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The Effect of Technological Innovation on Economic Growth: Evidence from ECOWAS Countries

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Abstract

This study examines the impact of technological innovation on economic growth in the Economic Community of West African States (ECOWAS) from 2008 to 2020, which are lacking behind in terms of their innovation activities. Technological Innovation has a crucial impact on improving the productivity of human and physical capital which will translate to higher economic growth. Given the importance of technological innovation to economic growth, this study empirically investigates the effect of technological innovation on economic growth in these countries and examines how the improvement in human capital, foreign direct investment, institutions, physical capital and annual population growth can stimulate economic growth. The study employed a panel model with a fixed effect, two-ways and time random effect estimation method which helps to observe the heterogeneities in these countries. The study found that technological innovation has a negative impact on economic growth in these countries which is due to its poor institutions and the inability of their governments to formulate and implement policies that will promote human capital development that will produce meaningful technological innovation and/or effectively utilize existing ones.

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1. Introduction

The study of modern economic growth has been pioneered by Solow (1956) and Swan (1956) and further modified by Solow (1957) to allow for technical change. The Solow neoclassical model of economic growth explains how long run economic growth can be achieve through the accumulation of physical capital and labour while technology and savings rate are exogenous in the model and savings rate typically constant overtime. Giving capital diminish over time, the Solow model predicts low-income countries with low capital stocks will converge to rich countries with higher physical capital to the same steady state with zero growth which is due to the so-called Inada conditions, countries with low capital stock will have a higher marginal productivity in factor inputs than countries with higher capital stock.

The prediction of the Solow model was unable to explain the different growth path across countries. Which result to the formulation of the endogenous growth model of Lucas Jr (1988) and Mankiw Gregory, Romer, and Weil (1992) which embodies human capital as a crucial driver of growth in the production function and was able to explain that long run economic growth may not be only as a result of exogeneous factors such as technical change as mentioned in the Solow (1957) model.

Romer (1990) further support the idea of non-concavity of the production function with human capital, the improvement in human capital increase the productivity of factor inputs use in the production function through the concept of learning by doing (Arrow, 1962). Moreover, this theory is not sufficient to explain the recent difference in growth across countries, giving that human capital depreciate too and if the knowledge human capital learned during the production process can't be transfer from one person to another or from generation to another.

In addition, giving the global environmental crisis which, we need a model that explain how we can produce efficiently without disrupting the ozone layers for a healthy economy, cleaner and more resilient environment. We cannot achieve a long run sustainable growth and development only by the improvement of physical and

human capital but rather a broader concept of innovation which can be drive through research and development expenditures, patenting, technological balanced of payment, machinery import and diffusion (Cameron, 1996) and most recently trademark applications (Aaker, 2007; Flikkema, Castaldi, Man, & Seip, 2015).

The Investment in Research and development has received the most support in promoting innovation due to data availability and data on research and development investment are easier to collect and thus more reliable that other measures. Rosenberg (2006) stated that since the mid-1990s, the investment in knowledge has risen more than the amount on investment in machinery and equipment in the OECD countries and empirical studies also found that the investment in research and development have a greater return than the investment in fixed capital accumulation and Uppenberg (2009) argue that this returns on research and development spending are higher at macro level than its impact on micro and firm level due knowledge spill over. At micro level, a knowledge spill over reduces incentive to individual firms to invest in knowledge generation, giving that the motive of individual firm is to make profit. Thus, in the presence of knowledge spill over means that other rival firms who are not investing in knowledge generation will be able to imitate the knowledge generated by the firm, at no cost which the generator cannot enjoy a monopoly power. While at the macro level since public spending means it will be public good others can improve it and its international spill over is a crucial driver to economic growth and development, and convergency across countries through foreign direct investment. Therefore, giving the important of innovation on economic growth and sustainability, this study will empirically show how improvement in technological innovation can spur economic growth and development in the Economic Community of West African States.

