EFFECT OF ICT ON REGIONAL GROWTH OF WEST AFRICAN STATES

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ABSTRACT
The study examined the effect of Information, Communication and Technology (ICT) on the regional growth of the Economic Community of West African States (ECOWAS). The two-step dynamic GMM method was applied for a balanced panel data of 14 countries from 2007 to 2021. The results revealed that economic activities and the use of ICT are skewed in the ECOWAS region. Further results indicated that, ICT specifically captured by internet connections and mobile phones contribute significantly to the growth of the entire ECOWAS region. A major policy implication of this finding is that an increase penetration of ICT through internet connection, especially through the use of mobile phones, will facilitate capital diffusion and trade activities among member countries, leading to the accretion of their overall economic growth.

Keywords: Economic Growth, ECOWAS, ICT, Panel GMM,
JEL Classification: C33; O30; O47

1.   INTRODUCTION

The role of technology in enhancing economic activities cannot be overemphasized. Technology has led to an increase in the division of labor and specialization of jobs, and has led economic agents to easily access natural resources and use them efficiently. The efficient allocation of resources, triggered by technology, has increased the total output of most economies globally, leading to greater economic development.

A branch of technology that has catalyzed economic activities and advanced the development of nations over the years, is information communication and technology (ICT). Information technology is the single most important element in the success and growth of international trade and job market growth that has allowed businesses to share information and conduct trade in less time (Hardee County Report, 2022). Undoubtedly ICT has increased regional activities around the globe, by facilitating strategies that improve international cooperation, ensure macroeconomic stability, and ultimately increase regional growth.

Studies predicated on the neoclassical theory have laid emphasis on the role of technology as a key strategy among others in strengthening regional integration. For instance, Hume (1758) hypothesized that technology breathes innovativeness in production activities, which in turn reduces the economic disparity among countries in regional groupings. Thus, technology provides leverage for smaller economies to grow faster and catch up with larger economies.

A fundamental aspect of technology that drives economic growth faster nowadays is information and communication technology (ICT). Karlsson, Maier, Trippl, Siedschlag, Owen and Murphy (2010) submit that ICT can be adopted by many sectors of the economy in ways that can drastically change their operations and products; and the relationships between the different sectors. Arguably, ICT opens up new opportunities rather than offering complete, final solutions

Bresnahan & Trajtenberg (1995); reduces production costs and improves productivity Meijers (2014); allows access to new markets, lower capital costs as a result of increasing the efficiency of the functioning of financial markets, reduces regional discrepancies in incomes and productivity (Pradhan, Mallik, & Bagchi, 2018). Reinforcing this argument, Bahrini & Qaffas (2019) posit that better information flows through mobile phones, could substantially improve information acquisition for depositors and financial institutions, enhance monitoring and, also bridge physical barriers and costs of distance among regional groupings.

The Economic Community of West African States is a regional grouping that is committed to fostering regional growth and strengthening regional integration. Even though, different strategies, protocols and Agreements have been put in place by ECOWAS governments to foster regional growth, high levels of inequality persist and the spread in the income per capita across the region is wide with weak inter-demand across the entire region as observed by Chuku (2015). This may be attributed to the low production of goods and services. One plausible reason for these inequalities and low production capacity may due to fact that less emphasis is laid on the conditions and consequences of ICT use, on regional growth. Thus, the main objective of this paper is to analyse the effect of ICT on the regional growth of ECOWAS.

The remaining article is structured as follows: literature is reviewed in section 2; section 3 presents the theoretical framework and methodology; section 4 reports the results, while section 5 presents the conclusion and recommendations.

2. LITERATURE REVIEW

Specifically, three theories have provided lucid information and direct or indirect links between ICT and economic growth – "Diffusion theory of technology, Growth theories and New Geographical theory". The Diffusion theory seeks to explain how, why and at what rate, innovative ideas and technology spread through economies. These innovative ideas can be in the form of new products, new processes, or new management methods (Ireland & Stoneman, 1986). Hume (1758) hypothesized that the diffusion of technology promotes economic convergence between countries because diffusion of technology provides leverage for smaller economies to grow faster and catch up with larger economies.

