Impact of Information and Communication Technology on Public Sector Productivity Growth in Nigeria

Jonathan Gimmy Leo

Innovation and Technology Policy Department,
Nigerian Institute of Social and Economic Research (NISER), Ibadan, Oyo State, Nigeria

Abstract: **This paper examined the impact of information and communication technology on public sector productivity growth from 2000 to 2019 in Nigeria. It also explained the effects of past or lag productivity growth values on current productivity growth in Nigeria. The paper employed the autoregressive model and technique to estimate and analyze the data. The study reviewed relevant literature on the impact of ICT on productivity. The literature review suggests that ICT is positively related to productivity, but a large number of studies have not demonstrated that in Nigeria. The results revealed that ICT had a significant positive impact on public sector productivity growth in Nigeria. The result also indicated that past-period productivity growth significantly influences current-period public sector productivity growth in Nigeria. That explained the autoregressive nature of productivity growth. The paper also provided evidence that capital, labour, education output and foreign direct investment significantly influence public sector productivity growth in Nigeria. The policy recommendations of the paper include that the Public Sector should be provided with more ICT investments and infrastructures by the Government to optimize ICT potential in the country. The Government should upgrade the ICT skills deficiency among employees in the Public Sector to improve performance, to mention but few.**

Key Words: **Information and Communication Technology, Economic growth, Public Sector, Productivity growth, Nigeria.**

JEL Classification: **D24, H11, 033, Q55**

I. INTRODUCTION

Technological innovations have been widely accepted as the driver of sustained economic growth in many countries of the world.[1] This is particularly true in the ability of information and communication technology (ICT) to stimulate efficiency and productivity in public and private sectors that utilize and invest in them. According to Reamer (2014), Paul Krugman was speaking for many Economist when he said ''productivity isn't everything, but in the long run it's everything'' because the ability to improve a country's standard of living over time depends almost entirely on its ability to raise its output per worker. Productivity is simply defined as the output per worker in an economy over a period of time. Anyanwu, (2000) puts it as the ratio of output to input in a given period of time.[2] Empirical studies have linked ICT to be positively related to productivity and economic growth while others have shown the opposite relationship. Detail explanation of the relationship between ICT and productivity are provided in section two of this paper. However, ICT encourages innovation, increases competition, contributes to productivity growth and attracts foreign investments into a country (International and Telecommunication Union (ITU), 2018). Recent development in the world's economy has shown that countries with high productivity growth are not only central to the determination of global balance of powers, but also serve as centres for stimulus, where world resources (including labour) are redirected to, as opposed to countries with low or declining productivity (Obadan and Odusola, 2000). Empirical studies however had shown evidence of productivity slowdown arising from ICT production in the United States of America and the world from the 1970s to 2000s (Solow, 1987; Brynjolfsson, 1993; Brynjolfsson and McAfee, 2011; Gordon 2012).

The Nigerian economy has witnessed rapid growth in the ICT sector for the past two decades. The growth in the ICT sector is gradually improving efficiency in public administration of Government and increasing transparency in the public sector (Leo 2021). Between 2012 and 2019, the ICT sector grew persistently by 8.59% on average (Nigerian Communication Commission, (NCC) 2020). As at second quarter 2020, the ICT sector contributed 11.20% of the GDP even with a series of lockdown and restrictions during the pandemic in Nigeria. Similarly, broadband penetration increased from 21.69% in January 2017 to about 45.02% in December 2020 (NCC, 2020). The ITU 2018 report reaffirmed the growing trends in the ICT world as more than half (51.2%) of the world's population is now online. The developments in the ICT sector is affecting our lives in one way or the order by exposing the Nigerian economy to global digital systems. Although the ICT sector is experiencing a boom, the productivity of workers in the Nigerian public sector appears to be declining over the years. Data from World Bank's

[1] Leipziger and Dodev, (2016) attributed the exponential rise in economic growth since the second industrial revolution and the massive rise in living standards in Europe to technological innovations. He also recognized the role of ICT in the emergence of emerging markets or economies in the world.

[2] Productivity growth however, is the increase in output per worker over a given period of time.

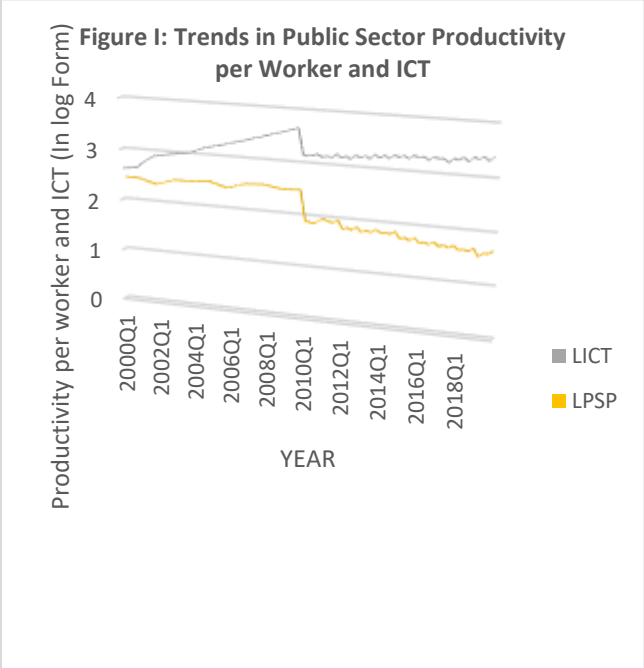
Development indicators for Nigeria suggest that industrial value added per worker declined from US$15,782.78 in 2016 to US$15,616.51 in 2019. The services sector value added per worker (ICT inclusive) declined in a similar manner from US$9,136.42 in 2016 to US$8,574.75 in 2019.[3] However, the agricultural value added per worker rose marginally from US$5,849.89 in 2016 to US$6,154.49 in 2019 (World Bank's WDI, 2021).

