FORCE

FOCUS ON RESEARCH IN CONTEMPORARY ECONOMICS

# ANALYSIS OF MOBILE TELECOMMUNICATION AND ECONOMIC GROWTH: EVIDENCE FROM ARDL MODELING

Ibrahim Musa*, Sule Magaji, Chukwumeka Ifegwu, & Ali Salisu

To cite this article: Musa, I., Magaji, S., Ifegwu, C., & Salisu, A. (2022). Analysis of mobile telecommunication and economic growth: Evidence from ARDL modeling. *Focus on Research in Contemporary Economics (FORCE), 3*(2), 369-393.

To link to this article: https://www.forcejournal.org/index.php/force/article/view/62/55



Published online: 14 February 2023.

FOCUS ON RESEARCH IN CONTEMPORARY ECONOMICS

Submission date: 28.07.2022 | Acceptance date: 13.01.2023 RESEARCH ARTICLE

# ANALYSIS OF MOBILE TELECOMMUNICATION AND ECONOMIC GROWTH: EVIDENCE FROM ARDL MODELING

Ibrahim Musa*, Sule Magaji, Chukwuemeka Ifegwu, & Ali Salisu

**ABSTRACT** This study examines the impact of mobile telephone on economic growth in Nigeria using ARDL (Autoregressive distributed lag) as methodology, with data from 2001-2017. The study reveals that mobile penetration had a positive impact on real GDP per capita. Which means as more people get access to mobile phones, GDP per capita is expected to grow. 10% increase in mobile penetration will lead to a 0.5 % increase in average annual GDP per capita. The study concludes that mobile telephony can aid sustainable economic development when used appropriately, with the full participation of all stakeholders, especially in a country like Nigeria. The intrinsic value of telecommunications lies not in easing communications and information, but in enabling growth and development. The study recommends that Consumer protection policies are needed to protect consumers from unfair calls and mobile data charges will ensure consumer get the value for their money, which will lead to increased consumption and investment in the industry.

**KEYWORDS:** *Telecommunication, economic growth, ARDL Model.*

***Correspondence concerning this article should be addressed to Ibrahim Musa, Department of Economics, University of Abuja.**
**E-mail: Ibrahim.musa@uniabuja.edu.ng**

## 1. INTRODUCTION

Telecommunication sector in many countries around the world witnessed exponential growth in the last three decades (Oladipo and Wynand, 2020; Leila 2019: Amavilah, Asongu, Andres, 2017). Telecommunication expansion has been observed both direct and indirect benefit to economic growth (WDI, 2018; Sajjad 2017 NCC 2014; Mohsin, Khan & Malik 2012).

In 2015 the estimated global number of people with mobile phones was at 4.7 Billion and the number of active mobile devices was at 7.6 billion which was more than the global human population; owing to the fact that some people have more than one mobile device. During the period the industry generated US$1.1 trillion in revenues, payed US$430 billion in tax, employed 17 million people directly and 15 million indirectly, was responsible for 4.2% of global GDP and global 4G connection passed 1 billion people across 151 countries according to GSMA (2016).

Global system for mobile communication (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 roles locally in advocating the several government communications initiatives and 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 had an incredible contribution of 53% in 2003 to the nation's Gross domestic product (GDP). In the year 2015, 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%.

Mobile telecommunication services are an integral part of economic activities so it continues to offer unprecedented opportunities for economic growth especially in the developing market. According to Lloyd and Fenio (2017). It has reduced the globe into a village through reduction of time and space".

Nigerian Government considers mobile telecommunication services to be so vital to national interest and economic growth that it was placed directly under its control until recently when deregulation and competition were introduced (Akinwale, Sanusi, Surujlal, 2018; Mamoun and Talib 2017 Lee, 2003). These

advances in mobile telecommunication 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.

Nigeria is witnessing a period of rapid growth in the use of mobile phones and mobile internet services which has led to an increase in the share of disposable income spent on mobile services. whether these is for business or social interaction, the tremendous impact on economic growth and the potentials for further growth cannot be ignored any more. Figures from the National Bureau of Statistics (NBS) shows that services now account for 52% of the GDP as of 2015 and ICT is a key driver of growth and according to the Nigerian Communications Commission (NCC); Nigeria has become the largest telecoms market in Africa and the middle east, with more than 140million active telecoms subscribers in 2015 and over 4 million phones entering the country every month. Nigeria accounts for 29 percent of all internet usage on the continent of Africa and this figure is expected to rise.

Nigerians spent over US$1.2 billion on 21 million mobile phones in 2012 (according to venture Africa) which means on average Nigerians spent N8,000 purchasing mobile phones. In contrast, the total expenditure on agricultural products in that year was below US$2 billion which is very close to the amount spent in purchasing phones, this is truly amazing because Nigeria is a net importer of agricultural produce which means Nigerians spent almost equal amount of money on food and mobile phones. So what government policies have been put in place to reap the huge benefits from the mobile phone market? What impact does the expenditure on mobile phone have on household income and business in Nigeria? According to the (NCC); Nigeria has 150 million active lines. When we calculate the number of active lines and the current average revenue per user (ARPU) benchmark of US$8 (N2516). Then we can assume that Nigerians spend a total of N380 billion on their lines monthly which adds up to about N4.5 trillion annually. A study by Sridhar and Sridhar (2004) found that the impact of telecommunications penetration on total output is significantly higher for developing countries than for OECD countries. So, what is the impact of the huge expenditure on telecom services on the economy? Has the expenditure facilitated economic activities and increased economic growth? Or has it been just a mere expenditure on a luxury item? These constitute the problem of interest for this research.

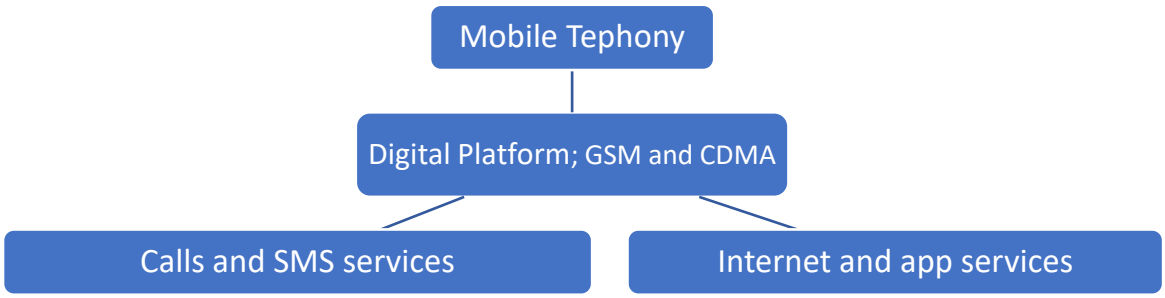
The objective of the research is to examine the impact of mobile telephony on economic growth in Nigeria. The study intends to cover a span of 17years (2001-2017) because GSM was introduced in Nigeria in 2001.This range was chosen to ensure availability of data and for the analysis to be meaningful and aid in the achievement of the objectives work

## 2. LITERATURE

### 2.1. Conceptual literature

Oxford dictionary refers to mobile telephony as simply the operation or use of mobile phones. It is a term use for telephone services provided to phones that may move around rather than stay in a fix position. In a nutshell all services provided to mobile phones primarily calls, SMS, internet and apps are referred to as mobile telephony.

