



## The Impact of ICT Innovation on the Economic Performance of sub-Saharan African Countries

Anicet Rwezaula<sup>1\*</sup>, Nicholaus Ngowi<sup>2</sup> and Mohamed Awadhi<sup>2</sup>

<sup>1</sup>Department of Population Studies, Institute of Rural Development Planning, P. O. Box 138, Dodoma, Tanzania

<sup>2</sup>Department of Regional Development Planning, Institute of Rural Development Planning, Lake Zone Centre, P. O. Box 11957, Mwanza, Tanzania

\*Corresponding author email: [arwezaula@irdp.ac.tz](mailto:arwezaula@irdp.ac.tz)

### Ikisiri

*Utafiti huu unachunguza matokeo ya uvumbuzi wa TEHAMA kwenye utendaji wa kiuchumi wa nchi 48 za Kusini mwa Jangwa la Sahara. Utafiti ulitumia takwimu za jumla za mwaka 2000-2020 na mbinu za uchambuzi wa matokeo mtambuka (Fixed and random effect models) kutathmini matokeo ya TEHAMA kwenye utendaji wa kiuchumi. Nguvu kazi, mfumuko wa bei na uwekezaji wa moja kwa moja wa kigeni vilitumiwa katika utafiti huu kama viashiria vya jumla vya utendaji wa kiuchumi. Matokeo yanaonesha kuwa uvumbuzi wa TEHAMA (yaani, usajili wa simu, na watumiaji wa mtandao) zina athari chanya na muhimu kitakwimu katika utendaji wa kiuchumi wa nchi za Kusini mwa Jangwa la Sahara. Hii inaonesha kuwa ongezeko la uvumbuzi wa TEHAMA huinua utendaji na ukuaji wa uchumi. Utafiti unaonesha zaidi kuwa ushiriki wa nguvu kazi una mchango chanya na muhimu kitakwimu wakati mfumuko wa bei una athari hasi katika utendaji wa uchumi. Utafiti huu unahitimisha kuwa uvumbuzi wa TEHAMA una mchango mkubwa katika maendeleo ya uchumi wa nchi za Kusini mwa Jangwa la Sahara. Hivyo inapendekezwa, Nchi za Kusini mwa Jangwa la Sahara kutoa kipaumbele katika sera na mbinu za uvumbuzi na ukuaji wa matumizi ya TEHAMA ili kuhakikisha upatikanaji wa zana za kidijitali katika kusaidia kukuza ujuzi, usajili wa simu, uwekezaji, ushiriki wa nguvu kazi, kupunguza kasi ya mfumuko wa bei, na kuboresha uwezo wa watumiaji.*

### Abstract

*This study examines the impact of ICT innovation on the economic performance of 48 sub-Saharan African countries. The study used fixed and random effect models to estimate the impact of ICT innovation on economic performance using panel data from 2000 to 2020 while controlling for the labor force, inflation rate, and foreign direct investment. The findings show that ICT innovations (i.e., telephone subscriptions, and internet users) have a positive and statistically significant impact on the economic performance of the sub-Sahara African countries. This shows that an increase in ICT innovation raises economic performance. Moreover, the findings show that the coefficient measuring the impact of ICT innovation as measured by internet users and telephone subscriptions on economic performance is positive. Furthermore, the study reveals that the labour force participation rate has a positive and statistically significant impact on the performance of the sub-Saharan African economy while inflation has an adverse effect. This study concludes that ICT innovation influences the performance of sub-Saharan African countries. It also recommends that sub-Saharan African countries provide priority to ICT innovation techniques and their related*

policies to guarantee the availability of digital tools to support internet use and phone subscriptions, increase investment in ICT innovations, labour force participation rate, reduced inflation rate, increase FDIs, and enhance users' ICT skills.

**Keywords:** ICT innovation; Economic performance; sub-Saharan Africa; Fixed and random effect models

## 1. Introduction

In recent years, the world has passed through a remarkable change in economic performance due to the introduction of Information and Communication Technology (ICT) innovations. ICT innovation has been defined as the new ways that involve the use of mobile phones and the internet to create more efficient initiatives and business operations (Kallal *et al.*, 2021). The ICT innovations uprising have rapidly spread across nations, sectors, and organizations bringing about the transformation of economic sectors (Vu *et al.*, 2020). ICT innovations (internet users and telephone subscriptions) have been considered the driving force behind economic performance in both developed and developing countries as they offer more information accessibility and new channels for communication (Appiah-Otoo and Song, 2021). Economic performance has been defined as *the achievement of economic policy objectives by considering inflation of consumer prices, foreign direct investment, and the labour force rate* (Beri *et al.*, 2022).