These countries are lacking behind in adopting and investing in innovation especially in term of technological innovation in their economic activities in the effort to cuddle global climate change for more sustainable growth in the long run which is due to their lack of investment in research and development and other innovation drivers.

None of the existing studies investigates how technological innovation can improve sustainable economic growth and development in these African countries Which needs an in-depth investigation to understand how adopting and promoting technological innovation will help to boost productivity and economic growth in these countries as combating global climate crisis no country should be left behind, every country activity affects all countries.

Innovation and technological advancement are view as an evolutionary process which are uncertain and compose of series of search efforts and development (Dosi & Nelson, 2013). The improvement of innovation sustains both capital accumulation and growth and a crucial driver for long run economic growth and the entrepreneur as the driver of innovation, will receive monopoly profit as reward for its innovation activities and this also create more incentive for the innovator to invest in research and development to further promote innovation or improve the existing innovation.

2. Literatures Review

Regarding the impact of innovation on economic growth, several bodies of research has investigated its impact on economic growth in more advanced and emerging economics. Aghion and Howitt (1996) stated that modern economics are characterized by variety of intermediate goods which are used to produce final goods and services. The improvement of the existing intermediate goods used in the production process which they called the horizontal innovation, increases the efficiency of the intermediate goods and thus have a beneficial effect on output while vertical innovation refers to the creation of new inputs used in the production process by making the old inputs obsolete which is the same as the Schumpeter creative destruction principle.

Cirera and Maloney (2017) postulated that most developed countries promote innovation activities through research and development and patenting which prevent other imitating the innovator innovation. In a competitive market, an entrepreneur will always want to stand out against its competitors which can be done by innovating the existing products or services and/or creating new product or service that will enhance consumer satisfaction, and the innovator enjoys monopoly power on his innovation this also encourage other firms to innovate which is because those firms that are more innovative can enjoyed an economic of scale and thus, they'll able to attract more consumers and these non-innovative firm can only be able to compete with the innovative firm by investment in innovation activities through research and development. While in most developing countries, due to the lack of patenting by firms create a spill over which other firms will be able to imitate and adopt the innovation of the innovator, and this will discourage further investment in research and development activities.

Aghion and Howitt (1996) also stated that if the amount of investment in research and development activities are exogeneous fixed, then the rate of growth will have a positive relationship with the level of research and a negative relationship with the level of development. Therefore, if governments subsidies research and development activities will lead to an increase in output level as this will compensate the knowledge spill over and the increase in output from the research and development activities will also shift human capital more into research and development activities.

Bernard and Jones (1996) also support the view that technological spill over will increase the speed of convergency across countries, they believed countries cannot converge due to the difference in technology which explains labour productivity over time.

We should also not forget that the outcome of research and development activities depends on human capital, which is an input in research and development, the higher the human capital the greater the research outcome. This can be seen in the difference between developed and developing countries. Spending more in research cannot determine the outcome of the research but if there are quality institutions, improve human capital such as proper managerial skill, technical expertise and know-how, will lead to the efficient use of the available resources in the research activities, the more efficient the research activities the greater the rate of growth and innovation without which research and development investment will be a sunk cost to those who invest in the research.

Grossman and Helpman (1994) argued that, the advancement in technology has been a driving force for the rising in living standard. Therefore, giving the Solow (1956) prediction of zero growth to countries with high capital due to decreasing marginal productivity of capital. This implies that this theory will be nullified if technology improved, the marginal productivities of the same input will increase. In support of this view, studies conducted in the US for the past 50 years also confirmed that, one half of the growth in labour productivity can be explained by improvement in the per capita capital growth and improvement in the allocation of labour and capital through technological innovation and recent studies believed that technological advancement would boost all sectors and techniques in the production process due to the present of technological spillover and this shift the production function.

Solow (1957) measures how much technical change contributed to growth in the US economy and found that technical change contributed 87.5% in the economy. Geroski (1989) measures the contribution of innovation to the total factor productivity growth of 79 UK firms from 1976 to 1979 and found that innovation contributed during the period of consideration about 50% of total factor productivity and 30% of the entry of firms.

