Macrothink Institute™

**Issues in Social Science**
ISSN 2329-521X
2023, Vol. 11, No. 1

# Dynamic Response of Economic Growth to Financial Development and Information and Communication Technology in Sub-Saharan Africa Countries

Olabode Eric Olabisi

Department of Economics

Elizade University, Ilara-Mokin, Ondo State, Nigeria

E-mail: olabode.olabisi@yahoo.com; olabode.olabisi@elizadeuniversity.edu.ng

Received: June 1, 2023 Accepted: June 22, 2022 Published: June 25, 2023

doi:10.5296/iss.v11i1.21113 URL: http://dx.doi.org/10.5296/iss.v11i1.21113

**Abstract**

The aims of this research work are to test the dynamic response of economic growth to financial development and information and communication technology (ICT), and to investigate whether the interaction of financial development with better ICT infrastructure can promote economic growth. Growth theories predict that financial development and ICT positively influence economic growth, but the results are mixed. Therefore, the current study examines the dynamic response of economic growth to financial development and information and communication technology (ICT) for eight selected sub-Saharan African (SSA) countries covering 2000–2021. Applying pooled mean groups and mean group estimators, the findings reveal that ICT enhances growth in SSA, but financial development is otherwise. The result further shows that with the interaction of ICT with financial development, economic growth is positively influenced. Since the region is still undergoing development, it is suggested that there should be more investment in the ICT infrastructure.

**Keywords:** Pooled Mean Group, Financial Development, Economic growth, Sub-Saharan African, Mean Group

**JEL Classification**: E51, G29, O16, O40

## 1. Introduction

Financial experts, investors, and researchers across the world are concerned about whether the financial sector enhances the economic activities of a country with the help of sophisticated ICT gadgets. This primary concern has spurred numerous research studies in this field. Among other things, the growth of African economies is a debatable macroeconomic goal among scholars. That is why all and sundry are agitating for an improvement in global countries' welfare and growth, especially in the developing nations. More so, the African countries homogeneity characteristics, such as a high poverty rate, low capital for investment, unemployment, a high rate of crimes, and so on, are common issues that affect the SSA region. To this end, improvements in African economies may be systematically dependent on improvements in growth determinants. To support this assertion, Solow's growth model suggests that a country can achieve its desired growth through new capital formation and sophisticated information and communication technology (ICT) gadgets. In view of this, the questions that need to be answered are: (1) Does financial development promote the economies of the selected SSA countries? (2) Does the interaction of ICT with financial development stimulate the economies of the selected SSA countries? These are the two major concerns of this study.

The previous works in the literature focused mainly on the relationship between financial development and GDP growth without much attention to the role of ICT in promoting financial development and economic growth (see Levine, 1997; Calderón & Liu, 2003; Assefa & Mollick, 2017; Asteriou & Spanos, 2019; Nguyen et al., 2022).

There are a few researchers in this area of research on the role of the interaction of information and communication technology with financial development in promoting economic growth, especially in Africa, which is why this current study is carried out. For instance, Sassi et al. (2013) considered the role of ICT in financial development and economic growth. Another scholar, Cheng et al. (2021), also focused on the effects of ICT diffusion, financial development, and economic growth for international cross-country analysis. Both publications applied dynamic generalized methods of moments (GMM) in their studies. The outcomes of these two papers are not sufficient to conclude the relationships between ICT, financial development, and economic growth. It is crucial to conduct several new studies with different estimation techniques that will cut across other regions or continents before a general conclusion can be drawn regarding this area of study. Although there are divergent views about the contributions of financial development to economic growth in the literature, For instance, Khan and Senhadji (2003) reveal that effective finance promotes economic growth. On the contrary, some authors believed that finance is only a factor and cannot stand alone in promoting economic growth; however, it does impact growth in interaction with other variables such as information and communication technology (ICT).

Despite these views, finance is still a major factor in growth determinants. Cheng et al. (2021) strongly believed that the positive outcome of ICT on economic growth can only be felt in developed economies but cannot be ascertained in developing countries. This is simply

because of the capacity of the advanced economies to mobilize adequate resources in the ICT sector (Kenny & Qiang, 2003). In developing nations, shortages of capital hinder the commitment of resources towards investment in ICT.

In the work by Jalava and Pohjola (2008), ICT contributed to almost 60% of the growth of the Finnish economy. Also, other authors concluded that ICT can enhance economic growth in less developed nations because its tools are extended to public utilities such as water, electricity, health, and transport services (see Datta & Agarwal, 2004). From the foregoing, the introduction of mobile banking in most less developed nations has allowed for the diversification of banking activities within countries and, hence, enhanced economic growth. Apart from banking activities, ICTs also increase economic activity in sectors such as education, agriculture, energy, etc. The contributions of ICT in firms allow flexible structures in production and reduce the cost of operations. In recent years, authors have been focusing on the effect of interactions between financial development and ICTs on growth, but a few pieces of evidence can be seen in the literature.

