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A Panel Analysis of Ecowas Countries on the Impact of ICT and Human Capital on Economic Growth

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Abstract: Information Communication and Technology drives the economies of the World today. This study is motivated by the most recent emerging countries, especially the Asian tigers and the further strengthening of the world powers through their mastery and exploitation of ICT. This technology emerged from the West like several others but reached Africa decades ago and it is the interest of this study to investigate to what extent an integrated region like ECOWAS has been able to harness this technology and make it reflect on growth of the region. This study therefore used Panel Regression Analysis to show that Human Development Index, Population, ICT Development Index and Trade Openness are significant determinants of GDP in ECOWAS while Gross Fixed Capital Formation, Inflation Rate are not significant determinants of the GDP of ECOWAS countries. The study recommends the continuous use of ICT in ECOWAS and its exploitation in many other sectors that will enhance production and make the markets more efficient so as to foster growth.

Key words: Panel Analysis · ICT · Human Capital · Economic Growth · ECOWAS

INTRODUCTION

The Information Communication and Technology (ICT) industry has changed dramatically over the past four decades and the world's biggest economies have been defined by the mastery of this constantly changing technology. ICT simply put, makes life better in terms of time economising, wider markets, lower man power needed, reduced deforestation, less task burdensome, no need for transportation and related cost, easier communications, reduced corruption and greater access to information, amongst others. ICT is at the top of scientific research and innovations today as the growth and development of the world at large from the dark age to the age of high mass production has sprouted on a series of scientific innovations. ICT is one of those innovations that has led to several other innovations and has placed economies on the bait of "the more its mastery the better you are". Every economy is composed of micro and macro organisations and institutions that are controlled and these thrive on indices like transportation, information and markets. Therefore the speed and access of these indices make things better-off, while its ineffectiveness only sets these organisations and institutions aback. ICT is the most potential force that drives these indices anywhere in the world and therefore turns to control every sector in the economy.

The developed world is at the forefront of this potential asset, based on the fact that they invented it and continually improve on it to be even more efficient fuelled by the competition that exists among them. Developing countries on the other hand are following suit and learning this technology from the masters. However, the faster in learning any of the developing countries has mastery in ICT and its use, the better and more developed they should become. The most instrumental use of ICT is in its contributions to human development. The benefit of ICT is only evident when the knowledge is fully exploited. It is therefore expected that human development's contribution to economic growth should improve with the advent of ICT in every society. Labour is said to be more efficient with Research and Development (R&D) which includes knowledge in ICT. [1] studied Malaysia's ICT impact on human capital development and opines that the application of ICT is an enabling tool and should be spread across all levels of education and regions.

> [2], notes that "for the past two decades most developed countries have been observed in almost all aspects of life: economics education, communication and travel. In a technology-driven society, getting information quickly is important for both sender and receiver. ICTs have made it possible to quickly find and distribute information. Many

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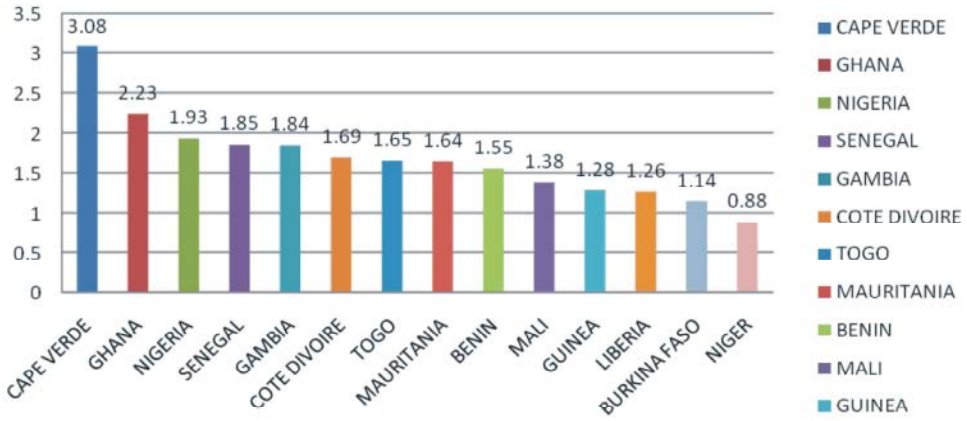

Fig. 1: ICT Development Index in 2011
Source: Authors computation based on data from ITU (2012)

initiatives have been taken at the international level to support Africa's efforts to develop a communication infrastructure and these efforts are designed to enable African countries to find faster ways to achieve durable and sustainable development".