Proponents of the diffusion theory posit that Information Communication and Technology (ICT) promotes economic convergence. This proposition is anchored on the timely accessibility and provision of information as well as its capacity to ease and fast-track communication. For instance, ICT enables widespread communication between companies so that reducing the cost of production and increasing productivity (Bristow, 2003); Johansson, 2006; Meijers, 2014); works as a source of employment and revenue (Ding & Hynes, 2006). Avgerou (2003) had earlier pointed out that ICT investment succeeds only in economies whose assets' implementation and use are efficient.

The Diffusion theory lays more emphasis on productivity, whereas, recent growth theories indicate that ICT must be accompanied by complementary capital investments and human capital (Karlsson, Maier, Trippl, Siedschlag, Owen, Murphy, 2008). Human capital can be enhanced by giving more attention to human capital development (see, Lucas, 1988; Romer, 1990). Hence, ICT which is overemphasized in the diffusion theory is just a part of technology as expressed in Solow's growth model that considers capital and labour as the main factors of production (see, Solow, 1956).

ICT adoption plays a fundamental role in regional groupings because it allows timely and easy access to information, which in turn enables the removal of an essential barrier to the effective

functioning of the market and reduction of information asymmetries. Its effective implantation reduces the cost of transactions and makes the production of goods and services more efficient (Ghalayini, Latifa, Nasser, Alissar, Ishker, Nermeen, 2020). This interplay is anchored on the New Economic Geography (NEG) theory proposed by Krugman (1991) and provides a theoretical understanding of the factors driving spatial transformations and the effects of these transformations on regional economic growth.

The NEG theory explains why economic activities concentrate in certain regions and not in others (Krugman, 1991; Fujita, Krugman & Venables, 1999; Johansson, Karlsson & Stough, 2002), which plausibly shows that ICT enables major reductions in geographical transaction costs by reducing spatial information frictions (Flamm, 1999; Sichel, 1997). Hence, a reduction in geographical transaction costs lowers production costs thereby increasing the export of goods and services across the entire region and to other regions (Karlsson, Maier, Trippl, Siedschlag, Owen & Murphy, 2008) However, earlier submissions by Dimelis and Papaioannou (2009) reveal that, technological gains are no more the same for all economies around the world and that each economy maintains different policies, conditions, and prerequisites to promote the implementation of new technology (ICT). In line with the above argument, Avgerou (2003) submit that ICT investment is successful only in those economies which have fundamentals for efficient asset implementation and use. Hence, developed countries must possess better technologies according to their natural endowments and existing infrastructure that is suitable for effective use. All these theories explain the current situation in ECOWAS. Transaction costs have reduced drastically among member countries, even though the rate of ICT diffusion is still low.

A few theoretical studies have established a positive relationship between ICT economic growth, while several empirical studies have produced contrary results for different countries. Some have actually confirmed that ICT diffusion significantly increases the level of economic growth. For instance, Lee, Levendis & Gutierrez (2012) using a panel Generalized Method of Moment (GMM) growth model showed that mobile phone expansion is an important determinant of economic growth in Sub-Saharan Africa (SSA). Sassi and Goaied (2013) found a positive and statistically significant impact of ICT on economic growth for all MENA countries after applying the same modelling approach. In another related study, Sepehrdoust (2018) established that a percent rise in financial development index and ICT variables will increase economic growth by 0.048 and 0.050 percent respectively, consistent with earlier results by (Nasab & Aghaei, 2009) for OPEC countries and (Andrianaivo and Kpodar 2011; Lee et al., 2012; Wamboye et al., 2015) for SSA region. Bahrini and Qaffas (2019) showed that except for the fixed telephone, the adoption of other ITC devices such as mobile phones, Internet usage, and broadband adoption will boost economic growth in the Middle East and North Africa (MENA) and the SSA regions

