

AN EMPIRICAL ANALYSIS OF INFORMATION AND COMMUNICATION TECHNOLOGY (ICT) AND ECONOMIC GROWTH IN NIGERIA

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—Abstract —

Nigeria has witnessed a great change in information and communication technology (ICT) as a result of the liberalisation of the telecommunication sector in the country in the early 2000s coupled with high rate of economic growth. Consequently, this study examines the relationship and impact of ICT on economic growth in Nigeria. Using a secure internet server per 1 million, mobile cellular subscription per 100 people, and investment in telecoms with private sector participation (in current USD) as proxies for ICT, and GDP as proxy for economic growth for the period 1997 to 2016, the outcome of the autoregressive distributed lag (ARDL) reveals that there is a cointegration between ICT and economic growth, which establishes the existence of a long-run relationship between them. In the short run, only secure internet server per 1 million and mobile cellular subscription per 100 people have a positive and significant impact on economic growth, whereas investment in telecoms with private sector participation was not significant. The Granger causality test shows the bidirectional causality between secure internet server per 1 million and economic growth. The results suggest that there is a need for a strong political will to support an enabling environment and to propel the ease of doing business in the sector to attract private and foreign investment into the sector, as this would improve the secure internet server, increase the penetration of mobile usage to the

rural communities, and increase the performance of other sectors of the economy that would foster the economic growth of Nigeria.

Keywords: Information and communication technology, ARDL, Nigeria

JEL classification: C01; 030; 041

1. INTRODUCTION

The emergence of information and communication technologies (ICT) spawned the beginning of the digital economy in the last two decades. This has heavily affected the opportunities and efficiency of how firms produce and provide goods and services (Cardona, Kretschmer and Strobel, 2013). Innovation and ICT have played various fundamental roles in the lives of businesses, households and the entire economy (Akinwale, Ogundari, Olaopa and Siyanbola, 2012; Thiebel, 2018; Akinwale, Akinbami and Akarakiri, 2018). Developed and emerging nations such as the USA, the UK, Singapore and South Korea, among others, have successfully used ICT to drive their economic growth. Investment in ICT has assisted some countries to develop innovations that have affected their economies. Nigeria as a country was not able to use ICT to drive most of its sector until the 21st century, when the telecommunication industry was liberalised. Prior to year 2000, in Nigeria, people travelled millions of miles to provide information with as few as three lines of words. Many people died on the road due to road accidents travelling from one region of the country to another, because there was a poor mailing system, and little or no telephone services, etc. This of course undermined productivity which consequently inhibited the growth of the economy.

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 30 000 subscribers to an outrageous 154.3 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). The contribution of the telecommunication sector to GDP was also steady at 9% in 2017 (CBN, 2017). Based on the aforementioned, there is little doubt

that there have been significant changes within the last two decades in the Nigerian telecommunication sector, after the deregulation of the sector. However, the performance of the sector is still relatively low when compared to some other emerging economies such as South Africa, South Korea and Malaysia, among others Danbatta (2017).

Despite the importance of ICT in an economy, the literature on this field of study is scant (Nath & Liu, 2017; Niebel, 2018), especially in developing countries such as Nigeria. Consequently, this study examines the short-run and long-run relationship between ICT and economic growth. The remainder of the study is structured as follows: section two synthesizes the literature, empirical procedure is outlined in section 3 and section 4 presents the results. The last section concludes the study.

2. LITERATURE REVIEWS

There are few studies on the impact and association of ICT and economic growth. Some of the early studies (Solow 1987; Baily 1986; Parsons, Gotlieb, and Denny 1990) could only find a negative impact of ICT on productivity. Solow (1987) asserted that the US economy was experiencing a 'productivity paradox', where one can see the 'computer age' everywhere but in the productivity statistics. These periods were dominated by little or no impact of ICTs on the nation's productivity. However, there had been reversed trends in recent studies on the impacts of ICT on productivity. For example, 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. Bertschek, Briglauer, Hüschelrath, Kauf, and Niebel (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. 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, Kretschmer and Strobel (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. They found that this is more evident in the US than in European countries. They

suggested that measures to rectify underinvestment are only justified in the presence of spillovers. Communication technologies lower the fixed costs of acquiring information and the variable costs of participating in markets (Leff, 1984). Brynjolfsson and Hitt (2003) investigated the association of ICT and productivity at firm- and industry level. They found a positive relationship between computer investment and firm productivity levels in which the firms that invested more in computers produced more output per unit of input.