**Figure 2.1: Basic structure of mobile telephony**




In Nigeria they are two main digital mobile telephony system which are GSM and CDMA. The NCC reports that there are about 139,486,832 GSM subscribers and 217,566 CDMA subscribers in Nigeria as of September 2021.

a. *Global Satellite(GSM);*developed by the European Telecommunications Standards Institute (ETSI) as a second-generation digital network used by phones and tablet. GSM is the most popular mobile platform in Nigeria (as in table 1 below) some example are MTN, Airtel, Glo and 9mobile.

b. *Code Division Multiple Access (CDMA);* CDMA is also a second-generation digital network but it uses code-division unlike GSM. The platform is very popular in Nigeria (table 1 below) although it had a very good start with STARCOM. Some of the CDMA service providers still in business are MULTILINKS and VISAFONE.

Both GSM and CDMA offer ways to cram multiple phone calls or Internet connections into one radio channel. In terms of network quality, they can both provide good network or bad network so network quality is dependent on the service provider. The most important distinguishing factor as far as the consumers are concern is that; GSM service providers usually store data of their subscribers on removable sim cards which makes it easier for customers to transfer their sims from one phone to another while the customer data on CDMA is stored on the phone giving the service providers greater ownership of the device.

**Table 1: Market share for technology**

| Year | Technology | Mobile (GSM) | Mobile (CDMA) | Fixed (Wireless/Wired) | VoIP |
|---|---|---|---|---|---|
| 2017 | Percentage | 99.70% | 0.15% | 0.10% | 0.03% |

(Source: NCC 2017)

The deregulations of the telecom industry in Nigeria in 2001 created an exponential growth in the GSM market which grew from barely less than a million subscribers to over 140 million subscribers as of 2017.

***Table 2: Telecom contribution to GDP***

| Year | 2017 | 2016 | 2015 | 2014 | 2013 | 2012 | 2011 | 2010 |
|---|---|---|---|---|---|---|---|---|
| Percentage | 9.50% | 9.13% | 8.50% | 7.60% | 7.40% | 7.70% | 8.60% | 8.90% |

(source: NCC 2017)

### 2.1.1. The mobile ecosystem in Nigeria

A very unique mobile ecosystem has evolved in Nigeria which has the telecom service providers or mobile operators (MTN, Airtel, GLO & 9Mobile) in the middle of it. A report by GSMA (2012) defines the mobile ecosystem as follows;

a. Suppliers of support services: such as Legal services, Advertising and Accounting services.

b. Mobile application developers: they develop applications for mobile phones. BudgIT, Traclis, Jobs in Nigeria, Genii games, and others.

c. Handset importers and dealers: On its own is a multibillion dollar sector some of the players here include Handset importers, Handset dealers, Emerging local manufacturers like SOLO Devices.

d. Other suppliers of capital items: Computer equipment, Motor vehicles, Furniture and other, office equipment.

e. Network equipment suppliers: Local infrastructure, suppliers and providers of maintenance, International equipment suppliers with local offices in Nigeria such as Ericsson, Huawei, Nokia, Alcatel and Aviat.

### 2.1.2. Telecommunication services in Nigeria

**a. e-Services and Mobile telephony**

Mobile telephony is the backbone of e-services in Nigeria. e-services are just a medium of bring goods and services to customers via electronic devices. It is vital in collecting information about user needs and preferences to guide producer's decision making. Some examples of e-services from different sectors includes.

**b. e-Government**

e-Government is the use of information and communication technologies(ICTs) to improve the activities of public sector organisations. Oyeneka (2013) refers to it as mobile government which is extending the concept of government further with delivery of information and services to the doorsteps of the citizens in a personalized way via what they already have, the mobile phone.

**c. e-Health**

e-health is the use of information and communication technologies(ICTs) in health Interventions. Apps like Smart Health app focus on providing accurate baseline information resource on HIV/AIDs, TB and malaria.

**d. e-Commerce**

e-commerce is a process of buying, selling, transferring, or exchanging products, services and/or information via electronic networks and provide contact information for customers. Most established business have a website where the attend to the needs of customers. SMEs and individual can sell their product on social media.

## 2.2. EMPIRICAL LITERATURE

Minges(2015 )examined the impact of various ICTs including fixed and mobile broadband services using cross sectional analysis for 120 developing and developed countries during the period 1980-2006 and the framework of the

analysis is based on endogenous growth model. 'The study concludes that a 10-percentage point increase in fixed broadband penetration would increase GDP growth by 1.21percent in developed economies and 1.38percent in developing ones. However, while the coefficient was significant at the 1 percent level for developed economies the significance was only significant at 10 percent for developing economies'

A report by Deloitte for GSM Association (GSMA) in 2012 measured the impact of next generation mobile services on economic growth which basically measured the impact of mobile data usage to economic growth. The report used Panel Data from several countries and econometrics analysis to measure the impact of mobile telephony on economic growth.

Zhang, (2021), examine the relationship between broadband and economic growth in China during the COVID-19 pandemic period (March 2020, April 2020, March 2019, and April 2019) anchored under Cobb-Douglas production function. The study used regression analysis and findings reveal that broadband penetration limited the effect of the pandemic on China's economic growth given the positive and significant relationship established with the variables. Maneejuk and Yamaka (2020) carried out an analysis of the impacts of telecommunications technology and innovation on economic growth in developed and developing economies using time-series kink regression of Hansen (2017) and Panel kink regression of Zhang et al. (2017), and Tibprasorn et al. (2017). Empirical findings reveal that the telecommunications technology and innovation give a relatively more massive impact on the economic growth of developing countries compared to developed countries. Using Panel Vector Auto regression analysis to examine the nexus between telecommunication infrastructures, economic growth and development in 46 Africa from 2000 to 2015(David, 2019). The scholar made use of human development index, and mobile line, fixed line and internet access penetration and result reveals existence of a bidirectional long-run relationship between telecommunication infrastructures, economic growth and development. The effect of telecommunication infrastructure development on the economic growth of 40 sub-Saharan African countries using panel data for the period 2006-15 was carried out by Haftu (2019). Outcome of the study reveal that per capita income of the region will have a positive impact on an increase in ICT in the shape of mobile phone subscribers in the selected period.