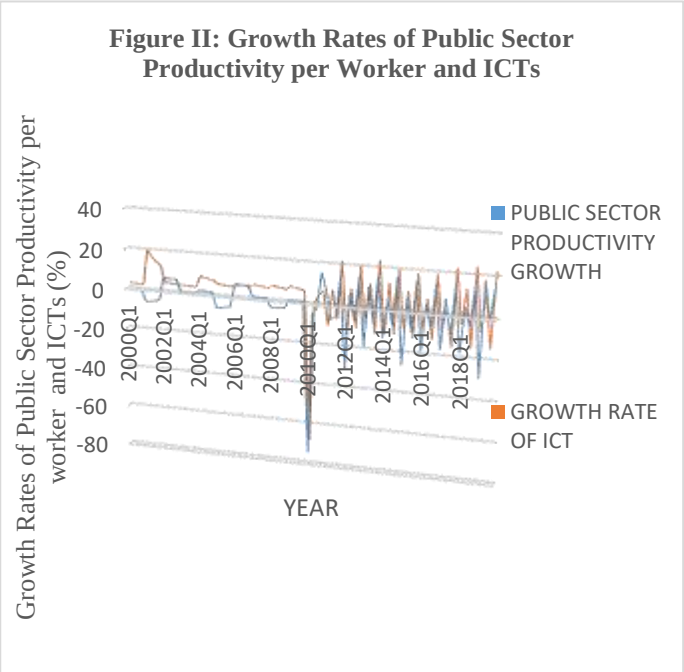
However, an important impediment to productivity growth and ICT sector's development in Nigeria is lack of ICT skills and weak ICT infrastructural facilities in the public sector.[4] Inadequate ICT skills and the frequent power outages experienced in Nigeria has limited innovation and the effective use of ICT for maximum productivity and growth in the Public Sector. Adeoti, (2020) argued that the Government has contributed to Nigeria's current state of innovation deficits through deficient policies and lack of commitment to building a knowledge-based and innovation-driven economy. If this is correct, then it suggests that the Public Sector has not invested enough in ICTs and its workforce to enable them acquire the required skills for improved productivity growth. Growth in productivity provides a significant basis for adequate public service delivery in Nigeria. The objective of this paper is to examine the impact of ICTs on Public Sector productivity growth in Nigeria. It will explain the effect of past productivity growth on current public sector productivity growth in Nigeria.

II. LITERATURE REVIEW

II.I. Conceptual Review

Public Sector productivity growth has become an issue of debate among policy makers during periods of economic reforms. The debate sprang from the partial perception that the private sector is always more efficient than the public sector. This is because of the fact that the public sector in most economies is considered as redundant, uncompetitive and unproductive in delivering public good or services.[5] This paper does not take part in the debate but seek to explain the effect of ICTs on public sector productivity growth in Nigeria. Public Sector Productivity growth is defined as the rate of increase in output per worker in the public sector.





Source: Author's computation from CBN, (2019) and NBS (2006).

It is the rate of increase in the ratio of public sector output to public sector input over a period of time. Obadan and Odusola, (2000), noted that the long-term productivity growth rates for Nigeria were disappointing as it recorded low average growth rate of -0.17 percent between 1974 and 1996. This low productivity growth rate could even be worse if the private sector is excluded from it. The reasons for the low productivity growth were tie to low level of manpower training in both private and public sectors in Nigeria (Obadan and Odusola, 2000). Brynjolfsson, (1993) defined productivity as the

[3] https://databank.worldbank.org/reports.aspx?source=World-Development-Indicators# Accessed 11th February, 2021

[4] In forty (40) out of eighty (80) countries for which data was available, less than half the population possesses basic computer skills such as copying a file or sending an e-mail with an attachment (ITU, 2019)

[5] Experience and empirical studies have shown that there no significant difference in efficiency between public and privately-owned enterprises in public service delivery across the world (EPSU, FSESP and EGOD, 2014)

fundamental economic measure of a technology's contribution. However, Public Sector productivity growth may entail improvement in quality of output or services delivered, improvement in efficiency, absence of public complaints, public or customer's satisfaction, and adherence to due processes, improved accountability and transparency in Public Sector management. Figure I showed the trends in public sector productivity per worker and ICT. Productivity per worker rises or falls as ICT contribution to GDP rises or falls in Nigeria. Similarly, in Figure II, the growth rates of productivity per worker and ICT appears to be moving in the same direction but slightly different. This relationship between public sector productivity per worker and ICTs will be fully established in section 4 of this study.