Bayarcelik and Taşel (2012) uses a sample of 22 Turkish chemical firms from 1998 – 2010 to assess how change in their innovation activities will affect economic growth using panel regression model with instrumental variable to replaced endogenous variables. Their studies use log GDP as dependent variable and patent, R&D expenditure and employee in R&D sector all in logs as an independent variable. They found no strong correlation between employee in the R&D departments, a weak correlation between R&D expenditure and economic growth while a negative correlation between GDP and number of patents.

Iyoboyi and NA-Allah (2014) examines how innovation in Nigeria can impact economic growth from the period 1970 to 2011 by using a dynamic ordinary least square estimation method. They use technology-embodied capital import as a proxy for innovation including human capital, structure of the economy and they found that innovation has a positive impact on economic growth. They also found that human capital and structure of the economy have a positive impact on economic growth while trade openness, institutions and share of government expending all have a negative effect on economic growth during these periods.

Pece, Simona, and Salisteanu (2015) studies how innovation and foreign direct investment can influence long run economic growth in Central and Eastern Europe from 2000 to 2013. They found that foreign direct investment has a major impact on economic growth by promoting international technological spill over and spending on R&D activities which foster innovation in these countries during the period of studies

Blanco, Gu, and Prieger (2016) examines how research and development affect economic growth in the United states from 1963 to 2007. They found that research and development have a long run significant impact on both on states output and total factor productivity during the period. Their study also found that if there is research and development spill over, will positively impact total returns and states with more human capital have greater research and development outcomes.

Maradana et al. (2017) studies the long run relationship between innovation and per capita economic growth in a sample of nineteen (19) European countries from 1989 to 2014 by using a cointegration and Granger causality approach. They found that there is a strong link between innovation and per capita economic growth in the long run in these countries. Giving the different measures of innovation used in their study, the Granger causality test shows both unidirectional and bidirectional relationship between innovation and per capita economic growth, but this differs across countries depending on the measure of innovation used.

Maradana et al. (2019) also employed a VAR approach with Granger causality relationship between innovation and economic growth for long run impact in 19 European Economic Area from the period 1989 – 2014 and found a mixed relationship between innovation and economic growth as result of the Granger causality, there was point in which innovation granger cause growth, some instance growth granger cause innovation and some instance both grangers cause each other.

Vuckovic (2016) studies the nexus between innovation and economic growth in emerging economics using a date from 1991 to 2013 and applying a multiple regression approach. He uses the number of patents by millions of citizens as a measure of innovation and found that there is no significant statistical relationship between economic growth and innovation while an increase in foreign direct investment was found to reduces the number of patents by citizens.

Sahin (2019) examines the casual relationship between high technology export and economic growth in Turkey from 1989 to 2017. He uses both the VAR method to see the short run impact and also applies the

Granger causality test to check if there is causality between high technology export and economic growth. From the estimation of the VAR, he found that high technology export has an effect on economic growth and the Granger causality test also shows that there is causality between these variables.

Alp, Seven, and Coşkun (2020) investigates the effects of innovation on economic growth from a sample of 20 developed and developing countries from the period 2000-2016 by employing a panel data approach. They found that there is no strong linkage between technological innovation and economic growth during the period of studies. Moreover, they also found that total patent application, gross capital formation and growth in total labour force has a positive statistically significant impact on economic growth in these countries while R&D expenditure was found to have a negative effect on economic growth, which they believed that this outcome of R&D expenditure will promote economic growth in the long run.

Bayar and Diaconu (2020) also examines how open market and education affect innovation in the emerging economic from 1995 to 2017 using a panel integration and causality approach. They found that there is a positive statistically significant link between foreign direct investment, education and innovation.