Okyere, Poku-Boansi, and Adarkwa, (2018) examine the relationship between telecommunication and transport sector in Ghana using Spearman's rank correlation technique. Empirical findings establish that telegraph, fiber optic networks and telephone facilities as components of telecommunication, exhibit bidirectional relationship with transport sector in Ghana. Similarly, study by Enowbi (2015) who adopted methodology of Datta and Agarwal (2004) to examine telecommunication and economic growth nexus across 44 African countries for the periods of 1990–2010. Finding shows that telecommunications (fixed and mobile lines) contribute in a major way to the economic development; in addition, investment in telecommunications is subject to increasing returns. In another study by Cleeve and Yiheyis (2014) who used Ad hoc structural analysis to examine telecommunication and economic growth in 36 African countries 1995–2010. Results reveal that increased mobile penetration contributes to the growth rate of GDP. In the study carried out by Jung, (2020) institutions and telecommunications investment a sample of 13 European countries during the period 2007–2015. The study uses panel regression and results confirmed positive association between institutional quality and telecommunication investment levels. Furthermore, findings also pointed out at institutional quality being more relevant for most disadvantaged countries, in terms of development and digital connectivity.

Usman, Ozturk, Hassan, Maria & Ullah, (2020) have conducted an analysis of the effect of ICT on energy consumption and economic growth in Bangladesh, India, Pakistan and Sri Lanka for the period of 1990-2018 using bounds testing approach of cointegration and error correction modelling. Finding confirms that, in the long-run, ICT exert positive and significant effect to the economic growth of India only while exhibiting contrary outcome on the other economies. In the study using Generalised Method of Moments technique investigates how information and communication technology (ICT) affects value added across sectors in 25 countries in Sub Saharan Africa for the periods of 1980–2014 (Asongu, Rahman, Nnanna & Haffar, 2020). Findings from the scholars show that mobile phone and internet penetrations exert indirect effects on value added to the agricultural and manufacturing sectors while there is direct effect on value added to the service sector. The study by Solomon and van Klyton (2020) carried out in 39 African countries from 2012 to 2016 to investigate the impact of digital technology usage on economic growth using GMM estimator. Finding shows that individual usage of ICT was positively associated with growth.

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.

Koutroumpis and Pantelis 2009 conducted a study covering 15 European Union countries for the period 2003-2006. Using panel data analysis with GDP, working population, mobile penetration and tertiary education per 1000. Regression analysis were run using two different technique (Generalized Method Moment (GMM) and Three Stage Least Square (3SLS)) with two control parameters (random and fixed effects). Their analysis found out that for each 10 percent point increase in mobile penetration there is a significant impact on GDP growth ranging from 0.26percent to 0.85percent.

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.

Magaji & Eke (2015) Used data from 16 West African countries and examines the links between Per Capita Income, Trade and Financial indicators, Education

and Freedom indicators. Others are Internet users, Broadband and Mobile Cell phone Subscribers. Meanwhile Fresh Water Supply (which is assumed as a bench mark public sector-led water resource management performance indicators) and Access to Safe Drinking Water (a bench mark private sector-led water resource management performance indicators) represents indicators of water resources management. The results show that income, ICT and government trade policies influence the efficient management of cross-country water resource. Freedom indicators strongly affect water resource management performance indicators (WRMPI). Moreso, Internet Users, Broadband Subscribers, and Mobile cell phones Subscribers have a positive association with WRMPI. Contrary to wide spread expectations, education does not influence WRMPI.

Although there is available empirical literature on mobile telecommunication and economic growth, a gap is crated as Nigeria is not well researched regarding telecommunication and economic growth which this study intends to undertake.

## 2.3. Theoretical framework

### 2.3.1. Endogenous Growth Theory

The sources, forms and effect of economic growth has always been an important topic of discussion throughout all the economic school of thoughts. What are the sources of growth, what are the forms of growth and how does growth effect the individual households and macro-economic activities at large. Economist argue whether economic growth is an end in itself or merely a means to an end (the end been economic development). But one fact they all agree on is that economic growth is an important perquisite in achieving economic development.

The endogenous growth theory or new growth theory was developed as a reaction to the flaws of the neoclassical (exogenous) growth theory it tries to prove that investment in capital, innovation and knowledge are key contributors to economic growth. Romer endogenous growth theory was first presented in 1986 in which he takes knowledge as an input in the production function. The theory aimed at explaining the long run growth by endogenizing productivity growth or technical progress. Romer believes technological change was generated by daily economic activity and so it is endogenous to the model of growth. It also gives emphasis to knowledge and information shift within industries which he considered as a public good and that firms should promote

learning by investing.

From equation(6) the Romer model introduce technology augmenting capital.

$$Y = f(A^t K^a L^{1-a}) \quad (1)$$

A is a constant that is >0 and represents technological change and if a = 1 then, $Y = A^t K^a L^{1-a}$

One limitation to the previous literature on this study is on an unresolved neoclassical model-theory of economic growth and that improvement in telecommunications infrastructure alone is not sufficient to stimulate economic growth. Therefore, we consider some possible theoretical objections against the theory. Growth is mostly due to advances in technology which is taken as exogenous. For this purpose, the neoclassical model's assumption of constant, exogenous technological change need not be a problem.

## 3. METHODOLOGY

### 3.1. Sources of data

The sources of data for this study will be secondary data from International Telecomm Union and World Bank. The period for the data will range from 2001 to 2017 because Mobile telephone services started in 2000 and data for the industry became available from 2001.

### 3.2. Technique of data analysis

To examine the relationships between the variables, the study employs Unit root test was carried out by the study using the Augmented Dickey Fuller (ADF) test (1979), the Phillips-Perron (PP) test (1988), and the Kwiatkowski-Phillips-Shin-Schmidt (KPSS) test (1992). the Study also employs autoregressive distributed lag model (ARDL) suggested by Pesaran et al. (2001) for cointegration investigation (time series data) and error correction (short run) analysis. The ECM version of modified ARDL is used to investigate the short run dynamic relationships. All this will be done through the ECM (Error Correction Mechanism) applied through the Ordinary Least Square (OLS) method. The long run model is used to generate the Error Correction Term (ect) by which we estimate the speed of adjustment of the model to long run equilibrium. Diagonestic test and stability test.