ICT innovations have transformed the global economy through the production of numerous products and services (Appiah-Otoo and Song, 2021; Vu *et al.*, 2020). In recent decades social structures, organizations, and economic systems have all undergone substantial improvement as a result of the application of ICT innovation (e.g., Schumpeter, 1942; Kallal

*et al.*, 2021). The use of ICT innovations simplifies the creation, storage, and transmission of goods and services hence the advancement of various sectors of the economy (Kallal *et al.*, 2021). ICT innovations have a profound effect on socioeconomic development because they make it easier to access information and customers online, which lowers the cost of conducting business and eliminates the need for physical stores (Palvia *et al.*, 2018). Accessibility to ICTs plays a crucial role in promoting communication and connectivity which allows businesses to maintain long-term relationships with clients (Kallal *et al.*, 2021). ICTs' effect on economic performance has not been consistent across all nations the GDP growth rates among ICT-growing economies and ICT-advanced economies are bi-polar (Yoon, 2020). However, investment in ICTs had a detrimental effect on labour productivity in small and medium-sized businesses (Yoon, 2020) whereby the use of ICT breakthroughs necessitates a competent workforce and a learning curve that avoid a mismatch between skills and technology.

The relationship between ICT innovation and economic performance depends on the capacity of countries to absorb technology through their potential to develop a highly skilled workforce (Kallal *et al.*, 2021). This study, therefore, aims at examining whether ICT innovations affect the economic

performance of sub-Saharan African countries. Most developing economies suffer from poor ICT infrastructures, which leads to substantial investment in ICT projects which might affect economic productivity (Sarangi *et al.*, 2022). The study is significant from an academic and policy perspective in three ways: it highlights the importance of having greater economic development in sub-Saharan Africa (SSA); it also highlights the relatively high potential for ICT penetration in SSA; it further highlights the growing importance of ICT innovations to spur economic performance in SSA.

According to World Bank Data (2020), the economic performance of SSA was recorded as follows; Nigeria recorded an 8.8 percent GDP growth rate while Ghana grew by 5.5 percent between 2000 and 2010. The Ugandan economy grew at 7 percent while the Tanzanian economy grew at 6.5 percent. The Ethiopian economy rose by 8.5 percent from 2000 to 2020, and by 10 percent between 2004 and 2008 meanwhile, Mauritius grew at 4.3 percent. The Malawian economy grew at about 5 percent, Kenya recorded an average of a 4 percent growth rate, and Cameroon's GDP maintained a 3.5 percent growth rate. Despite the crisis, the Congo Democratic Republic has a 6 percent while the economy of the Central African Republic has an economic growth rate of 2.11 percent. With a growth rate of 3.6 percent, South Africa's growth, the GDP of Swaziland grew by 3.4 percent. The trend was similar in Rwanda whose economy grew on average by 8 percent.

The significance of ICT innovations on economic performance has been studied

for various reasons. First, ICT innovation improves economic performance by giving economic sectors high-performing tools and software (OECD, 2003; Cardona *et al.*, 2013; Paunov and Rollo, 2016; Yoon, 2020; Asongu and Odhiambo, 2020). Second, ICT innovations enhanced professional and technological abilities that encourage innovation in the economy (Paunov and Rollo, 2016), as opposed to that of businesses or the government by having a substantial impact on growth (Solomon, and van Klyton, 2020). Other studies confirm that ICT innovations lead to investing in intangible assets through RandD that add value and increase productivity that resulting in economic performance (Corrado *et al.*, 2009; Marrano *et al.*, 2009; Yoon, 2022; Vu *et al.*, 2020; Sarangi *et al.*, 2022). Third, ICT innovation has increased capital deepening when there is a decline in ICT pricing (Ark *et al.*, 2008) and promotes innovation by facilitating business-to-business interactions, production spillovers, and network externalities (Cardona *et al.*, 2013; Paunov and Rollo, 2016; Solomon and van Klyton 2020). ICT advancement had a positive effect on innovation and economic modernization in ICT-growing economies, but not in ICT-advanced economies. Investments in ICTs are seen as a key driver of productivity growth and ICT use has a positive and significant impact on productivity (Adeleye and Eboagu, 2019; Niebel, 2018). Regarding developing countries, previous studies (Cheng *et al.*, 2020; Dewan and Kraemer, 2000; Niebel, 2018; Niebel *et al.*, 2017; Papaioannou and Dimelis, 2007; Stanley *et al.*, 2015) have not revealed the real effects of ICT innovation on the economic performance of SSA countries.