This study uses high technology export as proxy of technological innovation as per Alp et al. (2020) who used both high technology export and renewable energy as proxies for innovation and their study also includes gross capital formation and total labour force growth as independent variables. While Maradana et al. (2017) also uses a different measure of innovation such as total patent application both my residents and non-residents, R&D expenditures, R&D activities, high technology export and scientific and journal articles as proxies for innovation in the European countries and Maradana et al. (2019) uses R&D activities, number of patents both by residents, non-residents and total patent applications as proxies for innovation.

Moreover, Bayarcelik and Taşel (2012) used R&D spending, patent. employees in the R&D department all in log as an explanatory variable on the log of GDP, Iyoboyi and NA-Allah (2014) used human capital, innovation and control variables such as institutional quality, structure of the economy, government size and degree of openness on GDP growth and Vuckovic (2016) uses total number of patents both by residents and non-residents as dependent variable and GDP growth, net amount of Foreign direct investment and R&D spending as explanatory variables.

In the study of Vuckovic (2016), he completely ignored some econometric principles, using GDP as explanatory there are lots of factors that might explain GDP growth which are not included in the model and thus this has a serious effect on the validity of the estimates. Iyoboyi and NA-Allah (2014) also included irrelevant variables in the model which might not cause bias to the estimates, but the efficiency of the estimation may be tamped. In my view the size of a government cannot explain GDP growth. Therefore, the model employed will help to correctly estimate the effect of these variables on economic growth in these countries.

3. Method

The econometric model that will help to empirically analyze the effect of technological innovation on economic growth is given as.

$$GDP_{it} = \beta_0 + \beta_1 PC_{it} + \beta_2 FDI_{it} + \beta_3 Tech_{it} + \beta_4 HC_{it} + Z_{it} + \delta_i + \vartheta_{it}$$

Where $\boldsymbol{GDP_{it}}$ is the annual growth rate of Gross domestic product of country $\boldsymbol{i}$ at time $\boldsymbol{t}$; $\boldsymbol{PC_{it}}$ is the annual growth rate of gross capital formation, which is used to measure the annual growth rate physical capital of country $\boldsymbol{i}$ at time $\boldsymbol{t}$, $\boldsymbol{FDI_{it}}$ is the net inflow of foreign direct investment as percentage of GDP of country $\boldsymbol{i}$ at time $\boldsymbol{t}$, $\boldsymbol{TEC_{it}}$ is the measure of technological innovation of country $\boldsymbol{i}$ at time $\boldsymbol{t}$.

The study used Scientific and technical journal articles and High-technology exports (current US$) as a measure of technological innovation in these countries. $\boldsymbol{HC_{it}}$ is the total Government expenditure on education as a percentage of GDP, which is also used as a measure of human capital of country $\boldsymbol{i}$ at time $\boldsymbol{t}$ and a vector of control variables such as annual population growth and government effectiveness as a measure of country $\boldsymbol{i}$ institutions at the time $\boldsymbol{t}$. While $\boldsymbol{\delta_i}$ and $\boldsymbol{\vartheta_{it}}$ represent country specific fixed (time invariant) and vector of standard errors respectively.

It's important to note that, the GDP growth is used to measure economic growth of a country this because modern economic growth of a country is determined by its GDP growth and as found in many literatures, the greater the GDP growth of a country the more it will translate to improvement in other sectors and government investment and spending will also increase significantly. We also include annual grow in gross capital formation which according to the World Banks is the amount of fixed assets and change in inventories in the economy, the more country investment in fixed assets such as machinery's, equipment's, plants and other infrastructural projects increases, the more the amount of capital that will be available to use in the production process.

Moreover, the annual net inflow of foreign direct investment in also use in the model, which measures the amount of foreign capital and investment in a domestic economy. This foreign direct investment as argue in many studies, has been a major determinant for convergency in the developing countries through international knowledge spillovers, as foreign investment and business is pump to a domestic economy, means this international business bring along human knowledge and new technology in that particular country whereby those in the domestic countries will imitate the knowledge and technology which has a crucial benefit for the economy as a whole. Therefore, we aspect $\boldsymbol{\beta_2 > 0}$ which will indicate that foreign direct investment has a positive

impact on economic growth in these countries. $Tech_{it}$ is the main variable of interest in this study of finding the effects of technological innovation on economic growth in the ECOWAS countries from 2008 to 2020.