To this end, the objectives of this current research are two-fold: (1) to *test the dynamic response of economic growth to financial development and information and communication technology (ICT)* in the selected eight SSA countries; and (2) to investigate whether the interaction of ICT with financial development promotes economic growth in selected SSA countries. By applying recent econometric techniques, the outcomes of the research will contribute to the literature and also be useful to policymakers.

This study is divided into five sections: Section one provides the introduction. Section 2 provides a review of related literature, while Section 3 presents the methodology employed in the study. Section 4 is devoted to the empirical results. Lastly, Section 5 presents the conclusions and policy recommendations.

## 2. Literature Review

### *2.1 The Financial Development and Economic Growth Relationship*

The review of previous research in the finance-growth nexus is crucial in order to understand the findings, techniques, and models adopted so far. This will help the researchers know what further contributions can be made to the literature. The relationship between financial development and economic growth dates back to the works of Gurley and Shaw (1960). Theoretically, McKinnon's (1973) hypothesis opined that, especially in developing countries, when interest rates are liberalized, the real interest rate is increased; therefore, savings will increase as well, which spurs investment. An increase in investment would further lead to the economic prosperity of a country. Accordingly, development in the banking sector positively induces economic growth because banks' activity encourages saving, promotes efficiency in resource allocation, and stimulates technological innovation (Sassi & Goaied, 2013). However, not all the policies aimed at liberalizing financial development yielded favorable economic growth; some failed to promote economic growth. This poses a limitation to some of the research work whose findings showed that financial depth induces growth.

In the contributions to finance-growth literature, some findings showed a positive and

significant relationship between financial development and GDP growth. For instance, in the work of Huang and Lin (2009) on the finance-growth nexus, using a threshold regression with instrumental variables approach, their finding buttresses that development in the financial system positively impacts economic growth, and this impact is more crucial in low-income countries than high-income countries. In Nigeria, Olorogun, Salami, and Bekun (2022) revisited the empirical relationship between foreign direct investment, financial development, and economic growth. Using the Pesaran ARDL bounds testing and Toda-Yamamoto Granger causality approaches, findings showed positive effects of financial indepth on growth. Similarly, Afolabi (2022) examined the relationship between financial liberalization and GDP growth in Nigeria. Applying the dynamic ordinary least squares (DOLS) econometric technique, findings showed that financial development was positively related to economic growth.

On the contrary, some scholars argued that there is no way there could be a general consensus about the results of finance-growth nexus because of the differences in the samples, nature of the data, and estimation approaches used by different researchers in the literature. For instance, Adnan Hye and Islam (2013) examined the financial development and economic growth nexus, using the principal component method to construct the financial development index and autoregressive distributed lag (ARDL) estimation techniques, a negative relationship was found. Also, in mixed results by Giri, Mohapatra, and Debata (2023) on financial system and growth relationship, using a nonlinear approach, they found that a favourable shock in financial development promotes economic growth while a negative financial shock retards economic growth in India.

### *2.2 The ICT and Economic Growth Relationship*

Research on the relationship between ICT and economic growth are contemporary, but there has been tremendous progress in the last two decades. Some empirical researchers concluded a positive impact of ICT on growth, yet empirical studies on the subject matter produced mixed results.

In one direction, quite a number of empirical studies have produced a positive effect of ICT on economic growth. Dewan and Kraemer (2000) covered a sample of 36 countries spanning 1985 to 1993 and concluded that ICT induces growth only in industrialized economies. They explain that factors such as a lack of basic infrastructure, poor business practices, and poor government policies contribute to the insignificant level of investment in ICT in most developing countries. Also, using a time series data set of 39 countries, Pohjola (2002) concludes that ICT enhances economic growth only for 23 OECD member countries in the study, while a negative effect appears in other countries. Similarly, Nour's (2002) research on ICT-economic growth nexus in seven MENA countries, finding shows that ICT induces economic growth.

Seo, Lee, and Oh (2009) investigate the relationship between ICT and economic growth for a data set of 29 countries. In applying the simultaneous equations estimation method, finding shows that ICT induces economic growth. Nasab and Aghaei (2009) also reveal a positive result of ICT on growth by applying the GMM estimation technique for OPEC countries

during the period 1990–2007. Albiman and Sulong (2016) investigate the link between ICT and economic growth in SSA countries over the period 1990–2014, using the estimation techniquesof the general method of moments (GMM). Mobile phone and internet promote growth. Similarly, Albiman and Sulong (2017) reveal positive effects of ICT on economic growth in estimating non-linear and linear models for SSA countries from 1990 to 2014.

Solomon and van Klyton (2020) investigate the effect of technology on economic growth in 39 African countries over the period 2012–2016. Using the GMM estimator, the study finds a positive result of digital technology on economic growth. Awad and Albaity (2022) investigate the mechanisms through which ICT can affect economic growth in 44 SSA countries. Using panel-corrected standard errors (PCSE) and system GMM, the findings support the growth theory that ICT impacts economic growth positively.