### 3.3. Model specification

This study adopts and modifies a standard endogenous growth model similar to those used by Andrainavo and Kpodar (2011) and Lee, Levendis and Quteirrez (2009). The model by Andrainavo and Kpodar is the most elaborate model in the study of mobile telephony because it includes mobile penetration as endogenous determinants of growth. And since this study is adopting an endogenous growth model frame work the study intends to keep mobile penetration as determinant of growth. GSMA(2013) used 3G penetration as determinant variable but since there are no concrete data on 3G penetration in Nigeria, the study intends to replace these variable with mobile penetration. The adding of mobile internet penetration means the study is not studying a particular kind of GSM technology (edge, 2G or 3G) but the entire mobile internet usage notwithstanding the kind of mobile platform. Also the Andrainavo and Kpodar model is a panel model but would be modified into a time series model as we are concerned only about Nigeria in this study. The modified model is as follows;

$$gdp_t = \alpha gdp_{t-1} + \beta X_t + e_t \quad (2)$$

*Where:*

$X_t$ = *(gov, inv, trade,mobnet, mobpen)*

$E[e_{it}] = 0$

In the above growth equation, GDP is GDP per capita. From the model we assume a dynamic process in which the current value of the dependent variable may be influenced by past ones, that is why we include the lagged value of GDP as controlled on the right-hand side. trade is a country's annual trade volume as a proportion of its GDP and is a proxy for the degree of openness of a country to international trade-in is the annual share of the countries investment to GDP. Gov is the annual government consumption of goods and services as a proportion of GDP. mobPen is the level of mobile penetration measured my number of mobile phones per 100 population and mobnet is mobile internet penetration as measure the number of people using mobile internet data per 100 population. From growth literatures the aprior expectation for the magnitude of the coefficient of each $X_{it}$ is positive. Therefore;

***GDP : Real GDP per capita***

***Gov: Government expenditure as share of GDP***

***Inv: Investment expenditure as share of GDP***

***Trade: Trade expenditure as share of GDP (Openness of the economy)***

***Mobpen: mobile penetration***

***Mobnet: mobile internet penetration***

***e- Error term***

From equation (1) when we take the natural log of the equation. we derive the following;

$$\ln(gdp)= \alpha\ln(gdp_{t-1}) +\beta_1\ln(gov_t) + \beta_2\ln(inv_t) + \beta_3\ln(trade_t) +\beta_4\ln(mobnet_t) + \beta_6\ln(mobpen_t)+ e_t \ldots. \quad (3)$$

Following Pesaran et al, (2001), the ARDL representation of the model is expressed as;

$$\Delta lngdpt = \beta_0 + \beta_1 lngdpt_{-1} + \beta_2 lngovt_{-1} + \beta_3 lninvt_{-1} + \beta_4 lnmobnet\ t_{-1} + \beta_5 lnmobpen\ t_{-1} + \sum_{i=1}^{p} \phi^1\, \Delta lngdp^{t-i} + \sum_{i=1}^{p} \phi^2\, \Delta lngov^{t-i} + \sum_{i=1}^{p} \phi^3\, \Delta lninv^{t-i} + \sum_{i=1}^{p} \phi^4\, \Delta lnmobnet^{t-i} + \sum_{i=1}^{p} \phi 5\, \Delta lnmobpen^{t-i} + \mu_t \quad (4)$$

Equation 10 represents the Long run form of the model is model

$$\ln(gdp)= \alpha\ln(gdp_{t-1}) + \beta_1\ln(gov_t) + \beta_2\ln(inv_t) + \beta_3\ln(trade_t) +\beta_4\ln(mobnet_t) + \beta_6\ln(mobpen_t) + e_t \ldots\ldots\ldots \quad (5)$$

The short run dynamics is estimated using an error correction model (ECM) specified as;

$$\Delta lngdpt=\varphi_0+\sum_{i=1}^{p} \phi^1\, \Delta lngdp^{t-i} + \sum_{i=1}^{p} \phi^2\, \Delta lngov^{t-i} + \sum_{i=1}^{p} \phi^3\, \Delta lninv^{t-i} + \sum_{i=1}^{p} \phi^4\, \Delta lnmobnet^{t-i} + \sum_{i=1}^{p} \phi 5\, \Delta lnmobpen^{t-i} + \delta ECTt - 1 \ldots\ldots\ldots\ldots \quad (6)$$

$\Delta$ is the difference operator; $\beta_0$ is the constant term; and $\beta_1$ - $\beta_4$ are the long run elasticities (coefficients of the explanatory variables); $\phi_1$- $\phi_4$ are the short run elasticities (coefficients of the differenced explanatory variables); *Ln* is natural logarithm; *P* is the lag length; $\delta$ is the speed of adjustment parameter, *ECT* is error correction term lagged for one period, In the long run model, the a prior expectation is that the coefficient on all the explanatory variables are positive.

### 3.4. Justification of the inclusion of variable

The study measured the impact mobile telephony has had on the economic growth of Nigeria. Since we are not measuring the impact of telecom in general but the impact of mobile telephony in specifics, our model contains two variable that would serve as good indicators for the impact, mobile telephony has had on growth. First is mobile penetration which measures the number of mobile phone subscription as per 100 population which is indicative of how common and regular is the use of mobile devices in the country the source of the data is International Telecom Union (ITU). Secondly is mobile internet penetration which means the number of mobile internet users per 100 population, this variable is unique to the study and its from International Telecom Union (ITU).

Other variables included in the model are all standard determinants of economic growth; government expenditure as a share of GDP is included the effect of government consumption of goods and services in economic growth, as a measure of the degree of openness of the economy which has enormous impact on growth the model includes trade expenditure as share of GDP and investment expenditure as a share of GDP would capture the effect of ever changing investment expenditure on growth. All the above data are sourced from the World Bank.

Finally, GDP per capita would serve as a measure of economic growth. From the model we have GDP per capita as the dependent variable and a lag value of GDP per capita as an independent variable. The reason for having a lag of GDP per capita on the right side of the equation is because we assume that growth from one year's influences growth from the next year and the data is from World Bank.