The effect of ICT on the economy could be direct or indirect; According to Mohammad and [3], ICT affects output and economic growth directly through the production of ICT goods and services which form part of the total value added generated in an economy and the use of ICT capital as an input in the production of all goods and services that generate economic growth. On the other hand, ICT can enhance economic growth via the contributions of ICT industries to technological changes needed in the telecommunication industry and by extension to other sectors like the medical, education, services and security sectors. The Economic Growth in the Economic Community of West African States (ECOWAS) is composed of 15 member countries is practicing a Free Trade Zone that allows easy access to transportation, information, common economic market to promote common growth. They are expected to share common value systems and development in instruments such as the ICT and its impact within the region. Literature stipulates that this region is adopting the use and influence of ICT from the West. However, the statistics over the years has been rather slow. In 2012, the International Telecommunication Unit published the 2011 ICT development index and the West African countries were classified as;

The chart above shows that Cape verde is leading in the region in terms of ITU, followed by Ghana, Nigeria and then Senegal and the least is the Republic of Niger. The 15 member countries have all endeavoured in different ways to maximise the use of ICT through several policies, while some have made little or no efforts. However the big question is to what extent have they been able to allow this ICT revolution impact on their economic growth?

According to [4], the role of ICT-intensive industries on growth is threefold. First, to the extent that the ICT industry grows faster than other industries and translates to significant output growth. Second, industries with higher shares of ICT in total capital experienced larger gains in productivity growth. Lastly, spill-overs generated by ICT use such as learning-by-doing effects and accompanying organisationalprograms.

The influence of ICT on the education and health sectors is reflected in the quality of human capital. ICT has eased learning and health care such that students can do distance learning programs and online programs to get international standard knowledge from any part of the world. Also doctors use the internet to do online consultations and ICT based diagnoses to improve their expertise. Either way, they improve on human capital which is the most potential factor of a potential economy. Hence the better the human capital becomes, the greater the economic performance and hence economic growth.

The ICT has been proven to be a very potent tool in the rapid development of OECD countries and Asian countries [3, 5, 6]. And it is relevant that less developed countries tap into this new source of technology and maximise its use to enable higher productivity and enhance efficiency. According to [4], Robert Solow stated that, "You can see the computer age everywhere but in the productive statistics." This worry was due to the negligence of the impact of ICT on production that should reflect in production statistics. This negligence might also lead to the discounting of the potent of ICT in production and hence economies might miss the need to perfect their ICT use and influence in optimising economies. However

to perfect the use of ICT it is important to ascertain to what extent ICT has impacted on the growth of ECOWAS countries. It is with this respect that this study investigates the contributionsof ICT to economic growth in the region.

[5], in their study showed that the investments of ICT have an impact in various ways on most economies and that these impacts are different, in high income, mid income and low income countries. The impact of ICT is therefore not relevant only to rich countries but poor countries as well. Nevertheless, while the rich countries keep account of their degree of progress with respect to the impact of ICT, most poor countries have done little in that respect. Empirical literature abounds on the impact of ICT in many developed countries and regions, however such studies have not been carried out in the West African region. It is on this premise that this study investigates the collective impact of ICT on economic growth in the ECOWAS region.

The State of ICT in ECOWAS: The speed with which Information Communication Technology (ICT) is developing and its impact on socio-economic activities cannot be overemphasized. ICT, according to UNDP, has been defined to include the full range of electronic technologies and techniques used to manage information and knowledge. It is imperative that Africa is not excluded from the technological revolution. It is a stark fact that the use of ICT has been integrated into virtually every facet of commerce, education, governance and civic activity in developed countries and has become a critical factor in creating wealth worldwide. Unfortunately in Africa, ICT has barely taken a foothold. Computer illiteracy and lack of access to ICT are widely recognised as an increasingly powerful obstacle to the economic, civic and political development of Africa. According to the UN ICT Task Force, nowhere is the digital divide more pronounced than in countries of the African continent. Africa is the most unconnected in an increasing connected world [6].

According to the Data Development Group of the World Bank, ICT infrastructure in Ghana is progressing as compared to other low-income countries globally and above the 1.1% average for the Sub Saharan Africa. The government of Ghana both past and present and other agencies have over the years made several strides to develop the ICT infrastructure so as to bridge the digital divide between Ghana and the developed world. Though Ghana is not yet there as far as ICT infrastructure is concerned, it has been able to chalk some successes in attracting some foreign investors to the country. Some of them are Affiliated Computer Services (a Fortune 500 company and a global leader in IT and Business Process Outsourcing), Data Management International Inc., Rising Data Solutions, Global Response, Busyinternet, AQ Solutions and Supra Telecom. Most of these companies operating in the country have recorded an average of 50% in revenue and profits. Others U.S companies like Cincom System Inc.a call centre and Convergys Corporation are expected to open offices in Ghana.