### *2.3 Financial Development, ICT and Economic Growth Relationships*

The literature on financial development, economic growth, and ICT relationships is widely discussed in the previous literature, but empirical work on the interaction of financial development and ICT is very rare. Among the few studies was Shamim (2007), who concluded that financial depth, backed up with better ICT, positively and significantly promotes economic growth. The research work applied GMM estimator to 61 countries spanning from 1990 to 2002. She further reveals that an increase in mobile phone subscribers and internet users positively induces financial depth and business activities. Her findings are in line with the empirical findings and policy recommendations of Claessens, Djankov, Fan, and Lang (2002) that developing countries need to invest heavily in the ICT sector in order to attain sustainable growth. Also, Solarin et al. (2021) examine relationship among financial sector, ICT, economic growth and electricity consumption in Malaysia. Applying the cointegration and Toda-Yamamoto Granger causality estimation techniques to a quarter data set spanning from 1990 to 2015, their results show a positive effect of ICT, economic growth, financial development on electricity consumption. Findings further show bidirectional causality between ICT and electricity consumption, and economic growth and electricity consumption. Also, Sassi and Goaied (2013) confirm that the interaction between ICT inclusion and financial development forms the threshold for positive and significant economic growth using the GMM estimator.

Recently, Cheng et al. (2021) investigated the interaction of ICT diffusion and financial depth on the economies of 72 countries over the period of 2000 to 2015. They employed the principal component method and the GMM estimator in their study, and their findings are: First, financial development negatively affects economic growth. Second, ICT diffusion increases economic growth, especially in high-income nations. Finally, the interaction between ICT and financial development positively and significantly promotes economic growth.

## 3. The Empirical Study

### *3.1 Sources of Data and Variables Definition*

The panel dataset was extracted from the World Development Indicators published by the

World Bank and the International Telecommunication Unit (ITU). The analysis was based on annual data from eight SSA countries. The countries selection was based on a balanced mix of gross national income (GNI) classification by World Bank, that is, the low income, lower middle income, upper middle income, and higher income groups. Also, the availability of data used for estimation purposes. These above criteria led to the selection of the following countries: Botswana, Cameroon, Ghana, Kenya, Malawi, Mauritius, Nigeria, and Rwanda.

Table 1. Country GNI data used in the analysis and their grouping categories

| S/No. | Countries Name | GNI per capita, PPP (US$) as at 2022 | GNI per capita grouping | Member Regional Grouping |
|---|---|---|---|---|
| 1 | Botswana | 15,420 | Higher Income | SACU |
| 2 | Cameroon | 3,970 | Lower Middle income | CEMAC |
| 3 | Ghana | 5,820 | Lower Middle income | ECOWAS |
| 4 | Kenya | 5,130 | Lower Middle income | EAC |
| 5 | Malawi | 1,610 | Low Income | COMESA |
| 6 | Mauritius | 23,380 | Higher Income | SADU |
| 7 | Nigeria | 5,200 | Upper Middle Income | ECOWAS |
| 8 | Rwanda | 2,410 | Lower Middle income | COMESA |

Source: World Bank database, 2022.

Table 2. The variables and the sources of data used in this study

| Variables | Definitions | Sources of Data |
|---|---|---|
| GDP | Real GDP per capita growth is used as a proxy for economic growth. | World Bank Development Indicators |
| FIN | Financial development is proxied by the domestic credit provided by the financial sector (% of GDP). | World Bank Development Indicators |
| ICT | Information, communication, and technology are proxied by the number of mobile phone subscribers. | International Telecommunication Unit (ITU) |
| INFL | Inflation is the general rise in the price goods and services in a certain country. | World Bank Development Indicators |

### *3.2 Cross-Sectional Dependence Test*

The countries of SSA may have similar international trade activities such as exports, economic integration, imports, etc. Due to these similar economic activities, a cross-sectional dependence between them may occur. According to Chudik and Pesaran (2013), countries with similar economic activities are prone to common shocks. Therefore, the proposed Breusch and Pagan (1980) Langrage Multiplier (LM) test of cross-dependence in panel data is used in this study. The guideline is, when the null hypothesis is equal to zero, there is no cross-sectional dependence, otherwise, there is cross-sectional dependence.