Alternative estimation techniques have also validated the positive relationship between ICT diffusion and economic growth. Pradhan, Mak & Neville (2015) using the panel cointegration technique on a cross section data for 21 Asian countries, showed that ICT infrastructure and financial development are key determinants of the long-run economic growth of Asian countries. Results of recent studies don't differ with that of extant studies. Asongu and Odhiambo (2019) for Africa; Alshubiri, Jamil and Elheddad (2019) for Gulf Cooperation Council (GCC); Kurniawati (2020) for OECD; Kurniawati (2021) for Asian Countries and Fernandez-Portillo et al. (2020); Myovella, Karacuka, and Haucap (2020); Nair, M., Pradhan and Arvin (2020) for developed countries; Edna and Aaron (2020) for 36 African countries etc. All these findings among others, however, contradict earlier studies conducted by Freeman and Soete (1997); and Aghion and Howitt (1998) whose findings reveal that the diffusion of ICT could negatively affect economic

growth, especially in developing countries. Pradhan et al. (2015) in another strand of the study confirmed that ICT infrastructure or financial development did not contribute significantly to the economic growth of western Asian countries in the long-run, while Albiman and Sulong (2016) obtained mixed results. They discovered that the fixed telephone lines, mobile phones, and Internet exhibited a positive and significant linear relationship with economic growth. However, heavy ICT use in the SSA region retarded economic growth based on a nonlinear analysis.

3.   MEHTODOLOGY
3.1 Theoretical Framework

The empirical analysis of this work is anchored on the initial assumptions of Solow's neoclassical theory of growth, which is predicated on the initial theoretical foundations of the Cobb-Douglass production function and Romer's endogenous theory of growth. Solow's growth theory boils down to the standard production function which relates output (Y) to labor (L), capital (K) and the level of technology or productivity (A) which was assumed to be exogenous (Solow, 1956).

$$Y = Af(K, L) \qquad (1)$$

Solow submitted that capital exhibits diminishing returns as output increases. However, output increases less at high levels of capital than at low levels so that economy will reach a steady-state and only technological change, which is exogenous could increase output growth rate levels.

Solow's model reveals that technological change can enhance economic growth and argued that technological progress is a key determinant of long-term growth. Solow's model lay's a good foundation for the endogenous growth model. Romer (1986) extended the exogenous growth model making it endogenous by incorporating knowledge and technical progress into the production function as key factors that enhance the skills of workers hence, making it endogenous.

$$Y = f(A, K, L) \qquad (2)$$

Solow's model shows the relative importance of technological change and knowledge largely caused by intentional actions when people respond to market incentives (Romer, 1990). He further claimed that investing in human beings increases their knowledge which in turn increases the overall productivity of a company. Unlike the exogenous growth model, the endogenous growth model does not yield any diminishing returns of capital. Reinforcing the endogenous growth model, Castellacci (2011) submitted that technology and innovation could facilitate low-income countries' catch-up processes primarily through enabling improvements in education, knowledge dissemination, and labor productivity shifts. Thus, technological progress plays an important role in economic development. However, Hall and Jones (1999); Klenow and Rodriguez-Clare (1997); Caselli (2005) among others in their analysis found that, the rate of catch-up among countries is different due to technological differences and thus makes the level of development across countries uneven.

Treaties and Agreements among the West African Community (WAC) are meant to foster regional growth through free trade. This requires focusing on investment that encourages diversification and production of new goods and services. The process involves the use to high technology, mostly driven by ICT. Hence, ICT is an integral part of ECOWAS agenda.

3.2   Source of Data

A panel of the 14 ECOWAS countries was constituted based on the availability of secondary data and covered the period between 2007 and 2018. Incidentally, this period is when ICT diffusion was on the increase and coincides with ECOWAS Agreements on strengthening regional

integration. Data for the different variables were extracted from World Bank Development Indicators published by the World Bank. The variables include:

Economic growth is proxied by per capita gross domestic product (GDPP). World Bank's (2020) definition of ICT includes networks, software, hardware, and media for gathering, storing, processing, transmitting, and presenting information and associated services. Pradhan et al. (2018) refer to the mobile telephone, digital phone network, servers and capacities of the Internet and fixed broadband as ICT infrastructure. Thus, ICT variables are: Fixed telephones (TEL), mobile phones (MOB), internet subscribers (INT), number of fixed broadband subscriptions (FBS).

