefficient of Investment in Telecommunication (INVT) is 1008.747. It shows that a unit increase in Investment in Telecommunication (INVT) will bring about 1008.747 units increase in Gross Domestic Product (GDP) in Nigeria. It is positive showing a direct relationship between Investment in Telecommunication (INVT) and Gross Domestic Product (GDP) in Nigeria. Hence, the increase in Gross Domestic Product (GDP) led to increase in economic growth in Nigeria.

4.1 Policy Implications

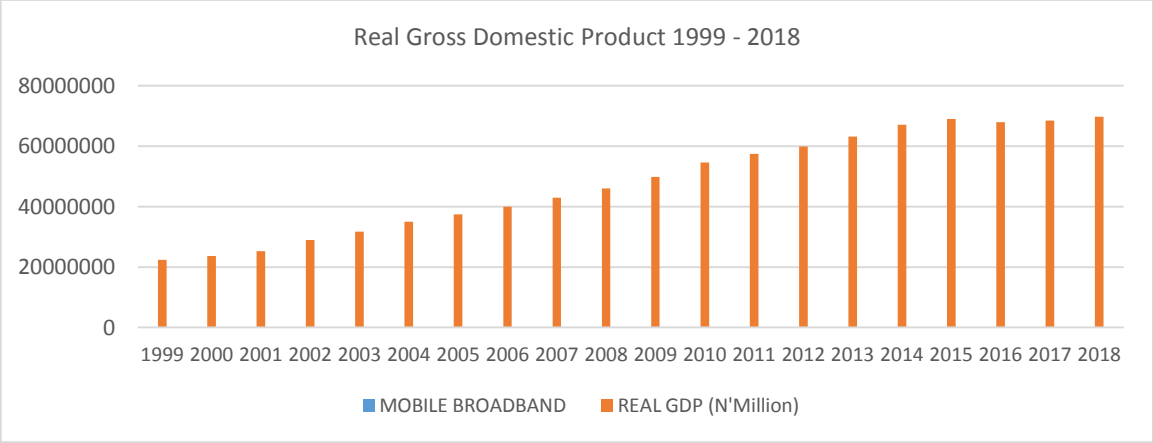
From the ongoing presentation and analysis of results, it was revealed that Teledensity had insignificant impact on Gross Domestic Product in Nigeria. This implied that an increase in Teledensity brought about increase in Gross Domestic Product. Hence, increase in economic growth in Nigeria. Furthermore, the result also revealed that Telecommunication Sector Revenue had insignificant impact on Gross Domestic Product in Nigeria. This implied that an increase in Telecommunication Sector Revenue led to increase in Gross Domestic Product. Hence, increase in economic growth in Nigeria. Lastly, the result showed that Investment in Telecommunication Sector had significant impact on Gross Domestic Product in Nigeria (See for instance, Snežana, Zoran, Zorana, 2019; Amavilah, Asongu, Andrés, 2017). This implied that an increase in Investment in Telecommunication Sector also resulted to increase in Gross Domestic Product. Hence, increase in economic growth in Nigeria.

Table 4.2: Results of the LogRGDP function

Variables	coefficients	Standard Errors	t-values
Log FDI	0.33128	0.0443923	9.23
EC	-0.21563	0.432188	-4.64
Unemp	-0.23481	0.345221	-4.32
Telcom	0.000232	0.0000523	3.7
TOP	-0.024457	0.0080248	3.42
Constant	12.12345	0.463832	33.62

Source: Author's Computation

In the model, the coefficient of the constant is 12.12345 which shows the value of LOG (RGDP) even if the impact of all explanatory variables are individually zero. It has a positive sign implying that, if other variables are assumed constant, the rate of growth will be equal to 12.1%. A unit increase in FDI leads to 0.33128 increase in RGDP. In other words, a percentage increase in FDI changes RGDP by 0.33%. A change in electricity consumption leads to decrease 21.5% decrease in Real GDP while unemployment and trade openness decrease RGDP by 0.23% and 0.34% respectively.