The tested hypothesis is as follows:

$$H_0: Cov(\omega_{it}, \omega_{jt}) = 0$$

$$H_A: Cov(\omega_{it}, \omega_{jt}) \neq 0$$

To control for bias in the estimation result, Pesaran (2003) proposed a revised form of *LM* equation as follows:

$$CD = \sqrt{\frac{2T}{N-1}} \sum_{i=i}^{N} \sum_{j=1+i}^{N} \frac{(T-k)\hat{\rho}_{ij} - \left[(T-k)\rho_{ij}^2\right]}{\text{var}\left[(T-k)\hat{\rho}_{ij}^2\right]} \quad (1)$$

*3.3 Homogeneity Test*

The presence of cross-sectional dependence implies that SSA countries can interact with each other due to the existence of common effects such as shocks, social networks, exchange rate volatility, etc. When this occurs, the condition of slope heterogeneity arises. Hence, there is a need to check for this occurrence in order to obtain a very robust estimate (Swamy, 1970). Pesaran and Yamagata (2008) suggested a panel data model, taking into account the fixed presence of heterogeneous slopes. In achieving this, they considered the equation written below:

$$Y_{it} = \beta_i + \delta' X_{it} + \varepsilon_{it} \quad \text{with} \quad i = 1, \ldots, N \text{ ; and } \quad t = 1, \ldots, T \quad (2)$$

To test for the slope homogeneity, the study tests the hypothesis below:

$$H_0 : \beta_j = \beta$$

$H_1 : \beta_i \neq \beta_j$ and for all $i = j$

*3.4 Panel Unit Root Test*

The essence of carrying out a unit root test is to determine whether the set of data used for the analysis is stationary or not because macroeconomic data requires that all the variables be stationary in order to produce reliable results. Therefore, this study employs the Im, Pesaran, and Shin (IPS) and Maddala and Wu tests to check the stationary of the data at both level I(0) and first difference I(1).

*3.5 Panel Cointegration Test*

This study adopts Pedroni (1999) to examine the cointegration among the series because the test has the capacity to take care of more than two variables. The use of the test required first approximating the cointegration relationship as given in the equation (3) below:

$$Y_{it} = \alpha_i + \delta_i t + \beta_{1i} x_{1it} + \beta_{2i} x_{2it} + \ldots + \beta_{Mi} x_{Mi} + \varepsilon_{it} \quad i = 1, \ldots N, \; ; \; t = 1, \ldots, T \quad \text{et} \quad m = 1, \ldots, M \quad (3)$$

*3.6 Pooled Mean Group Test*

The ARDL pooled mean group (PMG) estimator developed by Pesaran et al. (2001) allows the short-run parameters and error variances to differ across the countries. At the same time, it restricts the long-run coefficients to being identical across the cross-sectional units but allows the short-run coefficients and the intercept to be country-specific. An alternative estimation method is the Mean Group (MG) developed by Pesaran and Shin (1995), which permits the estimation of separate equations for each country as well as the computation of the mean estimates without any imposition on the parameters.

This paper used pooled mean group estimator because it allows for the long-run expected conditions of homogeneity among the cross-sections. Also, the short-run adjustment relies on the region's characteristics, such as general market imperfections, corruption, a high inflationary rate, and the vulnerability of external and domestic shocks. To test the homogeneity of the long-run coefficients between PMG and MG, the study used the Hausman test (1978). However, the test is based on the hypothesis that the two sets of coefficients generated by the PMG and MG estimators are not statistically different (O'Mahony and Vecchi, 2003). Although Pesaran et al. (1999) argued that the PMG estimator is consistent and more efficient than the MG.

To determine the long-run relationship between financial development, information and communication technology, and economic growth, the study adopts the semi-logarithmic pooled mean group estimation ARDL model introduced by Pesaran et al. (2001) as follows:

$$GDP_{it} = \sum_{j=1}^{p} \beta_{1ij} GDP_{i,t-1} + \sum_{j=0}^{p} \beta_{2ij} FIN_{i,t-j} + \sum_{j=0}^{p} \beta_{3ij} ICT_{i,t-j} + \sum_{j=0}^{p} \beta_{4ij} (FIN * ICT)_{i,t-j} + \sum_{j=0}^{p} \beta_{5ij} INFL_{i,t-j} + \mu_i + u_{it} \quad (4)$$

Where;

$GDP$ = gross domestic product per capita proxy for economic growth

$FIN$ = logarithm of domestic credit to the private sector as % of GDP proxy for financial development

$ICT$ = information and communication technology proxy by number of mobile phone subscribers (MPS)

$FIN * ICT$= interactions between financial development and information and communication technology

$INFL$ =annual inflation rate (%)

$\mu_i$ = denotes the country specific effects

$u_{it}$ = denotes the remainder disturbance

i = index cross-section dimension

t = time series dimension

$\beta_{2ij} - \beta_{5ij}$ indicates the parameters of the first difference of explanatory variables while $\beta_{1ij}$ represents the scalar coefficient of lagged value of $GDP$

The re-parameterised form of equation (4) can be written as follow :

$$\Delta GDPit = \psi_i \left(GDP_{i,t-h} - \emptyset_i' X_{it}\right) + \sum_{h=1}^{p} \beta_{1ih} \Delta GDP_{i,t-h} + \sum_{h=0}^{p} \Delta\beta_{2ih} \Delta FIN_{i,t-h} +$$

$$\sum_{h=0}^{p} \beta_{3ih} \Delta ICT_{i,t-h} + \sum_{h=0}^{p} \beta_{4ih} \Delta INFL_{i,t-h} + \sum_{h=0}^{p} \beta_{5ih} \Delta (FIN * ICT)_{i,t-h} + \mu_i + u_{it} \quad (5)$$

Where parameter $\psi_i$ indicates the error-correction mechanism (ECM). It is assume that the result of the ECM must be negative and significant. The parameter $\Delta$ indicates the first difference.