II.II. Theoretical Review

The theoretical relationship between ICT and productivity growth has its roots in the early work of Joseph Schumpeter ''Capitalism, Socialism and Democracy.'' Schumpeter's principles of 'creative destruction' envisaged a product and process innovation systems (ICT inclusive) in which new production units or products replaces the old or outdated ones in an economy.[6] This process of creative destruction does not only imply harnessing new technologies, but also developing new business models and exploiting old technologies in a new way (Leipziger and Dodev, 2016). The work of Solow (1956) added to the modern theory of economic growth because it sees growth arising from technological progress. Growth was determined by forces that are external to the economy. In the Neo-Classical theory, the aggregate production function is expressed as a function of factor inputs such as labour, capital, land, technology, etc. (Obadan and Odusola, 2000). This was contrary to the new growth theory that postulated that economic growth is endogenously determined within the economy. The new growth theory emphasized the role of technological innovations, knowledge and human capital investment in achieving economic growth.[7] These Neo-classical theories could not explain better how the public sector could achieve higher productivity and economic growth. For instance, the Keynesian economist may regard technological innovations or progress, human capital investment and acquisition of knowledge arising from government spending or interventions. Government intervention or spending appears to be crucial determinant of public sector performance or productivity growth. Although Keynesian economics did not explicitly recognize the role of technological innovations, it implicitly acknowledged it via government investment spending. Therefore, Keynesian economics is destined to lead public policy in most economies of the world because of its effectiveness in stimulating aggregate demand in all sectors of the economy.

However, Government spending alone in the public sector may not generate the desired results, the diffusion of technological innovation is crucial in ICT penetration of the public sector in Nigeria. Everett Rogers in 1962 tried to explain how technological innovations spread or diffuses from one section of the population to another over time.[8] The adoption and usage of ICT diffuses in all sectors before their full impact are felt on the entire economy. However, the diffusion of innovation theory remains a social theory that may be subjective concerning the impact of ICTs on productivity growth. According to Qiang, et al, (2003), there are three channels through which ICT can influence economic growth, namely total factor productivity growth in sector producing ICT, capital deepening and total factor productivity growth through reorganization and ICT usage.

II.III. Empirical Review

Empirical studies are many on the relationship between ICTs and economic growth. As general-purpose technologies, the impacts of ICTs extend not only to productivity gains, but also to economic and social transformations (by improving access to services, enhancing connectivity, creating business and employment opportunities, and changing the ways economic agents communicate, interact and engage themselves) (World Economic Forum and INSEAD, 2015). The impact of ICTs on economic growth have been demonstrated by several studies in the literature (Brynjolfsson, (1993); Brynjolfsson and McAfee 2011; UNCTAD 2011; Qiang, et al, 2003; Frontiers Economics 2011; Gordon 2012; Binuyo and Aregbeshola 2015; Leipziger and Dodev 2016; Nasab and Aghaei 2009; Bahrini and Qaffas 2019; etc.). These studies showed that ICT is positively related to economic growth. Some few studies have posited that ICT is negatively related to economic growth because computers and other ICTs devices is replacing human labour and creating unemployment in the economy. Brynjolfsson and McAfee, (2011) wasn't pessimistic when they contended that although the computer age was bringing deep changes in the economy, some human skills are more valuable than ever, even in an age of incredibly powerful and capable digital technologies. They see digital technologies as the key drivers of productivity and growth in the modern economy.

Studies in the literature have also linked ICT to productivity. Malaarachchi, et al., (2016) investigated whether ICT usage influence organizational productivity of Sri-Lanka's private sector using a qualitative multiple regression analysis. The study found that ICT device usage does not influence

[6] https://ia801602.us.archive.org/33/items/in.ernet.dli.2015.190072/2015.190072.Capitalism-Socialism-And-Democracy.pdf Accessed: 15th February, 2021.

[7] The new growth theory is attributed to Paul M. Romer. Romer (1994) identified the sources of endogenous growth to include results from research and development, knowledge and human capital investment.

[8] Everett Rogers identified five stages of diffusion of innovation which include innovators (2.5%), early adopters (13.5%), early majority (34%), late majority (34%) and laggards (16%). https://sphweb.bumc.bu.edu/otlt/MPH-Modules/SB/BehavioralChangeTheories/BehavioralChangeTheories4.html#:~:text=%20Diffusion%20of%20Innovation%20Theory%20%201%20Innovators,adopt%20new%20ideas%20before%20the%20average...%20More

organizational productivity but only ICT functional usage does influence organizational productivity in Sri-Lanka private sector. Sanjeev Dewan and Kenneth L. Kraemer, (2000) studied the key drivers of the demand for the product and services of the global information technology industry for 36 countries from 1985 to 1993. The study found significant differences between developed and developing countries with respect to their structure of returns from ICT capital investments. For the developed countries, the returns from ICT capital investments are estimated to be positive and significant while returns from non-ICT capital investments are not commensurate with relative factor shares. They also found that for developing countries, the returns from non-ICT capital were quite substantial, but those from ICT capital investments are not statistically significant. In a similar study, Spiezia Vincenzo (2012), used an econometric technique to analyze the contribution of ICT investments (computer, software and communication) to productivity (value added growth) in 26 industries in 18 OECD countries from 1995-2007. The study found the contribution of ICT investments to be between 0.84 and 3.5 percentage points lower according to non-parametric rather than to the parametric approach. Also, ICT producing industries accounted for no less than two-third of total factor productivity growth in Germany, Slovenia, and the United Kingdom, about 60% in the United States of America (USA) and just below 50% in France and the Netherlands. Total factor productivity increased for the ICT industries in Denmark, Czech Republic and Italy whereas it decreased for the total business sector. Using simultaneous equations to examine the effects of ICT in reducing aggregate technical inefficiency, Dimelis and Papaioannou, (2015) also provided evidence that ICT is positively related to labour productivity and that ICT is effective in reducing country inefficiencies. Obadan and Odusola (2000) showed bi-directional causality between productivity and employment in all cases except in the agricultural sector in Nigeria. They also showed a bi-directional causality in the industrial sector and unidirectional causality between productivity and unemployment in Nigeria. The results further showed that productivity is positively related to employment and inversely related to unemployment in Nigeria.