Farhadi, Ismail and Fooladi (2012) also examined the impact of information and communication technology (ICT) use on economic growth among 159 countries for the period 2000 to 2009. They used the number of internet users, fixed broadband internet subscribers and the number of mobile subscriptions per 100 inhabitants as proxies for ICT, whereas the growth rate of GDP per capita was used to proxy economic growth. Using generalised method of moments (GMM), the results revealed that ICT is positively related to economic growth in the countries sampled. Furthermore, the results indicated that the effect of ICT use on economic growth is higher in high-income groups, rather than other groups. Paunov and Rollo (2016) opined that there is a positive effect of industries' internet use on firm labour productivity, as revealed by their study of the World Bank Enterprise Surveys for 117 developing and emerging countries. Nath and Liu (2017) observed a positive impact of ICT on service trade among 49 countries for the period 2000 to 2013; they also found that ICT use is found to be more important than access and skills for trade in a number of services. Niebel (2018) analysed the impact of ICT on economic growth in 59 developing, emerging and developed countries for the period 1995 to 2010. The panel data regressions showed that there is a positive relationship between ICT capital and GDP growth for the combined sample, but the results of the subsamples showed that developing and emerging countries are not gaining more from investments in ICT than developed economies are. This indicates that the emerging and developing economies are not 'leapfrogging' through ICT for economic development.

However, empirical studies on the relationship between ICT and economic growth, especially in developing nations have been largely inconclusive and divergent. Lee, Gholami and Tong (2005) found a significant impact of ICT on the economic growth of several developed and newly industrialised economies (NIEs), but could not find the same in developing countries. Dewan and Kraemer (2000) also found a significant impact of ICT capital stock on GDP growth in developed countries, but the impact is not significant for developing countries. They opined that complementary

factors that could enhance information technology, such as human capital, could be missing in the developing nations, as the period of study (1985-1993) connotes merely the beginning of the rapid diffusion of ICT in developed countries, which might be too early to yield any significant impacts in developing countries. Yousefi (2011) used data for the period 2000 to 2006 to examine the impact of ICT on the economic growth of developed and developing nations, and the results showed that ICT capital investment has an insignificant impact of ICT capital investment on output growth for developing countries. Pohjola (2002) could not find any significant relationship between ICT and economic growth with data on 42 countries for the period 1985 to 1999. Similarly, Stiroh (2002) found a negative output elasticity of ICT capital on US manufacturing industries' data for 1984 to 1999 using pooled OLS and IV regressions.

Based on the empirical literature highlighted, it is clear that the studies of the relationship between ICT and economic growth are far from being concluded, especially in developing countries. Therefore, it is important to examine this relationship in Nigeria using more variables to proxy ICT and also using recent data.

3. METHODOLOGY AND DATA SOURCES

In an attempt to investigate the relationship between information communication technology and economic growth in Nigeria, an autoregressive distributed lag (ARDL) bounds testing procedure, suggested by Pesaran *et al.* (2001), is employed. ARDL is chosen because of its merits. For instance, an ARDL model takes sufficient numbers of lags to capture the data generating process in a general-to-specific modelling framework (Laurenceson & Chai 2003). A dynamic error correction model (ECM) can also be generated from an ARDL by means of linear transformation (Banerjee *et al.*, 1993). The ECM connects the short-run and long-run equilibrium without the loss of the long-run information. An ARDL also helps to avoid problems resulting from non-stationary time-series data (Laurenceson & Chai 2003). The estimated model for the study is given as follow:

$$\Delta GGDP_t = \beta_0 + \sum_{i=1}^p \beta_{1i} \Delta GGDP_{t-i} + \sum_{i=0}^q \gamma_{1i} \Delta Z_{t-i} + \phi_1 GGDP_{t-1} + \phi_2 Z_{t-1} + e_{1t} \dots \dots \dots 1$$