## 4. Estimation Results and Discussions

### *4.1 Cross-Sectional Dependency Test Result*

Applying the Breusch-Pagan (1980) dependence test to estimate the hypothesis of non-dependence between individuals' countries, the result in Table III indicates that the probability value is statistically significant at the 5 percent level. This result rejects the null hypothesis of independence, so the countries in the study are dependent on each other.

Table 3. Cross-sectional dependency test result

| **Test** | **Statistic** | **d.f.** | **Prob.** |
|---|---|---|---|
| Breusch-Pagan LM | 45,987 | 21 | 0.000 |
| Pesaran scaled LM | 2,881 | | 0.000 |

Source: Author's computation.

### *4.2 Slope Homogeneity Test Result*

To examine the slope of homogeneity among the selected SSA countries for this study, the Fisher test statistic is employed. The result of the associated p-value in Table IV shows there is a level of homogeneity among the countries. Thus, it can be concluded that fixed effects exist between the countries examined in the study.

Table 4. Slope homogeneity test result

| Test | Statistics | P-value |
|---|---|---|
| | 9.11 | 0.000 |

Source: Author's computation.

### *4.3 Panel Unit Root Test Results*

The panel unit root results in Table V show the Im, Pesaran, and Shin (IPS) t-test and Maddala and Wu (MW) for the selected sub-Saharan African countries. At a statistically significant level of 1%, results support the presence of a unit root in level data for all the variables across the countries. But estimating the data at the first difference shows that all the variables are stationary.

Table 5. Panel unit root tests

| Variables | *I*(0) | | *I*(1) | |
|---|---|---|---|---|
| | IPS | MW | IPS | MW |
| GDP | −0.19 | 24.23 | −4.67** | 53.11** |
| FIN | 2.61 | 14.11 | −5.19** | 28.08** |
| ICT | −0.09 | 31.22 | −6.01** | 68.02** |
| INFL | −0.49 | 26.41 | −5.21** | 45.23** |

*Note.* **Signifies no unit root test hypothesis at 1% level. *I*(0) and *I*(1) denote level and first differences data.

### *4.4 Panel Cointegration Test Results*

The results of the Pedroni panel cointegration test are summarized below in Table VI. The Pedroni uses within- and between-dimension panel cointegration tests. Results from with trend and without trend test statistics indicate that, at the 0.05 significance level, PP and ADF statistics are significant, and this confirms that a co-integration exists among all the variables. Therefore, the null hypothesis of no cointegration between FIN, GDP, INF, and ICT is rejected at the 0.05 significance level.

Table 6. Pedroni panel cointegration test results

| Test Statistics | Without Trend | | With Trend | |
|---|---|---|---|---|
| Panel cointegration (Within Dimension) | | | | |
| | Statistics | P-Values | Statistics | P-Values |
| Panel v-statistic | -0.25 | (0.13) | -0.68 | (0.75) |
| Panel ρ-statistic | -0.15 | (0.23) | 0.59 | (0.62) |
| Panel PP-statistic | -3.19 | (0.00)* | -4.15 | (0.00)* |
| Panel ADF-statistic | -2.90 | (0.00)* | -5.69 | (0.00)* |
| Group mean panel cointegration (Between Dimension) | | | | |
| Group ρ-statistic | 0.11 | (0.58) | 0.95 | (0.83) |
| Group PP-statistic | -6.46 | (0.00)* | -8.87 | (0.00)* |
| Group ADF-statistic | -4.11 | (0.00)* | -2.50 | (0.00)* |

*Note.* Schwarz Info Criterion (SIC) lag length with a maximum lag of 6 was employed. At 0.05 significant level, the Pedroni statistics results reject the null hypothesis of no cointegration.

*4.5 Pooled Mean Group*

To determine the long-run coefficients of the relationship between financial development, information and communication technology, and economic growth, the PMG result is reported. For the purpose of comparison, the MG results in Table VII are also presented. The Hausman test result shows a probability value greater than 0.05, that is, 0.97. This indicates that the null hypothesis of the long-run homogeneity restriction is not rejected. This further shows that the eight selected Sub-Saharan African countries in this study possess homogenous characteristics such as a high unemployment rate, a high inflation rate, a high rate of poverty, and so on. Meanwhile, the long-run period is when all the factors of production and costs vary. This implies that in the long run, the fixed costs of generating gross domestic product are able to adjust to all costs incurred, whereas in the short run, at least one of the inputs in the factor of production is allowed to be fixed while others are varied.