Kelly (1994) analyzed the effects of ICT on efficiency of production operations in 584 manufacturing firm's establishments and found a significant efficiency advantage from using programmable automation technology and that technological advantages accumulate with experience and with the repeated opportunities of learning associated with large volume and frequent product changes. Egwakhe, et al, (2020) studied the influence of technology transfer on labour productivity using multiple regression analysis in Nigerian automobile industry. The study found a positive significant relationship between technology transfer and labour productivity in Nigeria. However, Macuilyte-Sniukiene and Gaile-Sarkane (2014) tried to discuss the theoretical aspect of ICT development and its impact on labour productivity and economic growth. The study found theoretically that ICT development led to increase in labour productivity both in the sectors producing ICT and in sectors using ICT. The study however did not find any correlation between ICT development and labour productivity in some of the high and medium productivity countries in the European Union (EU). In five out of six countries with medium productivity and all the low productivity countries in the EU, ICT (fixed broadband internet subscription had significant impact on labour productivity. Corrado, et al, (2014) used an econometric approach to study the channels of intangible ICT capital influences productivity growth in the market sector of 10 EU countries. The study found that the estimated output elasticities of ICT capital is reduced when unmeasurable intangible capital are introduced suggesting that they complement each other in production. They also found that a positive relationship exists between ICT capital and productivity growth because the evidence of productivity spillovers tends to increase in intangible capital and workforce skills.

In the public sector, ICT is linked to public sector management. This is because of its ability to improve efficiency, transparency, and accountability in government. Oshi, et al., (2016) administered 250 copies of questionnaires to staff of five Ministries on the impact of ICTs on employee's productivity in Nigeria. They found partly that most employees in the public sector do not believe in the overall efficacy of ICTs as negative regression weight existed. The poor attitude towards ICTs by employees was largely due to age, lack of ICT skills and low educational background. However, others partly had positive regression weight showing that ICTs influence employee's productivity in the public service in Nigeria. ICT infrastructures are lacking in most public offices in Nigeria. Evans (2019) examined the effects of ICTs on public sector management in Africa from 1995 to 2015 using the generalized method of moments (GMM) and found that ICT is positively related to public sector management in Africa. He further showed a bi-directional causality between ICT and public sector management. None of the studies explained the effects of ICT on public sector productivity growth in Nigeria. This paper is an attempt in this direction.

III. METHODOLOGY

III.I. Scope and Sources of Data

In this paper, we examined the impact of ICTs on public sector productivity growth from 2000 to 2019. To be specific, quarterly secondary data were collected from different source for the study. The sample size is chosen because it is sufficiently large to represent the true population of the data. The data were collected from Central Bank of Nigeria (CBN), National Bureau of Statistics (NBS), Nigerian Communication Commission (NCC), and possibly World Bank's World Development Indicators were used for the study. The institutions were chosen because they produce data relating the ICT sector in Nigeria. Table I present the list of variables for which data were collected for the study.

Table I: Description of Variables

Variable	Description	Source
Y_t	Rate of change in public sector output per employee over a given over time.	CBN and NBS
K_t	Capital stock proxied by gross capital formation	CBN
L_t	Labour stock proxied by labour force	CBN and NBS
ICT_t	Value of ICT in GDP	CBN
P_t	General price level proxied by consumer price index	CBN
PS_t	Power supply proxied by electricity generation	CBN and NBS
EDU_t	Value of education output in GDP	CBN
FDI_t	Foreign direct investments	CBN
PSO_t	Value of public sector output in GDP	CBN
PSE_t	Number of public sector employees or workers	NBS

III.II. Theoretical Framework and Specification of the Model

Current productivity values are related to past period productivity values because the public sector, firms and individual users of ICTs may require some experience before becoming proficient (Brynjolfsson, 1993). In other words, the effects of ICT on productivity growth is assumed to move with a lag arising from learning and adjustment by employees in the public sector in Nigeria.[9] The paper tried to use both current and past information about the effects of ICT on productivity growth in Nigeria. The model of this paper is consistent with the endogenous growth model of Romer (1990) but differs from it because of the autoregressive productivity component.[10] Therefore, the aggregate Cobb-Douglas production function is of the form specified in equation 1.

$$Y_t = K^{\beta 1} L^{\beta 2} ICT^{\beta 3} P^{\beta 4} PS^{\beta 5} EDU^{\beta 6}$$

$$FDI^{\beta 7} Y_{t-1}^{\beta 8} \dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots (1)$$