The control variables are: labour force (LABF), investment (INV), government expenditure proxied by government consumption (GOVCON) and trade (TRADE).

3.3 Model Specification and Estimation Technique

Building on Andres and Vallelado (2008) and Sanda, Mikailu, & Garba (2005). Four models are extracted from equation (3), with each model establishing the effect of an ICT component (TEL, MOB, FSB) and INV on economic growth and ICT as follows:

$$\text{GDPPC}_{i,t} = \beta_0 + \beta_1 \text{GDPPC(-1)}_{i,t} + \beta_2 \text{TEL}_{it} + \beta_3 \text{MOB}_{i,t} + \beta_4 \text{FBS}_{i,t} + \beta_5 \text{TRADE}i,t + \beta_6 \text{GOVCON}_{it} +$$
$$\beta_7 \text{INV}_{i,t} + \beta_8 \text{FDI}_{i,t} + \beta_5 \text{FDI}_{i,t} + \delta t + \gamma t + \mu_{i,t} \qquad (3)$$

All the variables in equations (3) are defined already, and the i's represent country 1 through 165. The t represents values for the years from 2010 to 2018. The parameters β represent the constant term and the estimated coefficients for their respective models. The error term is split into three components: δt is the time effect, which controls for macroeconomic shocks, γt is the individual effect, which controls for unobservable heterogeneity and $\mu_{i,t}$ is the stochastic disturbance.

The panel data analysis technique is adopted for this study because of the pooled nature of the data set (mixture of time series and cross section) and its ability to take into account the unobservable and constant heterogeneity effects inherent in a data set. Instrumental variables were introduced to resolve the problem of endogeneity (Wooldridge, 2002). Thus, the Arellano & Bond's (1998) two-step system estimator is employed with adjusted standard errors for potential heteroskedasticity. The itinerary of this method considers the unobservable effects, transforming the variables into first difference and using the generalized method of moments (GMM) with instrumental variables to deal with endogeneity problems (see. Kama1 & Chuku, 2009).

4. PRESENTATION AND ANALYSIS OF RESULTS
4.1 Summary of Descriptive Statistics

The basic descriptive statistics on Table 1 enable us to ascertain whether the series follows a normal distribution while comparing the evolution of the indicators using measures of central tendencies: the mean, median, maximum and minimum of modified time series and standard deviation. Specifically, the standard deviation is used to measure the variability of the variables. A smaller value implies that the variables in the group are similar and vice versa. Skewness measures the degree of symmetry of the sample distribution, while kurtosis informs measures the peak of a distribution. The skewness and kurtosis of the distribution are equal to 0 and 3 respectively, for a normal distribution, which is further attested by the Jacque-Beta test.

The standard deviation measures the variability of the parameter and its size depends on the similarity of components in the region. The standard deviations of all the countries in the region are relatively high, implying that the DGDP(s) of ECOWAS countries are not similar. The values

of skewness and kurtosis neither have a value of 0 nor 3, meaning that the DGDP(s) of ECOWAS countries are not normally distributed.

The average per capita GDP (GDPPC) for ECOWAS countries is 2.109 with an average labour force of 0.094. Mobile telephone (MOB) has the highest mean value of approximately 1.796 compared to other ICT proxies: fixed telephone (TEL), Fixed broadband subscriptions (FBS) and internet subscription (INT). The values of skewness and kurtosis neither have a value of 0 nor 3, implying that all the variables considered for this study are not normal distributed, hence, economic activities and the use of ICT are skewed in the ECOWAS region.