# 4. RESULTS AND DISCUSSION

## 4.1. Unit root test result

**Augmented Dickey-Fuller Test**

The results from the test show that none of the series (GDP, GOV,INV,MOBNET,TRADE) is stationary at level as their test statistics are all smaller than the 5% critical value of -3.478305 for rejection of hypothesis of a unit root. However, the null hypothesis of non-stationarity is consistently rejected for all the when they are expressed in first differences suggesting that they are all integrated of order one (I(1)). The results reported are for those with intercept and trend. However, the results with no (intercept or trend) and with trend were not significantly different.

Test statistics with intercept and trend for the variable MOBPEN are smaller than the critical value of -3.478305 at 1%,5% and 10% both at level and first difference, suggesting that the series in I(2).

**Table 3: ADF Test results (with Intercept and Trend)**

| Variable | Test Statistics | Critical Value | Probability | Decision |
|---|---|---|---|---|
| With Intercept and Trend | | | | |
| LNGDP | -1.275897** | -3.478305 | 0.8853 | I(1) |
| D(LNGDP) | -8.986386** | -3.479367 | 0 | |
| LNGOV | -1.369394** | -3.482763 | 0.8605 | I(1) |
| D(LNGOV) | -7.726507** | -3.48397 | 0 | |
| LNINV | -3.12646** | -3.478305 | 0.1087 | I(1) |
| D(LNINV) | -7.998141** | -3.479367 | 0 | |
| LNMOBNET | -1.559144** | -3.482763 | 0.7979 | I(1) |
| D(LNMOBNET) | -3.721933** | -3.482763 | 0.028 | |
| LNTRADE | -1.999457** | -3.482763 | 0.5902 | I(1) |
| D(LNTRADE) | -8.014179** | -3.48397 | 0 | |
| LNMOBPEN | -2.91173** | -3.24657 | 0.0221 | I(0) |
| D(LNMOBPEN) | -1.417993** | -3.487845 | 0.8455 | |

**Source: Authors computation using E-views 9.0**

**D indicates the 1st difference of the variable. **, indicates 5% level of significance**

The results from the test show that none of the series (GDP, GOV,INV,MOBNET,TRADE) is stationary at level as their test statistics are all smaller than the 5% critical value of -3.478305 for rejection of hypothesis of a unit root. However, the null hypothesis of non-stationarity is 10 consistently

rejected for all the when they are expressed in first differences suggesting that they are all integrated of order one (I(1)). The results reported are for those with intercept and trend. However, the results with no (intercept or trend) and with trend were not significantly different.

Test statistics with intercept and trend for the variable MOBPEN are smaller than the critical value of -3.478305 at 1%,5% and 10% both at level and first difference, suggesting that the series in I(2).

**Philip-Perron Test**

**Table 4: Phillip-Perron Test**

| Variable | Test Statistics | Critical Value | Probablity | Decision |
|---|---|---|---|---|
| With Intercept and Trend | | | | |
| LNGDP | -0.973793** | -3.478305 | 0.9404 | I(1) |
| D(LNGDP) | -10.48629** | -3.479367 | | |
| LNGOV | -1.394228 | -3.482763 | 0.8533 | I(1) |
| D(LNGOV) | -7.726507 | -3.48397 | 0 | |
| LNINV | -3.324411 | -3.478305 | 0.0711 | I(1) |
| D(LNINV) | -7.998137 | -3.479367 | 0 | |
| LNMOBNET | -1.313268 | -3.478305 | 0.8761 | I(1) |
| D(LNMOBNET) | -15.35246 | -3.479367 | 0.0001 | |
| LNTRADE | -2.028279 | -3.482763 | 0.5747 | I(1) |
| D(LNTRADE) | -8.026641 | -3.48397 | 0 | |
| LNMOBPEN | -2.831394 | -3.478305 | 0.1916 | I(1) |
| D(LNMOBPEN) | -11.24646 | -3.479367 | 0 | |

**Source: Authors computation using E-views 9.0**

**D indicates the 1st difference of the variable. **, indicates 5% level of significance**

The Null hypothesis for the philip-perron (PP) test is that the variable has unit root and the alternative is that it doesn't. The PP test was conducted using intercept and trend. The spectral estimation method is the EViews default Bartlett kernel and bandwidth is Newey-west bandwith. The test statistics for all the variables is less than the critical values (5% level of significant) at level but greater than the critical values (5% level of significant) at 1st difference. These means the variables are stationary at order 1, making them all I(1) processes.

**Kwiatkwoski-Philips-Schmidt-Shin Test**

**Table 5: KPSS test result**

| Variable | Test Statistics | Decision (5% critical value = 0.146000) |
|---|---|---|
| LNGDP<br>D(LNGDP) | 0.23922<br>0.100263 | I(1) ** |
| LNGOV<br>D(LNGOV) | 0.190292<br>0.100613 | I(1) ** |
| LNINV<br>D(LNINV) | 0.092249<br>0.272895 | I(0) ** |
| LNMOBNET<br>D(LNMOBNET) | 0.272895<br>0.138327 | I(1) ** |
| LNTRADE<br>D(LNTRADE) | 0.201180<br>0.048277 | I(1) ** |
| LNMOBPEN<br>D(LNMOBPEN) | 0.259018<br>0.136249 | I(1) ** |

**Source: Authors computation using E-views 9.0**

**D indicates the 1st difference of the variable. **, indicates 5% level of significance. 5% critical value = 0.146000**

The Kwiatkowski–Phillips–Schmidt–Shin (KPSS) test figures out if a time series is stationary around a mean or linear trend, or is non-stationary due to a unit root.If the LM statistic is greater than the critical value, then the null hypothesis is rejected; the series is non-stationary.

The ADF test suggests that all variables are I(1) aside from MOBPEN which is I(0), in the PP test all the variables are I(1) and KPSS unit root test suggest that the variables are a mixture of I(0) and I(1) process. So according to Nkoro and Uko (2016) since the series is a mixture of I(0) and I(1) processes Pesaran and Shin (1999) and Pesaran et al (1996b) proposed Autoregressive Distributed Lag (ARDL) approach to cointegration or bound procedure for a long-run relationship will be appropriate.

## 4.2. ARDL Model Cointegration Test

**Table 6: Bound Test**

**Critical Value Bounds**

| Significance | I0 Bound | I1 Bound |
|---|---|---|
| 10% | 2.26 | 3.35 |
| 5% | 2.62 | 3.79 |
| 2.5% | 2.96 | 4.18 |
| 1% | 3.41 | 4.68 |

***Source: Authors computation using E-views 9.0***

***F statistics=15.06016 K=5 Prob(F-Statistics)=0***

The table above shows the bound test computation of the ARDL model at different level of significant (1%, 2.5%, 5%, 10%). The Null hypothesis for the test is of 'no cointegration'. Since the F statistics is 15.060 which is geater than the I(0) and I(1) bound, we therefore reject the null, implying that there is a long run relationship between the variables. This gives justification to the use of an Error Correction Model (ECM).