The study uses Scientific and technical journal articles and High-technology exports as a measure of technological innovation in these countries. The later measures products with high R&D intensity such as machines, computers, cars and so on, while the former measures the number of engineering and scientific articles published on technology, biomed research and field natural science fields which are result of high research and development expenditures.

According to the World bank database these two variables are some of the variables that are used to measures of technology. Giving the lack of data availability in these countries, these two variables were the available and sufficient data to assess the effects of technological innovation on economic growth in these countries during the period of studies.

The study also used the total Government expenditure on education as a measure of human capital development due to lack of sufficient date availability on human capital in these countries. Thus, government expenditure on education is proper measure of human capital, giving that human capital is the knowledge, skills and education acquire by population. Therefore, the more government spending on education (which composed on both tertiaries, technical and secondary) means the knowledge and skill of the work force will increase and this will translate to higher productivity and economic growth in these countries. Which we expect $\beta_4 > 0$ to reflect it positive impact on annual GDP growth.

Finally, I also used annual population growth and government effectiveness as a measure of a country institutions. According to the World bank, the later measures the quality of public service, civil service and independent from political pressures and the quality of policy formulation and implementation and governments credibility in committing to such policies.

3.1. Data Source

The data used in empirically estimating the effects of technological innovation on economic growth in the ECOWAS countries are taken form the World bank database. The data on GDP growth (annual %), Gross capital formation (annual % growth), Foreign direct investment, net inflows (% of GDP), High-technology exports (current US$), Scientific and technical journal articles, Population growth (annual %), Government expenditure on education, total (% of GDP) are from the World bank Development indicators (WDI) while Government Effectiveness: Estimate are taken from the World Governance Indicators. All the variables are in annual frequencies, covering a period of thirteen years strengthening from 2008 to 2020.

Moreover, the study use a panel data analysis to investigate the effects of technical innovation on economic growth in these countries, among the advantages of using panel data analysis is its ability to overcome endogeneity problem as a result of this estimation method will be able to control the time series dimension as well as the county specific fixed effect and thus using panel data will also provide efficiency in the estimation by providing more degree of freedom, more informative and in addition more sample variability to make an accurate inference about the estimated model (Hsiao, 2007).

As Paleologou (2013) also mentioned, one of the problems of using panel data analysis, is its ability to reduce efficiency of the estimation when the time series dimension is small and if the study focuses on subjects form different geographic region, social and economic development. Given that this study will investigate the effects of technical innovation on economic growth on countries that have similar economic status and located with the same geographical region, the efficiency of the estimates wouldn't be affected.

3.2. Method of estimation

In estimating the panel model, both random effect and fixed effect estimation method were used. This estimation method allows to control for time invariant factor δ_i such as government policies that are difference in each of these countries, if they're correlated with the explanatory variables and unobservable, then the fixed effect estimation may not be suitable while the random effect estimation assumes these factors as random components and do not have any correlation with the explanatory variables. The suitability of any of these estimation methods will be determine with the Hausman test, which test if this time invariants are correlated against the alternative hypothesis they are not. A p-value of less 0.05 means we support the alternative that they're correlated and the same for all countries.

4. Results and Discussion

4.1. Model Identification

To identify if the unobserved heterogeneity is random component or not, The study performed a Hausman test on the fixed model and time effect random which reported a p-value of 0.05929 while on the fixed effect and the two ways random effect it reported a p-value of 0.9998 which are both more than the significant level therefore we support the null hypothesis that the model is a random effect model, this country fixed effects are due to random errors they have no correlation with our covariates.