In both the short-run and long-run coefficients, the results of the financial development proxy of private credit available to investors are insignificant in determining the rate of economic growth in the SSA region. Meanwhile, the roles of information, communication, and technology are positive and significant in explaining the growth of SSA's economic activities. That is, increasing ICT by a 1 percent in sub-Saharan African countries increases economic growth by 0.68 percent. The result agreed with the hypothesis that ICT positively influence economic growth of the SSA region. The estimation result is consistent with the previous empirical findings in the literature (see Datta & Agarwal, 2004), which all proved that countries that are highly technologically driven are more likely to grow economically.

In the case of inflation, findings revealed that a 1 percent increase in inflation in sub-Saharan African countries decreases economic growth by 0.05 percent. The implication of this is that in any country with a high rate of inflation, the citizens suffer a decrease in income, little investment, and overall diminished welfare. This empirical result of inflation on economic growth is in agreement with the previous findings by Barro (1995). However, the recent work by Sequeira (2021) contradicts the result of Barro (1995) that inflation promotes growth.

The result further revealed that when financial development interacts with information, communication, and technology, economic growth increases. This implies that a 1 percent increase in the interaction of financial development with information, communication, and technology promotes economic growth by 0.07 percent. From this evidence, it shows that financial development cannot stand alone in determining the economic prosperity of the SSA countries until ICT is added.

Finally, the negative and significant value of -0.54 indicates the speed of adjustment of the error correction estimates. This value indicates that 54 percent of the disequilibrium in the current period (t) was corrected in the previous period (t-1).

Table 7. Pooled mean group results

| Dependent Variable: GDP | PMG | | MG | |
|---|---|---|---|---|
| Variables | Coefficient | P-value | Coefficient | P-value |
| **Long-run coefficients** | | | | |
| FIN | -0.08 | (0.65) | -0.68 | (0.23) |
| ICT | 0.68 | (0.00)* | 0.80 | (0.02)* |
| INFL | -0.05 | (0.32) | -0.2 | (0.05) |
| FIN*ICT | 0.02 | (0.00)* | 0.01 | (0.00)* |
| ECT | -0.54 | (0.00)* | -0.27 | (0.00)* |
| **Short-run coefficients** | | | | |
| Δ FIN (1) | 0.05 | (0.06) | -0.11 | (0.37) |
| Δ ICT (1) | 0.13 | (0.01)* | 0.14 | (0.06) |
| Δ INFL (1) | -0.02 | (0.82) | 0.05 | (0.07) |
| Δ FIN*ICT (1) | 0.07 | (0.00)* | 0.01 | (0.00)* |
| No. of observation | 8 | | | |
| Hausman Tests | Prob.>Chi2(5) = 0.97 | | | |

*Note.* The probability values are in brackets () at the 5 % significance level.

## 5. Conclusion and Recommendations

There is much concern about the present economic conditions of most developing countries, in particular African countries. This concern empowered this study to investigate the dynamic response of economic growth to financial development and information, communication, and technology in selected Eight (8) sub-Saharan African countries covering 2000–2021. Using a pooled mean group estimator within the framework of an autoregressive distributed lag model, empirical analysis results show that financial development is insignificant in explaining the economic growth of the SSA region, while inflation negatively affects economic growth. Findings further show that information, communication, and technology have a positive and statistically significant effect on economic growth in the SSA region. The result also provides evidence that the elasticity of the interaction between financial development and information and communication technology promotes economic growth.

The slow technological improvement in most SSA countries may be a major factor causing low economic growth in the region. Therefore, this paper recommends that governments in SSA countries should provide policies that encourage the use of highly standardized ICT infrastructure. With this, it is likely that the region will experience improved economic growth. Since information and communication technology infrastructure helps the growth of an economy, this implies that when governments increase budgets for ICT, more economic returns are likely to be achieved. Also, the presence of a high rate of inflation in the region affects the net income of the citizens, deteriorating their economic lives and limiting demand for goods and services, reducing economic growth. The governments of SSA countries should promote both monetary and fiscal policies that are capable of reducing inflation in the region.

Although financial development alone cannot promote economic growth, when combined with ICT, the result was significant and positive. Hence, it is recommended that a substantial investment be made in financial development and novel ICT innovation in order to grow the economies of the SSA region.