Equation one is a first order autoregressive (AR (1)) process which can be transformed into a stationary econometric model in equation 2 as follows;

$$\Delta Y_t = \beta_0 + \beta_1 \Delta LK_{t-3} + \beta_2 \Delta LL_{t-1} + \beta_3 \Delta LICT_t + \beta_4 \Delta LP_t + \beta_5 \Delta LPS_t + \beta_6 \Delta LEDU_t + \beta_7 \Delta LFDI_t + \beta_8 \Delta Y_{t-1} + U_t \dots\dots\dots\dots\dots\dots\dots (2)$$[11]

The a-priori expectation of the model requires that; $\beta_1 > 0, \beta_2 > 0, \beta_3 > 0, \beta_4 < 0, \beta_5 > 0, \beta_6 > 0, \beta_7 > 0, \beta_8 > 0$. Where; Δ = change; Y_t = public sector productivity growth at time t LK_{t-3} =log of capital stock (proxied by gross capital formation) at time t-3, LL_{t-1} =log of labour stock (proxied by labour force) at time t-1, $LICT_t$ = log of ICT in GDP at time t, LP_t = log of general price level (proxied by consumer price index) at time t, LPS_t = log of power supply (proxied by electricity generation) at time t, $LEDU_t$= log of education output in GDP at time t, $LFDI_t$ = log of foreign direct investment (FDI) at time t, Y_{t-1} = lagged value of public sector productivity growth at time t-1, U_t = the stochastic error term at time t, β_0 = the intercept or constant term, $\beta_1, \beta_2, \dots, \beta_7$ = the slope or the respective semi-elasticities coefficients of the explanatory variables with k = 1, 2, …., 7; and β_8 = the first order autoregressive coefficient (which determines the nature of dependence) of lag public sector productivity growth. The bottom-line of this paper is that productivity growth depends on capital stock, labour, ICT (Technology), price level, FDI, educational output, and past productivity growth in Nigeria.

III.III. Estimation and Analytical Techniques

After examining the unit root features of the data, the paper employed the autoregressive (AR) model's technique to estimate the regression equation specified in section 3.2. The null hypothesis of no unit root is rejected if the Augmented Dickey Fuller (ADF) test statistics is greater than the critical values at 1% or 5% level of significance. The autoregressive model helps correct the likely autocorrelation in the residuals of the model by removing the unit roots in the data.[12] However, the autoregressive models may pose estimation problems, if the lag productivity growth (Y_{t-1}) variable is correlated with the error term. The ordinary least square techniques (OLS) may become bias, inefficient and inconsistent. The paper will test for the hypothesis of no serial correlation in the regression residuals using the Breusch-Godfrey (BG) serial correlation lagrangian multipliers (LM) Test. The null hypothesis of no serial correlation is rejected if the probability of chi-square is less than critical 5% values. The regression estimates only become valid when autocorrelation does not exist in the residuals. The regression estimates become unbiased, efficient and consistent if there is no serial correlation in the error terms. The significance of the regression estimates will be validated using the coefficient's standard errors, t-statistics and the probability values. The significance of the estimates was determined at 1%, 5% and 10% levels of significance. The results will be interpreted using a robust content analysis.

IV. RESULTS AND DISCUSSION OF FINDINGS

The results in Table II showed that all the variables under investigation are integrated of order one (i.e. I (1)). The null hypothesis of no unit root was rejected at 1% and 5% level of significance respectively. The implication of this is that the variables will be differenced once to be stationary. The differenced equation (i.e. equation 2) has captured that process. The result presented in Table III, utilized the unit root results in its estimation process.

[9] Productivity growth is defined as rate of change in public sector output per employee over a given period of time. (i.e. $\frac{\Delta Y}{Y} \times \frac{100\%}{1}$ where, Δ= change, Y= Productivity)

[10] Romer (1990) specified a three component model of the type $Y_t = K^{\propto} L^{\beta} \sum_{i=1}^{n} X_i^{1-\alpha-\beta}$ where, Y_t = GDP per capital at time t, K^{α} = Capital stock, L^{β} = Labour stock and X_i = technological component.

[11] Equation 2 is a semi-log model. The semi elasticity coefficients will be interpreted by multiplying the coefficient by 0.01(or dividing the semi elasticity coefficient by 100).

[12] Autoregressive models are applied to time series data that are stationary and are likely to be co-integrated in the long run.

Table II: Unit Root Test Results

Variables	ADF Statistics	Order of integration	Critical values		
			1%	5%	10%
Y_t	-8.0965*	I (1)	-3.5242	-2.9024	-2.5886
Y_{t-1}	-8.0144*	I (1)	-3.5256	-2.9029	-2.5889
LK_t	-3.0687**	I (1)	-3.5203	-2.9007	-2.5877
LL_t	-3.8716*	I (1)	-3.5167	-2.8991	-2.5869
$LICT_t$	-10.9043*	I (1)	-3.5167	-2.8991	-2.5869
$LEDU_t$	-3.4548**	I (1)	-3.5203	-2.9007	-2.5877
$LFDI_t$	-12.2978*	I (1)	-3.5167	-2.8991	-2.5869
LP_t	-8.5419*	I (1)	-3.5178	-2.8996	-2.5871
LES_t	-4.8203*	I (1)	-3.5167	-2.8991	-2.5869

Source: Author's computation.