Moreover, to know if the two ways random effects has a significant effect in these countries, we also performed the Lagrange Multiplier Test - two-ways effects (Gouriéroux, Holly, & Monfort, 1982) using RStudio

programming, which also reported a very low p-value of 8.799e-07 which means than two ways effects has no statistically significant effect in these countries. Baltagi (2008) mentioned that that cross-sectional dependence will only be an issue in a long-time panel of twenty to thirty year but not in small time panel which therefore, the study ignored that in the regression diagnostics.

4.2. Pre-Estimation Analysis

Before doing a further analysis, I performed a descriptive statistic to know the nature and distribution of the variables so as to know the proper analysis and test to conduct for robust inferences. From the descriptive statistics the average growth in these ECOWAS countries stand at 4.60 which implies that there has been very low average growth rate of GDP in these countries and have similar growth rate of GDP during this period which is capture by the low standard deviation. In term of population, they have a high average growth rate in annual population, and they all have similar rate of population growth.

Moreover, the average growth rate in physical capital and foreign direct investment has also been very low in these countries during the period and no significant difference in physical capital and foreign direct investment, meaning that these countries have not been attracting more investors to the region. This is a result of poor institutions in these countries on average which is reported by the descriptive statistics and there has been a significant difference in their institutions setups and government effectiveness in formulating tangible policies that will attract foreign companies to these countries. Although having institutions do not guaranteed higher economic growth either quality of living standard, for the institutions to impact economic growth, there must be accountability and transparent in reducing corruption, formulating and promoting policies that will impact economic growth and development, the summary of the descriptive statistics is giving in the Table 1 below.

Table 1. Descriptive statistics of the variables.

Variables	Min.	Mean	Std Dev.	Max.
GDP	14.79	4.60	3.35	14.047
Population	1.09	2.67	0.59	3.907
Physical Capital	-240.72	8.13	33.02	218.754
FDI	-2.55	3.60	3.29	18.828
Scientific and technical Journal articles	2.47	490.61	1120.98	5602.28
Institutions	-1.50	-0.66	0.41	0.3210
High Tech Export	0.00	4.69	7.59	60.2998
Human Capital	1.58	4.56	2.74	17.463

In addition, the accumulation of human capital development has been very low in these countries on average, and there has been little focus on human capital development which is a fundamental driver of research and development and the creation of quality institution that will also be translated more involvement in research activities and proper utilization of existing technologies to promote economic growth in these countries.

Finally, the main variable of interest, Scientific and technical Journal articles and high technology export which measures technological capacity in these countries has also been low in these countries. These countries involvement in scientific and technological researches have been low which is a major factor for the low exportation of technological goods and services and there is no significant different in their research activities across these countries. Therefore, these countries should be investing in more human capital development and promoting more foreign direct investment activities which is a crucial driver of technological innovation and international knowledge spill overs.

Furthermore, Table 2 presents a Pearson correlation analysis to have a glimpse of the linear relationship between these variables. From this analysis, there have been a positive relationship between annual population growth and the rate of annual GDP as shown in the correlation matrix below.

Physical capital, human capital and foreign direct investment also positively relation to annual GDP growth in these countries but physical capital have more effect on annual GDP growth than human capital development and the annual net inflow of foreign direct investment. While institutions, Scientific and technical Journal articles have a negative correlation with annual GDP growth which might be due to these countries low involvements in scientific, technological research while positive linear correlation between high technology export and annual GDP growth. Since this is just a simple linear correlation analysis, the empirical evidence will help to understand the nature of the relationship between these variables and annual GDP growth and will help to know how technological innovation will impact economic growth in these countries during the period of studies.

Table 2. Pearson correlation analysis.

	GDP	Population	Physical	FDI	SJA	Institutions	Human	High Tech.
GDP	1	0.240	0.178	0.125	-0.098	-0.115	0.080	0.082
Population	0.240	1	0.037	-0.116	-0.043	-0.414	-0.159	0.364
Physical.	0.178	0.037	1	0.146	-0.052	-0.060	-0.010	0.020
FDI	0.125	-0.116	0.146	1	-0.216	0.293	-0.085	0.052
SJA	-0.098	-0.043	-0.052	-0.216	1	-0.209	0.667	-0.054
Institutions	-0.115	-0.414	-0.060	0.293	-0.209	1	-0.051	-0.046
Human	0.080	-0.159	-0.010	-0.085	0.667	-0.051	1	-0.027
High Tech.	0.082	0.364	0	0.052	-0.054	-0.046	-0.027	1

Note: SJA (Stands for Scientific and technical Journal articles).