In order to obtain the short-run behaviour of the variables, we make use of the error correction version of the ARDL model as follows:

$$\Delta GGDP_t = \delta_1 + \sum_{j=0}^p \delta_2 \Delta Z_{t-1} + wECM_{t-1} + \epsilon_t \dots \dots \dots 2$$

Where GGDP is the growth rate of GDP, while Z is the vector of measurements of information and communication technology such as secure internet server per 1 million (SIS), mobile cellular subscription per 100 people (MCS) and investment in telecoms with private participation (in current USD) (ITP). All the data have been sourced from the World Bank Development Indicators from 1997 to 2016.

4. EMPIRICAL RESULTS

4.1. Order of integration

The standard augmented Dickey-Fuller (ADF) and Phillips-Perron (PP) unit root tests were employed in order to investigate the time-series properties of the variables being investigated. The results of the unit root test are reported in Table 1. Using the probability values, all the series are stationary at level, except individual investment in telecom with private sector participation using ADF; while individual investment in telecom with private sector participation and mobile cellular subscription are nonstationary at levels using (PP). However, all the variables are stationary at first difference.

Table 1: Unit root test

Variables	ADF		PP		
	P-val at level	P-val at 1 st diff	P-val at level	P-val at 1 st diff	Order of Integration
GGDP	0.016*	0.0001*	0.016*	0.0000*	I(0)
LNITP	0.4893	0.0138*	0.4692	0.0138*	I(1)
LNMCS	0.000*	0.000*	0.2438	0.0244*	I(1)
LNSIS	0.0012*	0.0056*	0.0000*	0.05000*	I(0)

4.2. Bound testing (cointegration results)

The bound testing cointegration results are presented in Table 2. Pesarran *et al.* (2001) stated that the computed F-statistic should be compared with lower-bound and upper-bound values at chosen significance levels. From the bound testing

results, the computed F-statistic, which is 10.0258, is more than the upper bound value (4.35) at the 5% significance level. Consequently, the null hypothesis of no cointegration is rejected. The results conclude that there exists a long-run relationship between the economic growth and information technology in Nigeria, which is similar to the results found by Akinwale (2018).

Table 2: Bound testing results

The estimated F-statistic: 10.0258		
Critical value	Pesarran <i>et al.</i> (2001) Table Values	
	Lower bound value	Upper bound value
1%	4.29	5.61
5%	3.23	4.35
10%	2.72	3.77

4.3. Long-run analysis

Equation (3) pictures the results of the long- run relationship among the variables. The results show that there is a positive and significant long-run relationship between economic growth and mobile cellular subscription, while a negative long-run but insignificant relationship is observed between economic growth and investment in telecoms with private participation, as well as secure internet servers. This could be as a result of dwindling levels of private investment in telecoms when compared to other African countries, such as South Africa and Kenya.

$$\text{GGDP} = 8.029 - 0.445\text{LNITP} + 3.69\text{LNMCS} - 2.141\text{LNSIS} \dots\dots\dots 3$$

$$(-0.347224) \quad (2.130811) \quad (-1.325573)$$

4.4. Short-run relationship and error correction model (ECM) results

An investigation of the existence of a short-run relationship between the variables is carried out given the establishment of a long-run relationship between the variables. The error correction term gives the speed of the short-run adjustment