**Table 7: ARDL Model Cointegration form (Short run)**

| Variable | Coefficient | Std. Error | t-Statistic | Prob. |
|---|---|---|---|---|
| D(LNGDP(-1)) | 0.219605 | 0.10844 | 2.025124 | 0.051 |
| D(LNGDP(-2)) | 0.219605 | 0.10844 | 2.025124 | 0.051 |
| D(LNGDP(-3)) | 0.219605 | 0.10844 | 2.025124 | 0.051 |
| D(LNGOV) | -0.106138 | 0.046264 | -2.294186 | 0.0283 |
| D(LNGOV(-1)) | 0 | 0.037091 | 0 | 1 |
| D(LNGOV(-2)) | 0 | 0.037091 | 0 | 1 |
| D(LNGOV(-3)) | 0.160336 | 0.043601 | 3.677347 | 0.0008 |
| D(LNINV) | 0.226359 | 0.077855 | 2.907426 | 0.0065 |
| D(LNINV(-1)) | 0 | 0.045673 | 0 | 1 |
| D(LNINV(-2)) | 0 | 0.045673 | 0 | 1 |
| D(LNINV(-3)) | -0.076135 | 0.048247 | -1.578025 | 0.1241 |
| D(LNTRADE) | -0.034716 | 0.023276 | -1.491496 | 0.1453 |
| D(LNTRADE(-1)) | 0 | 0.029717 | 0 | 1 |
| D(LNTRADE(-2)) | 0 | 0.029717 | 0 | 1 |

| | | | | |
|---|---|---|---|---|
| D(LNTRADE(-3)) | -0.114728 | 0.030092 | -3.812503 | 0.0006 |
| D(LNMOBNET) | 0.149968 | 0.047407 | 3.16345 | 0.0033 |
| D(LNMOBNET(-1)) | 0 | 0.013395 | 0 | 1 |
| D(LNMOBNET(-2)) | 0 | 0.013395 | 0 | 1 |
| D(LNMOBNET(-3)) | 0.072522 | 0.021101 | 3.436822 | 0.0016 |
| D(LNMOBPEN) | 0.140941 | 0.035911 | 3.924666 | 0.0004 |
| CointEq(-1) | -0.942882 | 0.118468 | -7.95895 | 0 |

***Source: Authors computation using E-views 9.0***

***Estimated using ARDL***

Table 7 shows the short run cointegration form of the ARDL model, significance is at 5% level. The coefficient of the variable CointEq is the speed of adjustment in the ARDL which implies that the model moves towards long run equilibrium at the speed of 94%. However, since the bound test suggested that our variables are cointegrated, we then estimate an Error Correction Model (ECM).

## 4.3. Long run estimates

**Table 8 : Long run estimate**

| Variable | Coefficient | Std. Error | t-Statistic | Prob. |
|---|---|---|---|---|
| C | 4.349429 | 0.71401 | 6.091549 | 0 |
| LNGDP(-1) | 0.489486 | 0.083744 | 5.845019 | 0 |
| LNGOV | 0.072142 | 0.027126 | 2.65951 | 0.0102 |
| LNINV | -0.1157 | 0.044586 | -2.594934 | 0.0121 |
| LNTRADE | -0.05381 | 0.021296 | -2.526988 | 0.0144 |
| LNMOBNET | 0.000469 | 0.017327 | 0.027042 | 0.9785 |
| LNMOBPEN | 0.047178 | 0.015608 | 3.022726 | 0.0038 |
| R-squared | 0.984309 | F-statistic | | 585.5029 |
| Adjusted R-squared | 0.982628 | Prob(F-statistic) | | 0 |

***Source: Authors computation using E-views 9.0***

***Estimated using Least square method***

Table 8 above is the long run model,. The error correction term is generated via this process.

The coefficient of LNGDP lag is positive and significant which agrees with a prior expectation and economic theory which says economic growth from one year has an impact on economic growth for the next year. LNGDP has a coefficient of 0.434 which is statistically significant with a probability of 0.

The variable LNGOV is also positive and significant implying that government spending has a positively impact on GDP per capita. The significant coefficient

of government spending as a ratio of GDP, implies that a 10% increase in Government spending will lead to 0.7 percent annual growth rate of GDP per capita.

The coefficients of LNINV and LNTRADE, -0.115 and -0.05 respectively, are both negative and significant which is contrary to a prior expectation. A look at the individual observations of the variables showed that as real GDP per capita grew the ratio of investment to GDP fell and ratio of trade to GDP fell as well.

LNMOBNET has a coefficient of 0.000469 which is not statistically significant at 5% level of significant. This means that mobile internet penetration doesn't have a significant contribution to GDP per capita.

The coefficient of the variable LNMOBPEN (0.05) suggest that, for a given level of mobile penetration, a 10% increase in mobile penetration would increase annual growth rate of GDP per capita by an additional 0.5% point.

The model has a nice fit as the R-square is 0.98, which implies that 98% percentage of the variations in LNGDP is explained by the independent variables.

## 4.4. Short run dynamics

The coefficient of the ECT must be negative. It is the speed of adjustment of the system, the speed at which the system can get back to long run equilibrium.

**Table 4.4.1 : Error Correction Model**

| Variable | Coefficient | Std. Error | t-Statistic | Prob. |
|---|---|---|---|---|
| C | 0.005443 | 0.005984 | 0.909661 | 0.3689 |
| D(LNGDP(-1)) | 0.484504 | 0.3078 | 1.574088 | 0.124 |
| D(LNGOV(-1)) | -0.018452 | 0.054305 | -0.339784 | 0.7359 |
| D(LNINV(-1)) | 0.032927 | 0.072414 | 0.454709 | 0.652 |
| D(LNTRADE(-1)) | 0.007143 | 0.03751 | 0.190428 | 0.85 |
| D(LNMOBNET(-1)) | -0.026224 | 0.049387 | -0.530981 | 0.5986 |
| D(LNMOBPEN(-1)) | -0.00416 | 0.048425 | -0.085901 | 0.932 |
| D(LNGDP(-2)) | 0.132978 | 0.162803 | 0.816802 | 0.4193 |
| D(LNGOV(-2)) | -0.016341 | 0.047504 | -0.344003 | 0.7328 |
| D(LNINV(-2)) | 0.029484 | 0.059098 | 0.498898 | 0.6208 |
| D(LNTRADE(-2)) | 0.007356 | 0.037406 | 0.196653 | 0.8452 |
| D(LNMOBNET(-2)) | -0.030055 | 0.022072 | -1.361715 | 0.1815 |