Finally, I presented the empirical estimation of the effects of technological innovation on economic growth in the ECOWAS countries in Table 3. Giving the crucial important of technological innovation on sustainable growth and development and the current climate crisis, technological innovation activities should be a complement to economic activities for a more resilient environment. From the empirical estimation, physical capital and institutions has insignificant positive and negative effects respectively on Economics economic growth in the ECOWAS countries. A one percentage increase in accumulation of physical capital will impact economic growth by the same amount. This is so since these countries lack the human capital, knowledge and technology to effectively and efficiently use these available capital stocks which will be translated to larger economic growth. Accumulating more capital does not imply more economic growth since capital depreciates, the proper use of these capital will increase the marginal productivities of these capital. While the negative relationship of institution also implies these countries have been spending lot of funds in establishing improper institutions which are not promoting and formulation sound policies that can bring economic growth which means it a sunk cost to the economy and can prevent investment of the resources in a more productive sector. If these countries are serious about building institutions that are drivers to economic growth and development through the establishment of formidable policies must also focus on improving the quality of its institutions in reducing corruption and promoting more transparent economic activities.

Table 3. Empirical result: Fixed and random effect estimation.

Variables	GDP Growth		
	Fixed-Effect	Two-way Effect	Time effect
Physical Capital	0.02**	0.01	0.01
	(0.01)	(0.01)	(0.01)
Foreign Direct Investment	0.11	0.23***	0.18**
	(0.10)	(0.09)	(0.08)
Institutions	0.41	1.53	-0.70
	(1.76)	(1.44)	(0.67)
Human Capital	0.64**	0.62***	0.43***
	(0.26)	(0.17)	(0.12)
Scientific and technical journal articles	0.0005	-0.0001	-0.001***
	(0.001)	(0.001)	(0.0003)
Population	7.86***	4.25***	1.58***
	(2.36)	(1.45)	(0.47)
High Technology Export	-0.02	-0.03	-0.02
	(0.04)	(0.03)	(0.03)
Constant		-9.22**	-2.20
		(4.39)	(1.41)
Observations	156	156	156
R2	0.21	0.24	0.19
Adjusted R2	0.11	0.20	0.15
F Statistic	5.24*** (df = 7; 137)	45.51***	33.89***

Note: **p<0.05; ***p<0.01.

Human capital has a very positive significant effect on improving economic growth in these countries. A one percentage increase in expenditure on human capital development will likely increase economic growth by 4.3% which is very true and in tandem with prior studies (Bayar & Diaconu, 2020; Blanco et al., 2016; Iyoboyi & NA-Allah, 2014). The improvement in human capital will not only increase the productivity of physical capital but it will develop good institutions and increase research outcome since it an input in research activities, the more human capital development the more it will formulate policies that can bring economic growth and

development. Therefore, as argue with Romer (1990) this improvement in human capital development productivity cannot be concave and the economy can't face a diminishing return to inputs.

Annual population growth also plays a crucial role on annual GDP growth rate in these countries. An increase in annual population growth by one percentage point will result to an increase in annual GDP by 1.58 which is statistically very significant and make lots of intuitive sense. The increase in population has large economic benefit and from the so-called district theory, a country with higher population growth will have higher probability of having many genius individuals in its population. the recent growth of China is evidence to this fact, there large population has increase which provides lots of benefits to the growth and success of its economy and promote foreign direct investment to the country, due to cheap labour and the inflow of foreign direct investment will also bring new knowledge and technology which help the population to further improve and develop new knowledge and technology.