Meanwhile, Cote d'Ivoire was one of the first countries in sub-Saharan Africa to gain full Internet connectivity. Both fixed-line operators, Niger Telecom and MTN Niger offer a range of data services including ISDN, ADSL and local and international leased lines. Several Internet Service Providers are offering wireless broadband access. A new competition framework will liberalise VoIP Internet telephony completely, creating additional opportunities for them. The introduction of UTL's Freenet service and a special Internet tariff countrywide have helped to increase Internet usage, as has the recent strong growth of the fixed-line networks and an explosion of the number of cybercafes [3].

The introduction of cellular telephony has revolutionised Niger's telecommunications industry since the first network went live in 1995, with two more following in 1998 and 2001. As early as 1999 Niger became the first country on the continent where the number of mobile subscribers passed the number of fixed-line users and the ratio is now more than 18:1. The market is consistently growing at around 50% p.a., while market penetration is still low at less than 9%. The recent introduction of GPRS will enable the mobile operators to play a larger role in Internet service provision and a fourth licence for Third Generation (3G) mobile technology is being considered.

Internet access in Sierra Leone has been sparse, but is on the increase, especially since the introduction of 3G cellular phone services across the country and the arrival of the ACE cable in Freetown in the second half of 2011 [7]. Freetown has Internet cafes and other businesses offering Internet access. Problems experienced with access to the Internet include an intermittent electricity supply [8] and a slow connection speed in the country outside Freetown [9]. Outside of Freetown enterprises generally have to rely on VSAT satellite services. There are no government restrictions on access to the Internet or credible reports that the government monitors e-mail or Internet chat rooms. Individuals and groups engage in the expression of views via the Internet, including by e-mail [10].

Much of Liberia's communications infrastructure was destroyed or plundered during the two civil wars (1989-1996 and 1999-2003) [6]. With low rates of adult literacy and high poverty rates, television and newspaper

Table 1: Summary Statistics of internet indicators for ECOWAS countries

AFRICA	Population (2012 Est.)	Internet Users Dec-2000	Internet Users 30-Jun-12	Penetration (% Population)	Internet % Africa	Facebook 31-Dec-12
Benin	9,598,787	15,000	335,957	3.50%	0.20%	171,780
Burkina Faso	17,275,115	10,000	518,253	3.00%	0.30%	141,740
Cape Verde	523,568	8,000	167,542	32.00%	0.10%	107,340
Cote d'Ivoire	21,952,093	40,000	968,000	4.40%	0.60%	n/a
Gambia	1,840,454	4,000	200,057	10.90%	0.10%	97,280
Ghana	25,292,392	30,000	3,568,757	14.10%	2.10%	1,630,420
Guinea	10,884,958	8,000	141,504	1.30%	0.10%	68,780
Guinea-Bissau	1,628,603	1,500	43,484	2.70%	0.00%	n/a
Liberia	3,887,886	500	116,637	3.00%	0.10%	n/a
Mali	15,494,466	18,800	414,985	2.70%	0.20%	212,020
Niger	16,344,687	5,000	212,480	1.30%	0.10%	63,500
Nigeria	170,123,740	200,000	48,366,179	28.40%	28.90%	6,630,200
Senegal	12,969,606	40,000	2,269,681	17.50%	1.40%	675,820
Sierra Leone	5,485,998	5,000	69,240	1.30%	0.00%	76,880
Togo	6,961,049	100,000	356,300	5.10%	0.20%	117,420
sum	320,263,402	485,800	57,749,056			7,775,840
TOTAL AFRICA	1,073,380,925	4,514,400	167,335,676			51,612,460
Rest of World	5,944,465,997	84.70%	2,238,182,700	37.70%	93.00%	924,331,500
WORLD TOTAL	7,017,846,922	100.00%	2,405,518,376	34.30%	100.00%	975,943,960

Source: Internet World Stats (2014)

use is limited, leaving radio as the predominant means of communicating with the public. There exist 147,510 internet users that places them 162nd in the world, constituting 3.8% of the population, [11]. Liberia has 78 Fixed broadbandsubscriptions, that placed them 193rd in the world; less than 0.05% of the population, 192nd in the world (2012) and about 7 internet hosts, making them 228th in the world [12]. There are no government restrictions on access to the Internet or reports that the government monitors e-mail or Internet chat rooms [13].