## References

Adnan Hye, Q. M., & Islam, F. (2013). Does financial development hamper economic growth: empirical evidence from Bangladesh. *Journal of Business Economics and Management, 14*(3), 558-582. https://doi.org/10.3846/16111699.2012.654813

Afolabi, J. (2022). Financial Development, Trade Openness, and Economic Growth in Nigeria. *Iranian Economic Review, 26*(1), 237-254. https:*/doi: 10.22059/ier.2022.86982*

Albiman, M. M., & Sulong, Z. (2016). The role of ICT use to the economic growth in Sub Saharan African region (SSA). *Journal of Science and Technology Policy Management, 7*(3), 306-329. https://doi.org/10.1108/JSTPM-06-2016-0010

Albiman, M. M., & Sulong, Z. (2017). The linear and non-linear impacts of ICT on economic growth, of disaggregate income groups within SSA region. *Telecommunications Policy, 41*(7-8), 555-572. https://doi.org/10.1016/j.telpol.2017.07.007

Andersen, T. B., & Tarp, F. (2003). Financial liberalization, financial development and economic growth in LDCs. *Journal of International Development: The Journal of the Development Studies Association, 15*(2), 189-209. https://doi.org/10.1002/jid.971

Assefa, T. A., & Mollick, A. V. (2017). Financial development and economic growth in Africa. *Journal of African Business, 18*(3), 320-339. https://doi.org/10.1080/15228916.2017.1301162

Asteriou, D., & Spanos, K. (2019). The relationship between financial development and economic growth during the recent crisis: Evidence from the EU. *Finance Research Letters, 28(1)*, 238-245. https://doi.org/10.1016/j.frl.2018.05.011

Awad, A., & Albaity, M. (2022). ICT and economic growth in Sub-Saharan Africa: Transmission channels and effects. *Telecommunications Policy, 46*(8), 102381. https://doi.org/10.1016/j.telpol.2022.102381

Barro, R. J. (1995). Inflation and economic growth. *NBER Working Paper No. 5326*, 1-36.

Breusch, T. S., & Pagan, A. R. (1980). The Lagrange multiplier test and its applications to model specification in econometrics. *The Review of Economic Studies, 47*(1), 239-253. https://doi.org/10.2307/2297111

Calderón, C., & Liu, L. (2003). The direction of causality between financial development and economic growth. *Journal of Development Economics, 72*(1), 321-334. https://doi.org/10.1016/S0304-3878(03)00079-8

Chang, Y. (2004). Bootstrap unit root tests in panels with cross-sectional dependency. *Journal of Econometrics, 120*(2), 263-293. https://doi.org/10.1016/S0304-4076(03)00214-8

Cheng, C. Y., Chien, M. S., & Lee, C. C. (2021). ICT diffusion, financial development, and economic growth: An international cross-country analysis. *Economic Modelling*, *94(1)*, 662-671. https://doi.org/10.1016/j.econmod.2020.02.008

Choi, I. (2001). Unit root tests for panel data. *Journal of International Money And Finance*, *20*(2), 249-272. https://doi.org/10.1016/S0261-5606(00)00048-6

Chudik, A., & Pesaran, M. H. (2013). Large panel data models with cross-sectional dependence: A survey. *CAFÉ Research Paper No. 13.15*, 1-55.

Claessens, S., Djankov, S., Fan, J. P., & Lang, L. H. (2002). Disentangling the incentive and entrenchment effects of large shareholdings. *The Journal of Finance*, *57*(6), 2741-2771. https://doi.org/10.1111/1540-6261.00511

Datta, A., & Agarwal, S. (2004). Telecommunications and economic growth: A panel data approach. *Applied Economics*, *36*(15), 1649-1654. https://doi.org/10.1080/0003684042000218552

Dewan, S., & Kraemer, K. L. (2000). Information technology and productivity: Evidence from country-level data. *Management Science*, *46*(4), 548-562. https://doi.org/10.1287/mnsc.46.4.548.12057

Giri, A. K., Mohapatra, G., & Debata, B. (2023). Technological development, financial development, and economic growth in India: Is there a non-linear and asymmetric relationship?. *Journal of Economic and Administrative Sciences*, *39*(1), 117-133. https://doi.org/10.1108/JEAS-03-2021-0060

Gurley, J. G., & Shaw, E. S. (1960). *Money in a Theory of Finance* No. 332.4/G97m).

Hausman, J. A. (1978). Specification tests in econometrics. *Econometrica: Journal of the Econometric Society*, *46*(6), 1251-1271. https://www.jstor.org/stable/1913827

Huang, H. C., & Lin, S. C. (2009). Non-linear finance–growth nexus: A threshold with instrumental variable approach 1. *Economics of Transition*, *17*(3), 439-466. https://doi.org/10.1111/j.1468-0351.2009.00360.

Im, K. S., Pesaran, M. H., & Shin, Y. (2003). Testing for unit roots in heterogeneous panels. *Journal of Econometrics*, *115*(1), 53-74. https://doi.org/10.1016/S0304-4076(03)00092-7

Jalava, J., & Pohjola, M. (2008). The roles of electricity and ICT in economic growth: Case Finland. *Explorations in Economic History*, *45*(3), 270-287. https://doi.org/10.1016/j.eeh.2007.11.001

Kenny, C., & Qiang, C. (2003). *Information and Communation Technlogies and Boad-based Development in ICT and Development.* Enabling the Information Society., Washington World Bank. 12 July 2005.