Note: * and ** = significant at 1% and 5% levels of significance respectively4.1 ICT Impact on Public Sector Productivity Growth in Nigeria.

In Table III, the coefficient of lag public sector productivity growth (Y_{t-1}) did not meet the a-priori expectation of the model but was significant at 1% level of significance. The implication of this is that past productivity of workers is related to their current productivity growth in the public sector in Nigeria. The sign of the coefficient was negative meaning a reduction or an increase in one-quarter lag public sector productivity growth value by ₦1,000.00 per worker, current public sector productivity growth will increase or reduced its value by -0.568 units in Nigeria. A plausible explanation for this wrong sign of the AR (1) coefficient is that public sector ICT users may need time for learning and adjustment before they become proficient and productive in their jobs. ICT skills gap exist in Nigeria (Adeoti 2020) and more pronounced in the public sector where many of worker are deficient. Obadan and Odusosla (2000) was disappointed when they survey the productivity growth trends for Nigeria from 1974 to 1996. They uncover an average productivity growth rate of -0.17% during the period. Between 2000 and 2019, Nigerian public sector had a far lower average productivity growth rate of -0.97% than it was then. This suggests that past productivity growth rates have further slowed down even with the ICT usage in Nigeria. This low average productivity growth trends may be overturned with proper manpower training and capacity building for workers in the public service in Nigeria.

The coefficient of ICT is a semi elasticity coefficient. This paper multiplies the coefficient by 0.01% to make inference from the results. The elastic coefficient met the a-priori expectation and also significant. The implication is that ICT had a significant positive relationship with public sector productivity growth in Nigeria. A one (1) percent increase or decrease to ICT, will increase or reduce public sector productivity growth by 1.025 percentage point (i.e. 102.569×0.01%). This finding is consistent with previous findings such as Evans (2019) who found that ICT is positively related to public sector management in Africa. Dimelis and Papaioannou (2015) found that ICT is positively related to labour productivity and that ICT is effective in reducing country inefficiencies while Egwakhe, et al, (2020) found that technology transfer (ICT) significantly and positively influences labour productivity in Nigeria. Leo (2021) found that ICT do matter in public sector efficiency in Nigeria.

Table III: Regression Result of the Impact of ICTs on Public Sector Productivity Growth

Variables	Coefficient	Standard Error	t-Statistics	P-Value
C	0.939	2.151	0.437	0.663
$D(LK_{t-3})$	-82.182**	29.131	-2.821	0.006
$D(LL_{t-1})$	108.589	258.923	0.419	0.676
$D(LICT_t)$	102.569**	19.961	5.139	0.000
$D(LP_t)$	-83.396	128.653	-0.648	0.519
$D(LEDU_t)$	56.527**	13.159	4.296	0.000
$D(LFDI_t)$	12.188**	4.717	2.584	0.012
$D(LES_t)$	5.755	19.643	0.293	0.771
$D(Y_{t-1})$	-0.568**	0.061	-9.362	0.000
R^2 = 0.8154	Adj. R^2 = 0.7934	F-Stat. = 37.00**	Prob (F-Stat) = 0.000	D.W. Stat = 1.766

Source: Author's Computation.

Note: ** = significant at 5% level of significance.

Also, Corrado, et al (2014) found a positive relationship between ICT capital and productivity growth. This finding demonstrates that public sector productivity growth in definitely influenced by ICT investment and ICT usage. Izevbigie et al., (2019) further confirmed that ICT is positively correlated with public sector tax revenues in Nigeria. In the public sector, the utilization of ICTs lubricates production and makes work easier thereby enhancing productivity in the sector. Three-quarter lag capital stock did not meet the expected sign but was significant at 5% level of significance. A rise or fall in past three-quarter capital stock significantly influence current fall or rise in public sector productivity growth in Nigeria. A one (1) percent change in three-quarter lag capital stock will result to a 0.822 percentage point fall in public sector productivity growth in Nigeria. In practical sense, capital stocks rise with a rise in public sector productivity growth. The educational output coefficient was inelastic and significant at 5 percent level of significance. A one (1) percent change in educational output will result in a 0.565 percentage point change in public sector productivity growth in Nigeria. Education and training enable economic agents to improve their capacities and competencies thereby experiencing growth in their productivity level in the work place. The coefficient of foreign direct investment is inelastic and was also significant at 5 level. The implication is that foreign direct investment is positively related to public sector productivity growth in Nigeria. A one (1) percent change in foreign direct investment

will results in a 0.122 percentage point change in public sector productivity growth in Nigeria. Foreign investments and partnerships in the public sector increases productivity growth in the economy. The coefficients of electricity supply and general price level were statistically insignificant but also meet the a-priori expectation of the model. This suggests that although the effects of the two coefficient of electricity supply and price level were statistically insignificant, they also account for the variations in public sector productivity growth in Nigeria. The model has goodness of fit, since the coefficient of determination showed that about 81.54 percent of the variations in public sector productivity were explained by variations in capital stocks, labour stock, ICT, general price level, educational output, foreign direct investment, electricity supply and past productivity growth values in Nigeria. The F-statistics of 37.00 showed that the overall model is significant at 5% level of significance. The Durbin-Watson (D.W.) statistics of 1.766 showed absence of serial correlation in the error terms.