Guinea-Bissau is one of the poorest countries in the world [14]. This reality is reflected in the state of the country's telecommunications development. It is estimated that in 2012 there were only 5000 fixed telephone lines serving the country's 1.6 million inhabitants and that only 2.9% of the population had access to and were regular users of the Internet. They have 47,132 internet users making them 181st in the world [11]. There are no government restrictions on access to the Internet or reports that the government monitors e-mail or Internet chat rooms without judicial oversight [14].

In Mali, there are an estimated 24 private internet service providers. Recently an association has been formed called AFIM (Association de Fournisseurs de l'Internet au Mali), which is intended to represent these providers. Mali records 414,985 internet users or 2.9% of the population (2011). Internet usage is low by international standards, ranked 123 of 125 by the UN in [12]. SOTELMA the state telecom, provides X.25 and dial-up telephone services. Many operators offer dial-up internet service and wireless internet services. Most ISPs are small Bamako based providers with a VSAT connection, a cyber cafe and use wireless systems (Alviron, 802.11a,b, g, Motorola) to share their service with their clients. Bamako has at least 21 wireless providers, ranging from small VSAT operators, to sophisticated, multi-access point, full services providers.

Table 1 below shows summary statistics of internet indicators for ECOWAS countries.

The Impact of ICT on Economic Growth: The 1990's was noted for the investment of Information and Communication Technology (ICT) by OECD countries and by 2000 it accounted for 20% and 45% of all investment with the most visible impact being in the USA (Miles and Scott, 2005). They further state that from 1913 to 1972, U.S. Total Factor Productivity (TFP) grew at 1.6% per annum and then slowed to 0.6% between 1972 and 1995. But as ICT investment increased, TFP growth for the period 1995–99 rose to 1.8%. [15] proposed two approaches to the use of ICT for the development of economies. He classified them as a tool to promote economic growth and the use of ICT to support development. While [4], proposed three approaches, he merged those of [15] and adds two more; the gains of the total factor productivity gains in sectors that produce ICT and the benefits from the Capital accumulation. Economic growth could also arise from total factor productivity gains in sectors that use ICT. This usually focuses on providing the poor with opportunities to receive up-to-

date information or the ability to communicate more easily or achieve an enhanced ability to communicate with others. The explicit or implicit objective of an ICT-led development project such as Tele-centres is often on promoting economic growth through access tobetter opportunities to generate income and reduce poverty.

According to [15], the ICT-driven approach is often underpinned by the economic assumption that better information improves how economic resources are allocated. It is a fundamental axiom of orthodox economics that the capacity of an economy to operate efficiently depends on how well the markets work. Markets operate throughthe adjustment of supply and demand of goods and services through prices, whichsend signals about the balance between these two sides of the equation. In poor countries, the coordination of economic activity rarely works well. Economic literature stresses on the importance of capital and labour contributions to output and the emphasis is made on capital by many growth theories. The investment in ICT greatly improves the capital base and consequently improves output. According to [4], of all Capital accumulation effect in the USA, 0.56% was produced through ICT investment, with only 0.11% from non-ICT investment [15]. The production of ICT related products have created its own industry. The gains from this industry spans from the amount of jobs it has created, the increase in infrastructure, proceeds from local sales and export proceeds that improves the balance of payment situation. This alone has increased output for those countries that construct ICT products like China, Japan, USA, Dubai, UAE, UK and France amongst others.

Empirical Literature: There exist several cross sectional and country-specific studies that examine the relationships between Information and Communication Technology (ICT) and economic growth or output. Cross Sectional studies are at regional and sub-regional levels and Some of them include; [16] who investigated the effect of ICT on Economic growth in OPEC member countries and found that there exists a significant impact on economic growth of investments in ICT in the OPEC member countries. Then, [17] examined the effects of ICTs on growth by development level. The study used a panel data for a sample of 48 countries during 1995-2006. To show that ICTs have positive and significant effects on growth in Developed countries and in LDCs. Also, DAC (2004) used descriptive analysis in OECD countries and developing countries to demonstrate the impacts of ICT on economic growth and show that long term ICT investment increases productivity and not short run.