| | | | | |
|---|---|---|---|---|
| D(LNGDP(-3)) | 0.132978 | 0.162803 | 0.816802 | 0.4193 |
| D(LNGOV(-3)) | -0.016341 | 0.047504 | -0.344003 | 0.7328 |
| D(LNINV(-3)) | 0.029484 | 0.059098 | 0.498898 | 0.6208 |
| D(LNTRADE(-3)) | 0.007356 | 0.037406 | 0.196653 | 0.8452 |
| D(LNMOBNET(-3)) | -0.030055 | 0.022072 | -1.361715 | 0.1815 |
| D(LNGDP(-4)) | 0.531142 | 0.162803 | 3.262482 | 0.0024 |
| D(LNGOV(-4)) | -0.198957 | 0.047504 | -4.18823 | 0.0002 |
| D(LNINV(-4)) | 0.042803 | 0.059098 | 0.724274 | 0.4735 |
| D(LNTRADE(-4)) | 0.167724 | 0.037406 | 4.483849 | 0.0001 |
| D(LNMOBNET(-4)) | 0.035972 | 0.022072 | 1.629804 | 0.1116 |
| ECT(-1) | -0.706775 | 0.368675 | -1.917068 | 0.063 |

| | | | |
|---|---|---|---|
| R-squared | 0.625626 | Durbin-Watson stat | 2.039204 |
| Adjusted R-squared | 0.403025 | F-statistic | 2.810529 |
| | | Prob(F-statistic) | 0.002686 |

***Source: Authors computation using E-views 9.0***

***Estimated using least square method***

In the ECM the system is getting adjusted at the speed of 71% towards long run equilibrium. Which also implies that about 71% departure from long run equilibrium are corrected each period. The probability of on the Error correction term (ect) is 0.063 which is slightly greater than 5% level of significant, the model is significant at 10% level of significant. Therefore, the ect results, although suggestive of an association, did not achieve statistical significance ($P$ = 0.06).

The R-squared coefficient (0.62) implies that the fit of the model is good i.e. 62% of the variations in LNGDP is explained by the variations in the explanatory variables. The probability of the F-statistics (0.0026) confirms the statistical significance of the regression line at 5 per cent significance level. The R-squared was also found to be less than the Durbin Watson statistics to further confirm that there is no evidence of a spurious regression.

## 4.5. Model diagnostics result

**Table 4.5.1: Residual Diagnostics results**

| Residual test | F-Statistic | Prob. |
|---|---|---|
| Serial Correlation F(2,35) | 0.102872 | 0.9025 |
| Heteroskedasticity F(22,37) | 1.356046 | 0.2021 |

The null hypothesis of the Breusch-Godfrey serial correlation LM test is of 'no serial correlation'. The test rejects the null hypothesis of no serial correlation as the value of F-statistics is 0.102 and p-value of 0.9025, meanings the LM test

indicate that the residuals are not serially correlated.

For the Breusch-Godfrey heteroskedasticity LM test the null hypothesis is that the errors are homoskedasticity, while the alternative is the errors are heteroskedasticity. The F-statistics (1.356) at a probability of 0.202 which is greater than threshold ($p<0.05$), therefore we reject the null hypothesis which means the errors of the model are heteroskedastic.

## 4.6. Stability test

Figure 6: CUSUM Result

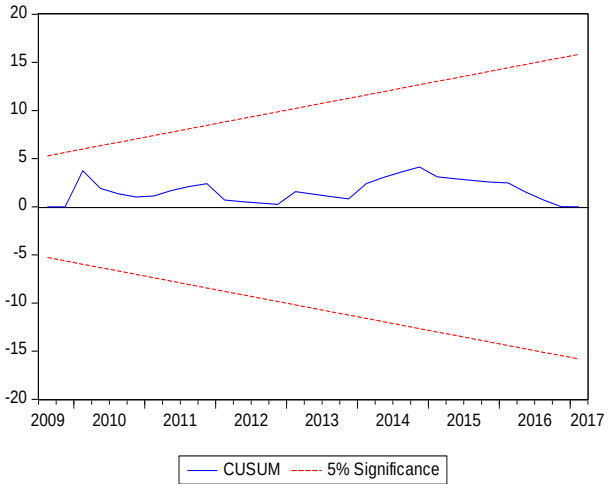
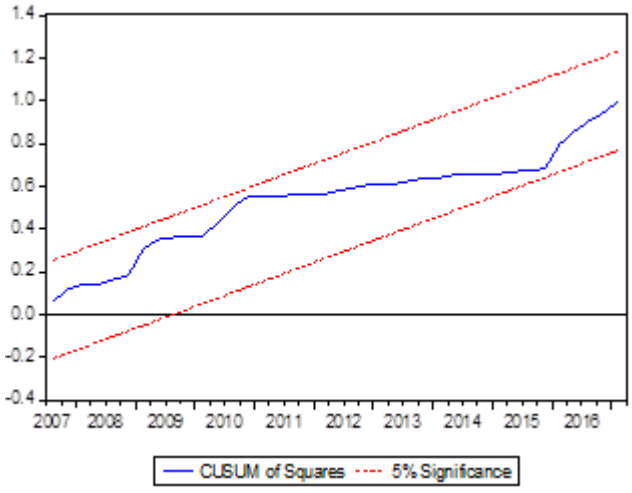



Figure7:CUSUMSQres




The plot of the CUSUM and CUSUMSQ in figure 4.2 and 4.3 respectively lies between the critical bounds at 5 per cent significance level. This implies that we cannot reject the null hypothesis and affirm that the model coefficients are stable over the sample time frame. Thus, the model parameters do not suffer from any structural instability.

## 5. CONCLUSION AND RECOMMENDATIONS

The study found positive impact of mobile telephony on economic growth of Nigeria so the study concludes that mobile telephony can aid sustainable economic development when used appropriately, with the full participation of all stakeholders, especially in a country like Nigeria. The intrinsic value of telecommunications lies not in easing communications and information, but in enabling growth and development.