Source: Author's Computation

Figure 1: Real Gross Domestic Product 1999 – 2018

SCATTER CHART

Figure 2 show the real gross domestic product (RGDP) from 1999 – 2018 as it increases in value yearly. This shows an increase in productivity in the last 19 years in the country.

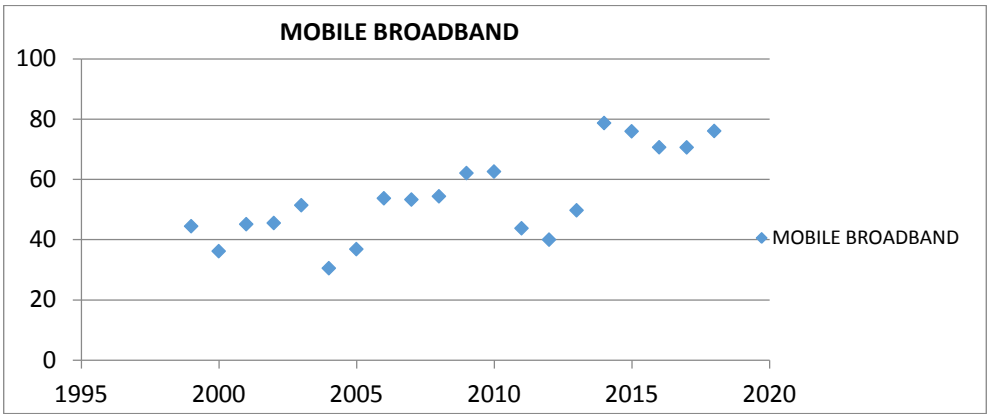
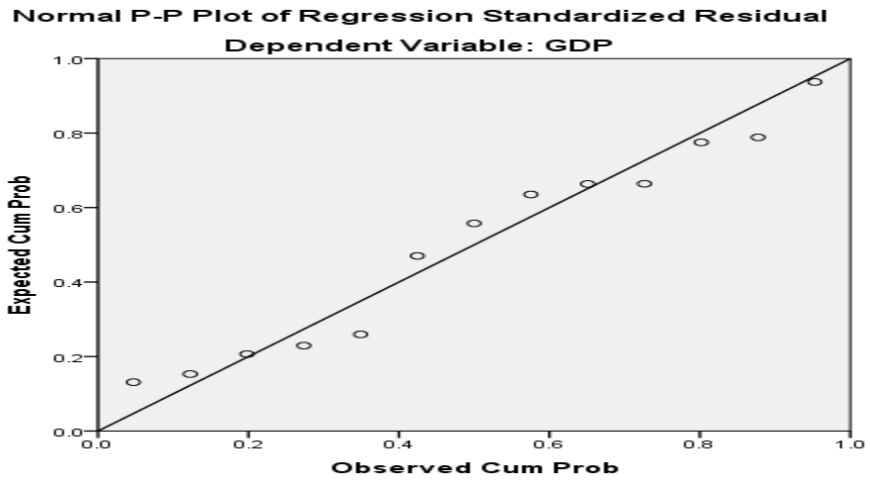


Chart B above postulate that the level of economy depends on the volume of GSM services rendered and telephone density.

Figure 4.3. Normal p-p plot of Regression Standardizes Residual



Source: Author's Computation

4.2 Collinearity Diagnostics

Three different models (i.e. model1, model2 and model3) were copiously used to examine presence of dependency among the independent variables and to also assess the extent to which the regression coefficients are affected by the presence of dependencies. The coefficients matrix of the three models is presented as table 4.3 below.