[18] examined the relationship between ICT and capital economic growth. They used 15 OECD countries and applied panel regression analysis to show that there exist a nonlinear relationship between initial income, human capital and ICT capital. Then, [19] investigated the impact of information and communication technology on Economic growth in 48 Islamic countries between 1995 and 2005. They employed a panel analysis to show that while ICT investment has a positive and significant effect on economic growth, the marginal products of ICT investment are smaller than the marginal products of investment in non-ICT capital thereby confirming the productivity paradox of ICT. And [20], examined the relationship between ICT and growth in the USA and in Europe. The study found thatup to 80%of the growth in productivity over the last few decades isattributed to the knowledge economy. On average, the study shows that a 10% increase in ICT investmentresults in a growth in output of 0.5–0.6%.

[21], made an empirical analysis of ICT on economic growth for a set of 48 countries. The study employed panel and their findings suggest that ICT has a significant positive effect on growth in developed and less developed countries. But, stated that the profit/benefit of ICT is dependent on the absorptive capacity and the adequate policies to make this technology extremely useful. [22], investigated the impact of ICT on economic development in Egypt and the Gulf countries. The paper compares the ICT market in both Egypt and the Gulf countries and the result suggests that both are lagging behind the developed countries, but Egypt has higher supply, whilethe Gulf countries have higher demand and spending. The two side correlationbetween ICT and economic development is verified. ICT diffusion is positivelycorrelated to economic growth and human capital/ education. Still in the Arab world, [23] develop a new theory of growth (endogenous growth) which shows that ICT and the skills of the workforce constitute the main factors of economic growth. [24], investigated the impact of mobile telephony on Economic growth. The coefficient of total mobile penetration (0.65) suggest that, in this sample of developed and developing countries, a 10% increase in a country's total mobile penetration would lead to an increase in the average annual growth rate of GDP per capita by 0.65 percent points. And that the coefficient of the 3G penetration variable would increase annual growth rate of GDP per capita by additional 0.15 percentage points.

[25], examined the effects of ICT and Human capital intensities on productive growth in Malaysia. They used the conventional growth accounting framework and the

results suggest that, the economic growth of Malaysian's economy is input-driven but rather, productivity growth driven when the results of total factor productivity per unit of labour growth have been compared. Then, [25], investigated the impact of ICT and human capital on Productivity, but this time for five Asian economies. These economies include Malaysia, Indonesia, Philippines, Singapore and Thailand. The study employed an econometric approach to estimate the coefficients and then used a growth accounting approach to calculate the growth ratesof the productivity indicators. The study further exposes the fact that the impact of ICT and human capital has been positive in the countries under considerations. And, [26] investigated the causality and long run relationship between ICT and economic growth in Malaysia. They divided their study period into two, which is 1960-1982 and 1983-2004 and used data from the DXEcon data base available at the MonashUniversityMalaysia and from the Malaysian department of statistics. The researchers employed the Granger causality test to examine the causality effect of ICT for both periods independently. Their results show that economic growth led to growth in ICT investment in Malaysia between 1960 and 1982, while ICT investment led to economic growth (the reverse) in the second period.

[27], examined the relationship between ICT and long run economic growth in Nigeria using Residual-based Engle-Granger-Dickey-Fuller cointegration test. They sourced data from the CBN statistical bulletin using time series data for the period 1970-2008. The results showed that, about 1% change in ICT component will lead to an 86% change in the mean of Gross Domestic Product (GDP) over the period of the study. While, [28] examined the relationship between human capital developmentand economic growth in European regions. The used the OLS estimation technique to show that investment by individuals in humancapital formation has distinct patterns. Those regions with a higher level of investment in tertiary educationtend to have a larger concentration of information and communication technology (ICT) sectors(including provision of ICT services and manufacture of ICT devices and equipment) and research functions.

[29], examined the importance of ICTs in making a healthy Information Society in the Ethiope East Local Government Area of Delta State, Nigeria. The study used a survey of a sample of 120 respondents; with questionnaires as instruments for data collection is the questionnaire. The results show that ICT is beneficial and used for capacity building, improvement of teaching conditions, job creation, increased in income, improvement of agricultural production, greater involvement in community matters better use of information, improvements in contact with relatives and friends and time saving. [30], analyzed the contribution of ICT investment to productivity growth by means of growth accounting, adopting the theoretical framework first formulated by Solow. The results show that the contribution of ICT assets to industrial production outcome (measured as total market Gross Value Added (GVA) growth) is quantitatively modest but high in relative terms, especially when the proportion of ICT investment over the total expenditure incurred by companies in the production process is considered.