Table 1: Summary Statistics of the Variables from 2007–2021

	GDPPC	TEL	FBS	INT	MOB	GOVE	TRADE	INV	FDI	LABF
Mean	2.109	0.830	0.957	1.241	1.796	1.175	1.820	1.291	0.371	0.094
Median	2.286	0.864	1.008	1.322	1.847	1.105	1.790	1.294	0.310	0.031
Maximum	13.743	1.757	0.623	1.169	2.133	1.925	2.493	1.670	0.304	0.151
Minimum	7.141	0.409	2.810	1.263	0.788	0.001	1.316	0.770	1.475	1.038
Std. Dev.	3.179	0.463	0.773	0.538	0.232	0.381	0.159	0.170	0.374	0.209
Skewness	-0.563	0.071	-0.51	0.517	-0.52	-0.25	0.115	-0.64	-0.01	-1.92
Kurtosis	2.142	3.763	2.641	2.214	2.596	3.695	1.582	2.674	3.034	0.175
Jarque-B	5.268	0.245	1.340	1.487	5.021	5.350	3.213	5.923	2.516	4.631
Probability	0.059	0.886	0.519	0.476	0.058	0.057	0.187	0.613	0.219	0.185
Observations	115	115	115	115	115	115	115	115	115	115

Notes: GDPC is average per capita GDP; INT is the number of Internet users; FBS is the number of fixed broadband subscriptions; FTS is the number of fixed telephone subscriptions; MOB is the number of mobile cellular subscriptions; GOVE is government final consumption expenditure; TRADE is the country's trade volume; INV is the domestic investment; FDI is foreign direct investment; UNEM is level of unemployment.

Source: Author's calculations

Table 2 shows the estimated results of the different models. All the diagnostic checks used here show that the different models are plausibly unbiased. The instrumental variables are suitably incorporated based on the J-statistic and resolve the problem of endogeneity. The Arellano and Bond (1991) first and second-order serial correlation tests show that the variables are not serially serial correlated, while GDPPC (-1) incorporated in all the models is to resolve the problem of serial correlation following the Chocran- Orcutt (1949) approach.

The estimated results based the model one show that the effect of fixed telephone (Tel) measured as a proxy for ICT on economic growth is negative and insignificant. This may be due to the

shortage and low subscription rate of fixed telephone lines in the ECOWAS. More so, the rapid substitution of fixed telephone lines by mobile telephones also accounts for the negative effect of fixed telephone lines on economic growth. This finding is in line with that of (Kumar, 2012; Sassi & Goaied 2013; Wamboye et al., 2015; Bahrini & Qaffas, 2019).

Mobile telephone (MOB) which is a proxy for the ICT variable has a positive and significant effect on economic growth in the ECOWAS region. This implies that MOB which is part of ICT is crucial in determining the growth of economic activities in the region. This corroborates the fact that increased subscription and penetration of MOB reduces physical constraints and transaction time (Andrianaivo & Kpodar 2011; Wamboye et al. 2015), and confirms the efforts of the respective governments and mobile companies to increase the number of subscriptions of MOB in the entire region. This finding is consistent with that of Bahrini & Qaffas (2019) for the MENA and SSA countries; Fernandez-Portillo, Almodovar-Gonzalez, & Hernandez-Mogollon (2020) for OECD European Union countries and Myovella, Karacuka, & Haucap (2020) in a comparative analysis of Sub-Saharan Africa and OECD economies.