back to equilibrium in the long run. The empirical result of the short-run relationship is shown in Table 3 show that error correction term (-1.260728) is negative and significant. This means that there is at least a long-run causality between measures of information technology and economic growth. It also confirms that all the variables are cointegrated and therefore have a long-run relationship. The error correction term of -1.2607 means that economy returns to its equilibrium state in less than a year. The results further show that mobile cellular subscriptions and secure internet servers have positive and significant impacts on economic growth in the short run, at the 10% level of significance. This is in line with some previous studies, such as Nath and Liu (2017), Paunov and Rollo (2016), and Farhadi et al. (2012), among others. Meanwhile, investment in telecoms with private participation is still found to have negative and insignificant impacts on economic growth. The negative impact of investment in telecoms with private participation on economic growth could be as a result of the poor level of ease of doing business in the country, coupled with the high cost of borrowing and the insecurity threat in the country, among others, which could have prevented the inflow of foreign direct investment. This is similar to the outcomes found by Yousefi (2011) and Pohjola (2002) in their studies.

Table 3: Short-run relationship and error correction model (ECM) results

Variable	Coefficient	Std. error	t-statistic	Prob
D(LNITP)	-0.561731	1.615020	-0.347817	0.7335
D(LNMCS)	4.664452	2.276144	2.049278	0.0612*
D(LNSIS)	15.901412	5.293725	3.003823	0.0102*
CointEq(-1)	-1.260728	0.183991	-6.852122	0.0000*

*Note: * denotes the rejection of null hypothesis at 10 percent level of significance*

Table 4 displays the results of the Granger causality test of the variables. The results provide evidence of bidirectional causality between secure internet server and economic growth, and unidirectional causality from investment in telecoms to

mobile cellular subscriptions in Nigeria. This means that higher numbers of secure internet servers could cause the economy to grow, and at the same time, economic growth could also cause the number of secure internet servers to increase. Furthermore, investment in telecoms with private sector participation could cause mobile cellular subscriptions in the country to increase. Consequently, there should be a robust policy that should be backed up by a strong political commitment that supports the increase in the number of secure internet servers and investments in telecoms, as this is expected to bring about an increase in economic growth.

Table 4: Granger causality results

Null hypothesis:	Obs	F-statistic	Prob.
LNITP does not Granger cause GGDP	18	0.14276	0.8683
GGDP does not Granger cause LNITP		0.08710	0.9171
LNMCs does not Granger cause GGDP	18	0.18341	0.8345
GGDP does not Granger cause LNMCs		0.15203	0.8605
LNSIS does not Granger cause GGDP	18	4.81471	0.0272
GGDP does not Granger cause LNSIS		5.41972	0.0194
LNMCs does not Granger cause LNITP	18	0.29915	0.7464
LNITP does not Granger cause LNMCs		4.17607	0.0397
LNSIS does not Granger cause LNITP	18	1.33104	0.2979
LNITP does not Granger cause LNSIS		2.15567	0.1554

4.5 Diagnostic test

The stability or otherwise of the long-run coefficients is verified by the short-run dynamics. Once the ECM model has been estimated, the cumulative sum of recursive residuals (CUSUM) is used to assess the parameter stability (Pesaran & Pesaran, 1997). The results are presented in Figure 1. The results show that our parameter estimates are stable, because the CUSUM statistics fall within the critical bounds of the 5% confidence interval of parameter stability.