[31], the impact of infrastructures and ICT on economic growth in Spain. The results show that the methodological differences related to government services flows are not quantitatively important as they give very similarestimates in terms of the pace of economic growth in Spain. Furthermore they found that neither ICT elasticities nor the aggregate rate ofgrowth of these types of assets are practically affected by the use of any of the twoapproaches. As a consequence, their contribution to the growth rate of labourproductivity does not seem to depend on the chosen methodology. Additionally, thegrowth accounting exercise carried out indicates that ICT contribution to Spanishproductivity growth has been higher than infrastructures in both sub-periods, 1995-2000and 2000-2004, even though its share in output has been lower.

The impact of ICT on human development and economic growth has been exploited by many authors. Few of them did a country specific study like that of [4, 25, 26, 32] in Malaysia. However many more have been done on a cross country basis. The cross country analysis has been made for OECD countries, Asian countries and Islamic countries with none of these studies looking at the effect of Information and Communication Technology on the economies of West African countries.

Methodology and Data: The methodology proposed for this study is that of a fixed effect panel analysis of 14 ECOWAS countries derived from a Solow theoretical framework. The panel analysis is the standard tool for analysing a pool of observations on a cross section of countries, as proposed by this study. According to [33] panel data has the advantage of controlling for individual heterogeneity, more information, less collinearity among the variables, more degrees of freedom and studies the dynamics of adjustments.

The standard growth model that has been more frequently used in empirical growth applications is the Solow growth model of Solow (1956). In the Solow growth model the impact of investment is only transitory and technological change is the only driver of growth which is said to be exogenous. The Solow growth model or neoclassical growth model is an extension of the Harrod-Domar model in which the production function is defined as the relationship between the input of the production factors and the outputs or income [34]. The Solow growth model is therefore extended to take into account the technological progress embodied in the form of ICT investment and human capital and labour to be the inputs [9].

The study assumes to follow a Cobb-Douglas production function, as the interest here lies in the impact of ICT on growth. The number of different types of capital is narrowed down to only the physical capital, human capital and ICT as opined by [19].

The Cobb Douglass production function is therefore given as;

$$Y=C^{\beta}K^{\alpha}H^{\varepsilon}(AN)^{1-\beta-\alpha-\varepsilon} \quad (1)$$

where C = ICT,
K = Physical Capital,
H = Human Capital,
A = Technological Progress,
N = Labour
β,α,ë = Constants

The basic difference here is that technology is labour augmenting and the constant returns prevail in production. The Solow model assumes that a constant fraction of output is invested in each type of capital, hence their output with respect to effective labour is:
y= Y/AN – Output
k= K/AN –Physical Capital
c= C/AN – ICT
h= H/AN – Human Capital

The state variables could therefore be represented in the following equations;

$$dc(t)/dt = S_c y(t) - (\alpha+n+\delta_c)c(t) \quad (2)$$
$$dk(t)/dt = S_k y(t) - (\alpha+n+\delta_k)k(t) \quad (3)$$
$$dh(t)/dt = S_h y(t) - (\alpha+n+\delta_h)k(t) \quad (4)$$

where, S_k, $S_c$and $S_h$are the fractions of income invested in physical ICT and human capital,respectively and δ's are the rates of their depreciation. The steady-state level of output perlabour, i.e. of labour productivity, is positively related to the rates of savingsineach type ofcapital but negatively related to the rates of population growth and depreciation of capital. Labour input is assumed to grow and technology to advance at the exogenous rates of *n* andα, respectively.

[19] derived certain assumptions that differ from the Solow model and the assumptions are as follows

$$A_t = A_0e^{gt} * Ac_0e^{gct} \text{ and } L_t = L_0e^{gt}$$

Their first assumption states that, overall technological progress is the product of ICT and non ICTtechnological progress. From an econometric perspective, this makes clear that thehypothesis of no correlation between the observable (proxied by ICT diffusion) and thenon-observable part of technological progress is quite weak. Our model has the followingimplications for steady state dynamics. Mohammad and Meysam therefore establish the steady state as the log of per-capita output to begiven by;

$$\ln y_j = \alpha_0 + (\alpha c/1-\beta)\ln s_{cj} + (\alpha k/1-\beta)\ln s_{kj} + (\alpha k/1-\beta)\ln s_{hj} - [(\alpha c + \alpha k + \alpha h)/(1-\beta)]\ln(\alpha + nj + \delta) + e_j \quad (5)$$

whereα_0 = A(0) = at, $\beta = \alpha_c + \alpha_k + \alpha_h$ and β<1 by assumption. The depreciation rate δ is assumed to be the same for all types of capital.