Model 4 reveals that the number of internet subscriptions (INT) has a positive and significant effect on the economic growth of ECOWAS countries while model 3 shows that Fixed broadband subscriptions i.e., the effect of the fixed broadband subscriptions (FBS) on high-speed public internet is positive but not significant. The insignificance of the FBS is indicative of the fact that public usage of public internet has reduced drastically across the region with the advent of android portable phones. Theoretically, Lucas (1988), Romer (1990), Aghion & Howitt (1998) and Barro (1998) all posit that internet usage fast-track economic development and triggers innovation processes leading to competition, which results in the development of new products, processes and business models. Hence, the findings of this study are in conformity with the mentioned theoretical underpinnings. The overall findings mirror that of (Wamboye, Tochkov, & Sergi, 2015; Pradhan et al. 2018) for developing countries and (Bahrini & Qaffas, 2019) for SSA and MENA countries. The control variables in the different models show that trade significantly contributes to economic growth due to the increasing number of internet subscribers. Hence, ICT facilitates trade and the accretion of economic growth in the ECOWAS region. However, trade-deals with MOB is faster because it has a higher coefficient than that of INT and FBA. Government final consumption expenditure (GOV) exhibits a negative relationship with the GDP per capita of ECOWAS Countries. This result is plausibly enough since various governments are saddled with different socio-political issues to tackle, rather than growth-oriented programs. Investment (INV) increases growth in the four models but is highly significant with the use of mobile phones only. All proxies of ICT exhibit a positive and significant relationship with economic growth, whereas, only MOB increases the foreign direct investment (FDI) of these countries.

Table 2: Impact of ICT on Economic Growth of ECOWAS Countries 2017–2021

Dependent Variable	Model 1	p-values	Model 2	p-values	Model 3	p-values	Model 4	p-values
GDPPC	TEL		MOB		FBS		INT	
Independent Variables	Coef.	P>|t|	Coef.	P>|t|	Coef.	P>|t|	Coef.	P>|t|
GDPPC(-1)	0.039	0.656	-0.473	0.036**	0.027	0.733	0.064	0.490
TEL	-1.964	0.872						
MOB			2.4	0.048**				
FBS					0.256	0.895		

INT TRADE	0.075	0.012**	28.081	0.000***	24.841	0.000***	2.770 23.378	0.039** 0.000***
GOVCON	-0.108	-0.458	-11.43	0.368	-12.907	0.203	-2.736	0.708
INV	0.020	0.047**	3.080	0.550	10.321	0.195	6.257	0.263
FDI	0.395	0.422	-1.521	0.400	-1.407	0.592	-3.324	0.149
LABF	0.033	0.046	4.180	0.947	3.520	0.840	1.141	0.958
J-Statistic	6.916	0.546	6.831	0.555	10.232	0.176	8.183	0.416
AR_1	-0.809	0.418	NA		-0.621	0.535		
AR_2	0.418		NA		0.442	0.658	-0.565	0.572

Notes: The 10%, 5%, and 1% significance levels are denoted by *, **, and ***, respectively. Standard errors are
reported in parentheses next to the coefficient estimates. All values are based on a two-step Generalized Method of
Moment (GMM) estimator.

Policy Implication
The results suggest that individual countries can improve communications and transactions through the use of mobile telephones, which will increase the level of growth through trade interactions and investment. A major policy implication of these findings is that an increased penetration of ICT through the internet connection, especially through the use of mobile phones, will facilitate capital diffusion and trade activities among member countries, leading to the accretion of their overall economic growth.

5. Conclusion
ICT has increased regional activities around the globe, by facilitating strategies put in place to improve international cooperation, ensure macroeconomic stability, and ultimately increase regional growth. This study examined the effect of Information, Communication and Technology (ICT) on the regional growth of West African States. The two-step dynamic GMM method was applied for a balanced panel data and the results revealed that economic activities and the use of ICT are skewed in the ECOWAS region. Further results indicated that ICT, specifically captured by internet connections and mobile phones contributes significantly to the growth of the entire ECOWAS region.
Based on the above findings and policy implications, ECOWAS governments should increase the penetration of mobile phones since this will facilitate economic transactions among the different West African nations, leading to the overall growth of the entire region. This can be done by encouraging more people to subscribe through the reduction of the cost of subscription and the provision of a fast and stable network.
Furthermore, the various ECOWAS governments should embrace the installation of the 5G optic fiber network. This will increase the speed of the ICT network, thereby, increasing the level of technology, hence, increasing the pace of economic activities among member countries. This can simply be done by employing the available resources required (both human and physical capital) to acquire the high-tech ICT network, which most developed and some emerging countries have started operating.

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