Better Telecom regulations will foster growth in the mobile phone industry which the study has found to have a positive impact on economic growth. Consumer protection policies that protect consumers from unfair calls and mobile data charges will ensure consumer get the value for their money which will lead to consumption and investment in the industry. Mobile services providers as well have to be protected from damage to facilities angry communities, bandits etc., also laws that protect intellectual properties would be hugely beneficial to software developers, Apps developers and everybody that provides intellectual content in the mobile telephony ecosystem.

## DISCLOSURE OF CONFLICT

The authors declare that they have no conflicts of interest.

## AUTHOR(S) DETAILS

Ibrahim Musa
Department of Economics
Faculty of Social Sciences
University of Abuja
E-mail: ibrahim.musa@uniabuja.edu.ng
ORCID ID: https://orcid.org/0000-0002-7949-4298

Sule Magaji
Department of Economics
Faculty of Social Sciences
University of Abuja
E-mail: sule.magaji@uniabuja.edu.ng
ORCID ID: https://orcid.org/0000-0001-9583-3993

Chukwuemeka Hegwu
Department of Economics
Faculty of Social Sciences
University of Abuja
E-mail: Chukwuemeka.eke@uniabuja.edu.ng
ORCID ID: https://orcid.org/0000-0002-9837-7951

Ali Salisu
Department of Economics
Faculty of Social Sciences
University of Abuja
E-mail: asalisu.eco@buk.edu.ng
ORCID ID: https://orcid.org/0000-0003-2690-2080

## REFERENCES

Asongu, A., Rahman, M., Nnanna, J. & Haffar, M. (2020) Enhancing Information Technology for Value Added Across Economic Sectors in Sub-Saharan Africa, IDEAS. Working Papers 20/064, European Xtramile Centre of African Studies (EXCAS).

Bertschek,I. Briglauer, W., Hüschelrath, K., Kauf, K. & Niebel, T. (2015), The Economic Impacts of Broadband Internet: A Survey, *Review of Network Economics*. https://doi.org/10.1515/rne-2016-0032

Cardona, M. Kretschmer, T. & Strobe, T. (2013), ICT and productivity: conclusions from the empirical literature, Information Economics and Policy 25(3), 109-125

Datta, A. & Agarwal, S.(2004) Telecommunications and economic growth: a panel data approach. *Applied Economics*. 36(15), 1649-1654

Gruber, H, Hatonen, J, Koutroumpis, P (2014). Broadband Access in The EU: An Assessment of Future Economic Benefits.*Telecommunication Policy*; 18: 1046–1058.

Gruber, H. & Koutroumpis, P. (2010) Diffusion of new technology generations in mobile communications, *Information Economics and Policy*. *22*(1), 51-60

Haftu, G. G. (2019) Information communications technology and economic growth in Sub-Saharan Africa: A panel data approach. *Telecommunications Policy*. *43*(1) DOI:10.1016/j.telpol.2018.03.010

Harrison, C. S. & Menezes-Filho, N. (2011), ICT and Productivity in Developing Countries: New Firm-Level Evidence from Brazil and India. *Review of*

*Economics and Statistics*, 93, 528-541. http://dx.doi.org/10.1162/REST_a_00080

Jung, J. (2020) Institutions and Telecommunications Investment Information Economics and Policy, 50(11), 2020, 100849

Lloyd and Fenio (2017). An Investigation into the Impact of Mobile Technologies on Economic Growth and Employment in the Caribbean. *Athens Journal of Business & Economics 3(3)*, 263-278 https://doi.org/10.30958/ajbe.3.3.3 doi=10.30958 /ajbe.3.3.3

Mamoun & Talib Mohamed Warad (2017). The Impact of Telecom Infrastructure on the Economic Growth: The Case of Oil-producing and Non-Oil Producing Arab Countries. *International Journal of Economics and Financial Issues*, 7(3), 423-428.

*Maneejuk, P.* & *Yamaka, W (*2020) *An analysis of the impacts of telecommunications technology and innovation on economic growth*. Telecommunication Policy. *44(10), 2-4*

Michael Enowbi Batuo The role of telecommunications infrastructure in the regional economic growth of Africa Journal of Developing Areas, Tennessee State University, College of Business, vol. 49(1), 313-330

Minges, M. (2015). Exploring the Relationship between Broadband and Economic Growth. *World Development Report, 3.*

Mohsin Shakeel, Raja Abdul Ghafoor Khan & Haniya Rehman Malik (2012). Telecommunications Role in Economic Growth with Respect to Pakistan. *Global Journal of Management and Business Research, USA* 12(19) 28-33

Okyere, D.K., Poku-Boansi, M., & Adarkwa, K.K. (2018). Connecting the dots: The nexus between transport and telecommunication in Ghana. Telecommunications Policy, doi:10.1016/j.telpol.2018.07.008

Oyenike M. O. (2013). Mobile Government Framework – A Step Towards Implementation of Mobile Government in Nigeria. *International Journal of*

*Information Science p-ISSN: 2163-1921 e-ISSN: 2163-193X*

Sajjad Hossine Sharif (2017). Telecommunication and Its Impact over the Economic Development of SAARC Countries. *International Research Journal of Interdisciplinary & Multidisciplinary Studies (IRJIMS)* ISSN: 2394-7969 (Online), ISSN: 2394-7950 (Print) 3(1), 114-124

Solomon, E.M. and van Klyton, A. (2020) The Impact of Digital Technology Usage on Economic Growth in Africa. Utilities Policy, 67, Article ID: 101104. https://doi.org/10.1016/j.jup.2020.101104

Sridhar, K. S. & Sridhar, V. (2008). Telecommunications Infrastructure and Economic Growth: Evidence from Developing Countries. *Applied Econometrics and International Development, Vol. 7, No. 2, 2007*. Available at SSRN: https://ssrn.com/abstract=1250082

Usman, A., Ozturk, I., Hassan, A., Maria Zafar, S. and Ullah, S., (2020). The effect of ICT on energy consumption and economic growth in South Asian economies: *An empirical analysis, Telematics and Informatics (2020),* doi:10.1016/j.tele.2020.101537

Vu, M. K. (2013), Information and Communication Technology (ICT) and Singapore's economic growth, *Information Economics and Policy* 25, (4), 284-300

World Development Indicators (WDI). World Bank, 2000–016. https://data.worldbank.org/ (accessed 1 September 2018).

Zhang, F., & Li, D. (2018). Information & management regional ICT access and entrepreneur-ship: Evidence from China? Information & Management, 55 (2), 188 – 198. doi: 10.1016/j.im.2017.05.005 1418