Table 4. 3 Collinearity Coefficients Matrix

Model Dimensions		Eigenvalue	Condition Index	Variance Proportions						
				(Constant)	TELREV	TELINV	TELDEN	AGRIC	unemp	Ec
1	1	4.916	1.000	.00	.00	.00	.01	.00	.00	.00
	2	1,108	2.105	.00	.00	.01	.01	.00	.00	.0
	3	.650	2.750	.00	.00	.03	.06	.00	.00	.01
	4	.295	4.083	.00	.00	.03	.72	.00	.00	.01
	5	.017	17.057	.00	.52	.55	.13	.11	.00	.01
	6	.010	22.520	.31	.02	.19	.07	.01	.32	.02
	7	-004	36.365	-69	.46	.19	.00	.00	.16	.23
2	1	4.008	1.000	.00		.01	.01	.00	.00	.00
	2	1.063	1.942	.00		.06	.00	.00	.00	.42
	3	.648	2.488	.00		.15	.08	.00	.00	.16
	4	.265	3.886	.00		.24	.76	.00	.00	.16
	5	.010	20.128	.35		.30	.12	.07	.90	.04
	6	.006	26.400	.65		.24	.03	.93	.09	.21
3	1	3.940	1.000	.00		.01	.01	.00	.00	.00
	2	.730	2.324	.00		.24	.03	.00	.00	.00
	3	.313	3.551	.00		.16	.73	.00	.00	.00
	4	.011	19.256	.17		.12	.20	.25	.99	.66
	5	.007	23.516	.83		.47	.03	.75	.00	.00

a. **Dependent Variable: GDP**

Source: Author's Computation

In table 4.3 above, near dependency was observed in one of the variables in model1 because the condition index is greater than 30. The variance proportions of some of the variables were also above 0.50. But in model2 and model3 there is no presence of near dependency or competing dependencies among the independent variables even though variance proportions of few of the variables are still above 0.50. This is a pointer to the fact that there is no multicollinearity amongst the variables in Model2 and model3 (Pradhan, Arvin, & Norman, 2015; Palvia, Baqir, & Nemati, 2018).

5. Conclusions and Recommendation

Economic growth in Nigeria is principally a function of variation in some macroeconomic fundamentals. There is need for a macroeconomic environment that will encourage telecommunication industry and foreign direct investment in order to enhance growth in Nigeria. The outcome of the empirical and stochastic investigations shows that Telecommunication Infrastructural Development has a positive relationship with output growth in Nigeria (See Ayse et al., 2016; Mohammed, & Sulong, 2017).). The impact is of a higher magnitude. The introduction of Global System for Mobile telecommunication (GSM) led to 17 percent rise in the output growth. The use of mobile phones in Nigeria has become very useful for individuals and industries in both the urban and rural areas.

Therefore, the output of industries has increase and the life of many Nigerians improved within the era of improvement in telecommunication industry. The demand side of electricity is determined by the amount of energy supplied. This is why we have contrary result to a priori expectation of the parameter for electricity consumption. On the side of the degree of trade openness, Nigeria is still a developing nation that needs a mild check on the nature of openness which her infant industries face. There is need to checkmate the trend of unemployment as it

impacts negatively on economic growth in Nigeria. Telecommunications can aid sustainable economic development when used appropriately, with the full participation of all stakeholders in the developing economies. The intrinsic value of telecommunications does not lie in easing communications and information, but in enabling growth and development. In a country like Nigeria, where a vast section of the population is below the poverty line, telecommunications offer a chance to empower the residents and transform them into more productive human capital.

Based on findings and conclusions presented above, the paper recommends that government should expand tele-density and directly make telephone communications cheap and accessible through granting more licenses to GSM operators in order to allow for healthy competition among the GSM operators (See Wamboye, & Sergi, 2019; Wamboye, Adekola, & Sergi, 2016; Song, 2015). In addition, the interests of the consumer of telecommunication services are protected by promoting competitive pricing of such services and combating the abuse of market power. The government should provide non-monetary incentives including the funding of the development of other infrastructure particularly electricity. To encourage rural telephony, the government should consider providing further concessionary fiscal incentives to investors who are willing to commit resources to the marginally profitable areas. The development of rural telephony will greatly assist growth of employment and incomes. The outcome of our study shows that investment in telecommunications infrastructure have direct and indirect linkage to economic growth. This is corroborated by the works of Anyasi and Otubu (2009) and Osotimehin et al. (2010).

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