The empirical estimation also shows that Foreign direct investment also has a significant positive impact on economic growth in these countries. An increase in foreign direct investment by a percentage point will spur economic growth in the ECOWAS by 18% this is because, increase in foreign direct investment means the creation of more job opportunities to these countries and this increasing in foreign direct investment will lead to international knowledge spill over and create and bring new knowledge in the ECOWAS. This result is also shown in the study earlier studies such as Bayar and Diaconu (2020); Pece et al. (2015).

Finally, due to the lack data on Research and development expenditure in these countries which is most used as a measure on technological innovation, the study used the available data from the World bank that according to the World Bank measures technology which are the Scientific and technical journal articles and the High technology export. As stated before, the former measures the scientific articles published on technology, biomedical research and so on which are based on research and development and thus, it's a part of research and development expenditure while the later measures the export of highly intensive technological products which are produce in these countries during the period of studies. Therefore, these variables can accurately help to account for technological innovation on economic growth in these countries.

From our estimation, Scientific and technical journal articles have very low and significant negative effect on economic growth in the ECOWAS countries. A unit increase in the number of Scientific and technical journal articles will reduce economic growth by 0.001 units. While high technological export has negative insignificant effect on economic growth. Sahin (2019) also finds a similar relationship between high technology export and economic growth in Turkey while (Erkisi & Boğa, 2019) found a mixed relationship between high technology export and economic growth in the EU-15 countries from 1998 to 2017.

These estimates make lots of intuitive sense in assessing the impact of technological innovation on economic growth in these ECOWAS countries. Scientific and technical journal articles will reduce economic growth in these countries this is because, increasing in expending on Scientific and technical journal articles which are not implemented in the economic production process will not translate into any economic benefits and the poor-quality human capital the outcomes of Scientific and technical journal articles may not be up to standard or produce meaningful journal articles. Giving that these countries are not producing technology or other technological driven goods and poor quality of its human capital, the more spending in high technology goods that do not have consumer market is a sunk cost to the economy.

5. Conclusion

Innovation has become a fundamental driver of modern economic growth which has been neglected by earlier growth theories, which needs more attending giving the divergencies across countries and the serious threat of climate which shows the need to be more innovating in our production process for a more sustainable environment and growth.

The study investigates the effects of technological innovation on economic growth in the ECOWAS countries which use Scientific and technical journal articles and the High technology export as a measure of technological innovation due to lack of data availability in these countries, but these variables are use as measure of technology by the World bank.

From the empirical estimation, the study found that Scientific and technical journal articles have a negative significant effect on economic growth in these countries while the High technology export has insignificant negative effect on economic growth in these countries during the period of studies. Which is because these countries have not been efficient in their research activities due to low human capital development and poor institutional quality and the negative impact on high technology export is also the result of low technological or lack of manufacturing technological output which became a sunk cost in these countries.

Therefore, this concludes that in order to technological innovation to stimulate economic growth in these countries, they should focus more on the human capital development and formulating and implementing quality institutions which will promote foreign direct investment which have a significant impact on economic growth and the more human capital develops, the more efficient it can produce meaningful technology and the spill overs from foreign direct investment will be efficiently utilized.

6. Limitation

The paper assessed how technological innovation can stimulate economic growth in the ECOWAS countries from the period 2005 to 2020. Most of earlier research on the effects of innovation and technology on economic growth uses Research and development expenditure, patents applications, high technology as a percentage of manufactured export and more recently, trademark applications are also used as a measure of technological innovation. Moreover, due to the lack of data availability on these variables to assess the impact of technological innovation in these ECOWAS countries, the study uses Scientific and technical journal articles and high technology export in current US dollars to measure technological innovation, which are found to have a negative and positive impact respectively on economic growth in these countries.

Furthermore, for more evidence on the effects of technological innovation on economic growth in the ECOWAS countries, more research needs to be done in future when the data is available on the mostly used variables in measuring technological innovation and/or new measures of technological innovation which will provide more support to this finding.

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