Table IV: Breusch-Godfrey Serial Correlation LM Test

F-Statistics	0.6227	Prob F-Stat (2,65)	0.5396
Obs*R-Squared	1.4289	Prob. Chi-square (2)	0.4895

Source: Author's Computation

The Breuch-Godfrey serial correlation LM test in Table IV also indicated that the error terms are not serially correlated. The probability of F-statistics of 0.5396 is far greater than the 5% critical value. Also the probability of Chi-square of 0.4895 is greater than the critical 5% value. We therefore accept the null hypothesis of no serial correlation in the regression residuals

V. CONCLUSION AND POLICY RECOMMENDATIONS

This paper examined the impact of information and communication technology on public sector productivity growth in Nigeria. It also explained the effects of past or lag productivity growth values on current productivity growth in Nigeria. The results revealed that ICT had a significant positive impact on public sector productivity growth in Nigeria. The result also indicated that past period productivity growth significantly influence current period public sector productivity growth in Nigeria. That explained the autoregressive nature of productivity growth. The paper also provided evidence that capital, labour, education output and foreign direct investment significantly influence public sector productivity growth in Nigeria. The influence of electricity supply and general price level on public sector productivity growth was shown to be statistically insignificant in Nigeria. There is no doubt that Government decisions or policies on ICT can influence public sector productivity growth in Nigeria. This paper makes the following policy recommendations for the Government;

- The Public Sector should be provided with more ICT investments and infrastructures (especial electricity power supply and broadband internet) by the Government to optimize ICT potentials in the country.
- The Government should upgrade the ICT skills deficiency among employees in the Public Sector to improve performance
- Digital literacy and awareness campaigns should be created and pursued by the Government to sensitize the public or citizens that they can be productive even in their homes or houses.
- Procurement and distribution of ICT or digital devices by the Government to public institutions of learning at all levels of education in the country to improve ICT skills in the country.
- Partnership with foreign investors or development partners for capacity building and training for public sector employees on best practices and latest technology in governance.

REFERENCES

[1] Adeoti, J. O., (2020). Economic Competitiveness and New Opportunities for Industrializing Nigeria. Nigerian Institute of Social and Economic Research (NISER) Ibadan, Nigeria.

[2] Anyanwu, C. M., (2000). Productivity in the Nigerian Manufacturing Industry. https://www.cbn.gov.ng/out/publications/occasionalpapers/RD/2000/ABE-00-7.PDF

[3] Bahrini, R., and Qaffas, A., (2019). Impact of Information and Communication Technology on Economic Growth: Evidence from Developing Countries. Economies. Vol. 7, No. 21. MDHI. www.mdpi.com/journal/economies

[4] Binuyo, A. O., and Aregbeshola, R. A., (2015). ICT Adoption and Economic Growth Nexus: Evidence from Leading African Economies. Journal of Economics and Management Studies. Vol. 7, No. 5. ISSN: 2220-6140.

[5] Brynjolfsson, E., (1993). The productivity paradox of Information Technology: Review and Assessment. Communications of the ACM.

[6] Brynjolfsson, E., and McAfee, A., (2011). Race Against the Machines: How the Digital Revolution is Accelerating Innovation, Driving Productivity and Irreversibly Transforming Employment and the Economy. Digital Frontier Press, Lexington, Massachusetts.

[7] Corrado, C., Haskel, J., and Jona-Lasinio, C., (2014). Knowledge Spillovers, ICT and Productivity Growth. IZA Discussion Paper No. 8274.

[8] Dimelis, S. P., and Papaioannou, S. K., (2015). Technical efficiency and the Role of ICT: A Comparison of Developed and Developing Countries. Emerging Market Finance and Trade. Vol. 47 (2). Pp. 41.54. ISSN 1540-496X. DOI 10.2753/REE1540-496X4701S203

[9] Egwakhe, A. J., Amos, N. B., and Nicodemus, T., (2020). Can Technology Transfer Stimulate Labour Productivity: Experience from Nigerian Automobile Sector. Canadian Centre of Science and Education- International Journal of Business and Management. Vol. 15, No. 4. ISSN 1833-3850

[10] EPSU, FSESP and EGOD, (2014). Public and Private Sector Efficiency. A Briefing for the EPSU Congress by ESIRU. Public service and the EU.

[11] Evans, O., (2019), Digital Government: ICT and Public Sector Management in Africa. Research Gate.

[12] Frontiers Economics, (2011). Contribution of the Digital Communication Sector to Economic Growth and Productivity in the UK: Economic Analysis Paper. Final Report Prepared for Department for Culture, Media and Sport (DCMS). Frontiers Economics Ltd London.