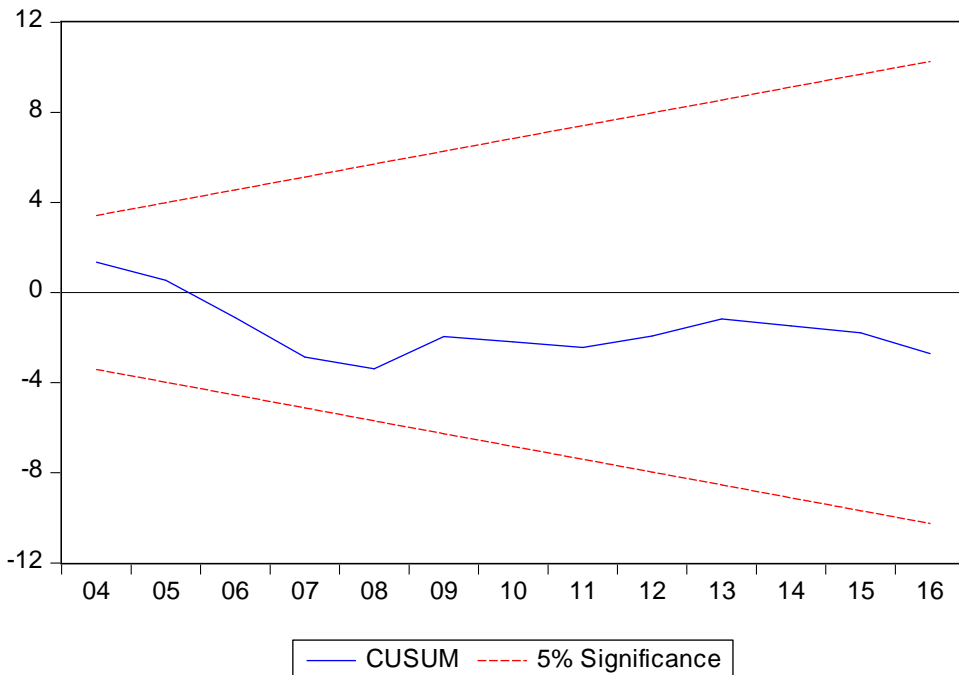


Figure 1: Plot of CUSUM test

Furthermore, Table 5 shows that there are no serial correlations or heteroscedasticity. The null hypotheses of no serial correlation and no heteroscedasticity were accepted because the probability values are not significant, since they are greater than 5 percent. Furthermore, the null hypothesis of normality distribution was accepted, since the probability value is greater than 5 percent. The results generally indicate that the series passed the whole of diagnostic tests as expected, which therefore

proved that the series could be relied upon to make inferences which could be used for effective policy making.

Table 5: Diagnostic test results

Item	Applied test	P-Val	Decision
Serial correlation	LM test	0.1704	No serial correlation
Normality	Jacque Bera	0.1251	Variables are normally distributed
Heteroscedasticity	Breusch Pagan Godfrey	0.5831	No heteroscedasticity

5. CONCLUSION

This paper examined the relationship between information and communication technologies and economic growth in Nigeria during the period 1997 to 2016. It was important for this study to be conducted, as the liberalisation of ICT in Nigeria since the early 2000s has made the telecommunication sector witness some dramatic changes in terms of the number of mobile phones and internet service users, among others. It is equally important to examine whether these changes have resulted in any positive and significant impacts on the economy, as they ought to.

The study employed autoregressive distributed lag mode (ARDL) and empirical results reveals that there is a long-run relationship between ICT and economic growth, as the bound test shows that the null hypothesis of no cointegration is rejected, and consequently supporting that there is a cointegration and long-run relationship between the variables that measure ICT and economic growth. In the short run, secure internet server per 1 million people and mobile cellular subscription per 100 people have a positive and significant impact on economic growth at the 10 percent level of significance, whereas investment in telecommunication with private sector participation is negative and not significant in influencing economic growth. Furthermore, Granger causality indicates that there is bidirectional causality between economic growth and secure internet server, and unidirectional causality from

investment in telecoms with private sector participation to mobile cellular subscription.

The implication of the general result of this study is that the level of investment in telecoms with private sector participation is still relatively low, as this is not statistically significant in having a direct positive impact on the economic growth. Therefore, there is a need for both the government and the private sector to increase the level of investment in the sector. However, the current Minister of Telecommunication is seriously talking about increasing the investment in this sector in 2018, and we can just hope that this will be backed up by the required political will. Of paramount importance is also the number of secure internet servers, as this has been shown to Granger cause economic growth. This is because, as the numbers of secure internet servers increase, this will provide an integrated health system, an enhanced education facility, improved research activity, an efficient financial system and a productive agricultural system, among others.

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