The model is specified based on the Solow theoretical framework. However to suit this study certain extensions have been made to capture the impact of ICT, by narrowing capital to just three major types physical, ICT and human capital.The model would be used to capture theobjectives of this study. The functional form of the modified Solow model is therefore derived from the first equation above.

$$y = f(c, k, h, n) \quad (6)$$

where y is the output proxied with Gross Domestic Product, c is ICT, k is the physical capital, h is human capital and N is the labour proxied with population. The linearized form of the multiplicative equation in equation 1 above is gotten by assigning log on both the left hand

sides and right hand sides and can therefore be represented mathematically as;

$$Logy = \beta_1 logc + \beta_2 logk + \beta_3 logh + \beta_4 logn \quad (7)$$

where the β's are the coefficients of the independent variables.

To ascertain the variables that have not been captured by the explanatory variables we now specify an econometric equation with the error term (ε). And θis the unobserved country heterogeneity that may affectoutcome. The log of lower cases would be replaced with upper cases and presented as

$$Y = \beta_0 + \beta_1 C + \beta_2 K + \beta_3 H + \beta_4 N + \theta + \varepsilon \quad (8)$$

However we admit that these are not the only effects of output based on other environmental factors. In the words of Romer (2006, p.14) "The Solow model is grossly simplified in a host of ways…it is natural to think of the features of the model as defects: the model omits many obvious features of the world and surely some of those features are important to growth". It is in the light of this that we employ Inflation Rate and Trade Openness as opined by Mohammad and Meysam (2007). Trade Openness is to capture the effect of International Trade on the output. The model is therefore extended to be;

$$Y = \beta_0 + \beta_1 C + \beta_2 K + \beta_3 H + \beta_4 N + \beta_5 I + \beta_6 O + \theta + \varepsilon \quad (9)$$

where I is Inflation and O is for Trade Openness.

However, these equations are not specified in panel form. The panel data analysis requires the variablesto be specified in time and cross sectional units. This leads us to the estimable equation;

$$Y_{it} = \beta_0 + \beta_1 C_{it} + \beta_2 K_{it} + \beta_3 H_{it} + \beta_4 N_{it} + \beta_5 I_{it} + \beta_6 O_{it} + \theta_{it} + \varepsilon_{it} \quad (10)$$

where i= 1-14 and t = 1985- 2012 and i denotes countries while t denotes time.

The above equation would be estimated to ascertain the regional impact of ICT..

Panel data analysis endows regression analysis with both a spatial and temporal dimension. With repeated observations of enough cross-sections, panel analysis permits the researcher to study the dynamics of change with short time series. The combination of time series with cross-sections can enhance the quality and quantity of data in ways that would be impossible using only one of these two dimensions [7].

Table 2: Panel analysis regression results for ECOWAS countries

Variable		Coefficient	t-value	P >ÐtÐ
Human Development Index		1.528636	2.79	0.007*
Population		0.2361468	6.84	0.000*
ICT development index		0.3024729	2.33	0.023*
Gross fixed capital formation		0.0074169	1.95	0.055
Inflation rate		0.0057774	1.52	0.133
Trade openness		-0.1753966	-2.71	0.009*
Constant		19.92206	55.74	0.000*
R-square	Within	0.8118		
	Between	0.8984		
	Overall	0.8872		
F-probability	0.0000			

*Significant at 5% significant level

The study employed data from the World Bank Indicators, Statistical Bulletin, National bureau of statistics, the International Telecommunication Union and the Human DevelopmentIndicators. The Data covers the period 1998 to 2012 and considering the fourteen West African countries; Nigeria, Ghana, Cote D'ivoire, Senegal, Republic of Benin, Mali, Niger,Burkina Faso, Cape Verde, Guinea, Guinea Bisau, Liberia, Togo and The Gambia. This therefore excludes Sierra Leone due to its unavailability of data on ICT development index (IDI). The analysis aims at covering the periods between 1998 and 2012 across 14 countries that gives us enough degrees of freedom to enable our estimates to be efficient. The study uses the ICT Development Index (IDI) which is gotten from the ICT infrastructure and uptake, to proxy ICTfor each country, as computed by the International Telecommunications Union. The IDI is made up of three sub-indices that cover ICT access, use and skills for various countries.

Presentation of Panel Analysis Regression Results for ECOWAS Countries: The study first of all performs a Hausman Specification Test to investigate whether to use a fixed effect or random effect panel analysis. The Hausman test which is a 3-step procedure as shown in the appendix shows that the probability chi square is 0.9924 which is greater than 0.05 hence the study does not reject the null hypothesis and therefore concludes that fixed effect is a better fit.