[13] Gordon R. J., (2012). Is U.S. Economic Growth Over? Faltering Innovation Confronts: The Six Headwinds. National Bureau of Economic Research (NBER) Working Paper 18315. http://www.nber.org/papers/w18315

[14] International Telecommunication Union (ITU) (2018). Measuring the Information Society Report Statistical Report 2018. ITU Publication, Volumes 1&2.
[15] International Telecommunication Union, (2019). Measuring Digital Development: Fact and Figures 2019. ITU publication.
[16] Izevbigie, N. J., Arodoye, N. L., and Moses, R. E., (2019). Information and Communication Technology and Tax Administration in Nigeria: Theoretical and Descriptive Analysis. Journal of Economics and Allied Research. Vol. 3, No. 1. ISSN 2536-7447.
[17] Leipziger, D., and Dodev, V., (2016). Disruptive Technologies and their Implications for Economic Policy: Some Preliminary Observations. Institute for International Economic Policy Working Paper Series, Elliott School of International Affairs. The George Washington University
[18] Leo, J. G., (2021). Does Information and Communication Technology Matter in Public Sector efficiency in Nigeria? Journal of Economics and Allied Research (JEAR). Volume 6, number 1. Page 159-172.
[19] Obadan, M. I., and Odusola, A. F., (2000). Productivity and Unemployment in Nigeria. https://www.cbn.gov.ng/out/publications/occasionalpapers/RD/2000/ABE-00-10.PDF
[20] Macuilyte-Sniukiene, A., and Gaile-Sarkane, E., (2014). Impact of information and Telecommunication technologies development on Labour productivity. Elsevier Ltd. Procedia-Social and Behavioural Sciences 110 (2014): 1271-1282.
[21] Malaarachchi, D. N., Wickramasinghe, C. N., and Dasanayaka, S. W. S. B., (2016). Information and Communication Technology Usage on Organizational Productivity in Sri-Lanka Private Sector. Department of Management Technology, University of Moratuwa, Katubedda, Sri-Lanka. International Conference in Technology Management, 2016 Edition.
[22] Maryellen R. Kelly, (1994). Productivity and Information Technology: the Elusive Connection. Management Science. 40 (11): 1406-1425. http://dx.doi.org/10.1287/mnsc.40.11.1406
[23] National Bureau of Statistics (NBS), (2006). Annual Abstract of Statistics. The Federal Republic of Nigeria. Abuja. Nigeria.
[24] National Bureau of Statistics (NBS), (2006). The Nigerian Statistical Fact Sheets on Economic and Social Development. The Federal Republic of Nigeria.
[25] Nasab, E. H., and Aghaei, (2009). The Effects of ICT on Economic Growth: Further Evidence. International Bulletin of Business Administration. Euro Journals, Inc. 5 (2009) ISSN 1451-243X. http://www.eurojournals.com/IBBA.htm
[26] Nigerian Communication Commission (NCC), (2020). Statistics and Reports: Industry Statistics https://ncc.gov.ng/statistics-reports/industry-overview#view-graphs-tables-7
[27] Oshi, J. E. O., Onwuka, E. M., and Enyia, C. D., (2016). Impact of ICTs on Employees Productivity in Public Enterprises In Nigeria: A Study of Selected Enterprises in Rivers State. Research Journal of Management. Vol. 4, No. 6. ISSN 2347-8217.
[28] Qiang, C. Z. W., Pitt, A., and Ayers, S., (2003). Contribution of Information and Communication Technology to Growth. The World Bank. World Bank Working Paper No. 24.
[29] Reamer, A., (2014). The Impact of Technological Invention on Economic Growth: A Review of the Literature. The George Washington Institute of Public Policy. George Washington University, Washington D.C.
[30] Romer, P. M., (1994). The Origin of Endogenous Growth. Journal of Economic Perspectives. Vol. 8, No. 1. Pp. 3-22.
[31] Romer, P. M., (1990). Endogenous Technological Change. Journal of Political Economy. Vol. 98, No. 5. Part 2. Pp. S71-S102. http://web.stanford.edu/~klenow/Romer_1990.pdf
[32] Sanjeev Dewan; Kenneth L. Kraemer, (2000). Information Technology and Productivity: Evidence from Country-Level Data. Management Science 46 (4): 548-562. http://dx.doi.org/10.1287/mnsc.46.4.548.12057
[33] Schumpeter, J. A., (1942). Capitalism, Socialism and Democracy. Harper and Brothers Publishers. New York and London.
[34] Solow, R. M., (1956). A Contribution to the Theory of Economic Growth. The Quarterly Journal of Economics, Vol. 70, No. 1. Pp. 65-94. http://www.econ.nyu.edu/user/debraj/Courses/Readings/Solow.pdf
[35] Solow, R. M., (1987). We'd Better Watch Out. Manufacturing Matters http://www.standupeconomist.com/pdf/misc/solow-computer-productivity.pdf
[36] Spiezia, Vincenzo (2012). ICT investments and Productivity: Measuring the Contribution of ICTs to Growth. OECD Journal: Economic Studies, Vol. 2012/1. http://dx.doi.org/10.1787/eco_studies-2012-5k8xdhj4tv0t
[37] UNCTAD, (2011). Measuring the Impacts of Information and Communication Technology for Development. United Nations Conference on Trade and Development (UNCTAD) Current Studies on Science, Technology and Innovation. No. 3 UNCTAD/DTL/STICT/2011/1
[38] World Bank WDI, (2021). World Development Indicators (WDI) https://databank.worldbank.org/reports.aspx?source=World-Development-Indicators#
[39] World Economic Forum and INSEAD, (2015). The Global Information Technology Report 2015: ICT for Inclusive Growth. Edited by Dutta S., Geiger, T., and Lanvin, B., Insight Report.
[40] https://sphweb.bumc.bu.edu/otlt/MPH-Modules/SB/BehavioralChangeTheories/BehavioralChangeTheories4.html#:~:text=%20Diffusion%20of%20Innovation%20Theory%20%201%20Innovators,adopt%20new%20ideas%20before%20the%20average...%20More