Khan, M. S., & Senhadji, A. S. (2003). Financial development and economic growth: A review and new evidence. *Journal of African Economies*, *12*(2), ii89-ii110. https://doi.org/10.1093/jae/12.suppl_2.ii89

Levine, R. (1997). Financial development and economic growth: Views and agenda. *Journal of Economic Literature*, *35*(2), 688-726. Retrieved from https://www.jstor.org/stable/2729790

Mckinnon, R. I. (1973). *Money and capital in economic development.* Washington, D.C: The Brookings Institute.

Moon, H. R., & Perron, B. (2004). Testing for a unit root in panels with dynamic factors. *Journal of Econometrics*, *122*(1), 81-126. https://doi.org/10.1016/j.jeconom.2003.10.020

Naceur, S. B., & Ghazouani, S. (2007). Stock markets, banks, and economic growth: Empirical evidence from the MENA region. *Research in International Business and Finance*, *21*(2), 297-315. https://doi.org/10.1016/j.ribaf.2006.05.002

Nasab, E. H., & Aghaei, M. (2009). The effect of ICT on economic growth: Further evidence. *International Bulletin of Business Administration*, *5*(2), 46-56.

Nguyen, H. M., Le, Q. T. T., Ho, C. M., Nguyen, T. C., & Vo, D. H. (2022). Does financial development matter for economic growth in the emerging markets? *Borsa Istanbul Review*, *22*(4), 688-698. https://doi.org/10.1016/j.bir.2021.10.004

Nour, S. S. O. (2002). *ICT opportunities and challenges for development in the Arab World* (No. 2002/83). WIDER Discussion Paper.

Olorogun, L. A., Salami, M. A., & Bekun, F. V. (2022). Revisiting the Nexus between FDI, financial development and economic growth: Empirical evidence from Nigeria. *Journal of Public Affairs*, *22*(3), e2561. https://doi.org/10.1002/pa.2561

O'Mahony, M., & Vecchi, M. (2003). *Is There an ICT Impact on TFP? A Heterogeneous Dynamic Panel Approach* (Vol. 219). NIESR.

Pedroni, P. (1999). Critical values for cointegration tests in heterogeneous panels with multiple regressors. *Oxford Bulletin of Economics and Statistics*, *61*(S1), 653-670. https://doi.org/10.1111/1468-0084.0610s1653

Pesaran, M. H. (2003). Estimation and inference in large heterogenous panels with cross section dependence. *CESIFO WORKING PAPER NO. 869*, 1-58.

Pesaran, M. H., & Shin, Y. (1995). *An autoregressive distributed lag modelling approach to cointegration analysis* (Vol. 9514). Cambridge, UK: Department of Applied Economics, University of Cambridge.

Pesaran, M. H., & Yamagata, T. (2008). Testing slope homogeneity in large panels. *Journal of Econometrics*, *142*(1), 50-93. https://doi.org/10.1016/j.jeconom.2007.05.010

Pesaran, M. H., Shin, Y., & Smith, R. J. (2001). Bounds testing approaches to the analysis of level relationships. *Journal of Applied Econometrics*, *16*(3), 289-326. https://doi.org/10.1002/jae.616

Pohjola, M. (2002). The New Economy: facts, impacts and policies. *Information Economics and Policy*, *14*(2), 133-144. https://doi.org/10.1016/S0167-6245(01)00063-4

Sassi, S., & Goaied, M. (2013). Financial development, ICT diffusion and economic growth: Lessons from MENA region. *Telecommunications Policy*, *37*(4-5), 252-261. https://doi.org/10.1016/j.telpol.2012.12.004

Seo, H. J., Lee, Y. S., & Oh, J. H. (2009). Does ICT investment widen the growth gap? *Telecommunications Policy*, *33*(8), 422-431. https://doi.org/10.1016/j.telpol.2009.04.001

Sequeira, T. N. (2021). Inflation, economic growth and education expenditure. *Economic Modelling*, *99(1)*, 105475. https://doi.org/10.1016/j.econmod.2021.02.016

Shamim, F. (2007). The ICT environment, financial sector and economic growth: A cross-country analysis. *Journal of Economic Studies*. *34*(4), 352-370. https://doi.org/10.1108/01443580710817452

Solarin, S. A., Shahbaz, M., Khan, H. N., & Razali, R. B. (2021). ICT, financial development, economic growth and electricity consumption: New evidence from Malaysia. *Global Business Review*, *22*(4), 941-962. https://doi.org/10.1177/0972150918816899

Solomon, E. M., & van Klyton, A. (2020). The impact of digital technology usage on economic growth in Africa. *Utilities Policy*, *67(1)*, 101104.

Swamy, P. A. (1970). Efficient inference in a random coefficient regression model. *Econometrica: Journal of the Econometric Society*, 38(2), 311-323. Retrieved from https://www.jstor.org/stable/1913012