The study then further used the fixed effect panel analysis and the results are presented on the table below;

The result above shows that the regression analysis is highly significant given that the F-probability is 0.000. Also the R-square within, between and overall are all high

at 81%, 89% and 88% level. This implies that the independent variables explain up to 88.72% of the dependent variable according to the overall R-square. The findings opine that the human development index significantly and positively determines Gross Domestic Product (GDP) of ECOWAS countries, given its t-value of 2.79 which is greater than 2 and its probability value of 0.07 which is less than the standard 5% significant level. This is however expected a priori since the human development index is computed from educational enrolment level and health status (life expectancy) which strengthens the labour force of every economy and should translate to increasing GDP figures.

Population shows a significant and positive effect on GDP. The t-value of 6.84 and probability value of 0.000 suggests that the increase of an individual in the ECOWAS region significantly increases the GDP by 0.2361468 unit. Though population is much broader than the working population, the results show that it is significant in determining GDP, this could be explained by the fact that most of the ECOWAS countries are made of a huge working population with an old age population that retires and still gets involved in active economic activities as well as children that get involved in some economic activities though not legalised.

The ICT development index which constitutes the variable of interest for this study equally shows a positive and significant effect on GDP of ECOWAS countries. The t-value is 2.33 which is greater than 2, while the probability value is 0.023 which is less than 0.05 hence a unit increase of the ICT development index increases ECOWAS GDP by 0.3024729 unit. This is encouraging as it shows that ICT is now a major contributor to ECOWAS GDP which is expected as it is evident in most developed countries. Surprisingly, Gross Fixed Capital Formation (GFCF) is not a significant determinant of GDP. The t-value is 1.95 which is less than 2 and the p-value of 0.055 is greater than the standard 0.05 hence not statistically significant. This is not expected a priori given that investments should ordinarily boost GDP; however this slight limitation could be attributed to the poor investment climate in the region plagued by insufficient power, poor transportation and high costs of production amongst others.

In the same light, inflation rate is a positive and non-significant determinant of GDP in ECOWAS. Given its t-value of 1.52 and p-value of 0.133 the study concludes that inflation is not statistically significant. It is however positive due to the role it plays on price that translates to GDP eventually. On the other hand, the result suggests that trade openness has a significant but negative relationship with GDP of ECOWAS countries due to the negative sign on the coefficient. The magnitude t-value of trade openness is given as 2.71 and the p-value is 0.009 hence opining that a unit increase of trade openness significantly reduces GDP for ECOWAS countries by 0.1753966 unit. This result has significant implications as it suggests that the higher ECOWAS countries open up trade to the world the lower the GDP. This is however not expected according to theory unless opening up is not followed by an export led growth.

Conclusion and Policy Recommendations: This study is motivated by the most recent emerging countries, especially the Asian tigers and the further strengthening of the world powers through their mastery and exploitation of ICT. This technology emerged from the West like several others but reached Africa decades ago and it is the interest of this study to investigate to what extent an integrated region like ECOWAS has been able to harness this technology and make it reflect on growth. This study therefore used Panel Regression Analysis to show that Human Development Index, Population, ICT Development Indexand Trade Openness are significant determinants of GDP in ECOWAS while Gross Fixed Capital Formation,Inflation Rate are not significant determinants of the GDP of ECOWAS countries.

It is on this premise that the study recommends the continuous use of ICT in ECOWAS and its exploitation in many other sectors that will enhance production and make the markets more efficient so as to foster growth. And also for the Republic of Guinea to make conscious efforts to set up favourable policies that enhance the use of this technological novelty called ICT.

In the light of the analysis and findings of this study, the following recommendations are considered necessary for the short, medium and long term implementations. The study recommends that human development index is a significant and positive determinant of Gross Domestic Product in ECOWAS. This is expected and is encouraged in most countries. Education must be taken more and more serious as well as the health conditions of people or workers, as this translates directly to the GDP of the economy. Furthermore, human Development Index should also be backed by the development in ICT to meet up with the contemporary world demand. ICT enhancement must be met with trained and equipped staff that can use this technology else it becomes useless. This will go a long way to improve middle and long term human development therefore enhancing their effect on economic growth.

It is encouraging to note that ICT significantly affects GDP in ECOWAS, efforts must therefore be made to sustain these effects and boost other sectors like enhancing the markets, improving security, facilitating information and communication as well as reducing overall cost of production. The Information and Communication Technology has been exploited by most world powers today to become even more powerful and this could be emulated in ECOWAS as a major way out of the poverty, dearth of information and general poor economic state in which they have been if the region must eschew itself from stifled economic growth.

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