The motivation for this study is based on three folds, first, according to World Bank Data (2020), sub-Saharan African countries have a very low percentage of internet users (30%) compared to 85% in Europe and 92% in North America. Second, although the adoption rate of ICT innovation (i.e., internet use and telephone subscriptions) in the SSA region appears to be accelerating rapidly, from 4.4% in 2010 to 30% in 2020, the proportion of people using ICT innovation services is still in question if compared to other regions of the world (World Bank Indicators, 2022). Third, though there is a regional expansion in the adoption of ICT innovations, there is inadequate literature assessing the effects of ICT innovations on economic performance with the majority of studies focusing on the developed nations. Therefore, it is intriguing to close these gaps by looking at the case of developing economies focusing on sub-Saharan African countries. A key originality of this study is that we used fixed and random effect models to estimate the impact of ICT innovation on the economic performance of SSA countries by considering the World Bank Indicators database from 2000 to 2020.

## 2. Methodology

### 2.1. Data Sources

This study examines a panel of 48 sub-Saharan African (SSA) countries using the World Bank Indicators database from 2000 to 2020. The chosen period is determined by data availability following

$$y_{it} = x_{it}\beta + \alpha_i + v_{it}, i = 1 \dots N \text{ (countries)} \quad t = 1 \dots T \text{ (time)} \dots \dots \dots (1)$$

Where  $y_{it}$  is the dependent variable (economic performance) as explained by

African literature on ICT innovation (Asongu and Nwachukwu, 2017), by employing two ICT innovation indicators: internet usage (% of the population) as measured by the quantification of data transferred between your network and the Internet (Helsper, *et al.*, 2016). The telephone subscriptions as measured by the number of telephone subscriptions are divided by the country's population and multiplied by 100 (Bankole, *et al.*, 2015). A telephone subscription refers to a subscription to a public telephone service that provides access to the Public Switched Telephone Network (PSTN) using phone technology. GDP per capita at a constant US dollar in 2015 is used as an indicator of economic growth that measures a country's economic performance. The study included three control variables namely: inflation, labour, and Foreign Direct Investment (FDI). All data used for this study were obtained from the World Bank Development Indicators Database (2021).

### 2.2. Estimation Procedure

We used both fixed and random effect models to estimate the impact of ICT innovation on economic growth in 48 selected sub-Saharan African countries. The fixed and random-effects analysis which accounts for unexplained heterogeneity will continue to be prominent in the ICT innovation on economic performance literature (Riley, *et al.*, 2011). The following model was considered:

the explanatory variables;  $x_{it}$  is the observation of the explanatory variables

(internet use, telephone subscriptions, inflation, labour, and FDI)  $\beta$  is the vector of parameter, while,

$\alpha_i$  is the unobserved country-specific time effect and error term  $v_{it}$  is uncorrelated across time and countries. All variables were transformed into natural logarithms to reduce heteroskedasticity and make the data more linear.

The advantage of using fixed and random effect models is that the model assumes the explanatory variables to have different relationships with the response variable within groups (Timoneda, 2021). Fixed effect models are recommended when the fixed effect is of primary interest. The random-effects models are appropriate for studies where it is not possible to identify which individuals belong to which subgroups (i.e., nesting is not possible). If the fixed effect model is used on a random sample, one can't use that model to make a prediction or inference on the data outside the sample data set (Chowdhury, 2021). The fixed-effects model assumes that the individual-specific effect is correlated to the independent variable (Damrongplasit and Hsiao, 2022). The random-effects model assumes that the individual-specific effects are uncorrelated to the independent variables (Wang *et al.*, 2022).

### 2.3. Robustness test

**Table 1: Descriptive summaries**

Variables	N	Mean	Min	Max
GDP per capita (constant US\$2015)	972	2120.85	258.63	16438.64
Telephone subscriptions	953	233299.9	0	4961743
Internet use (% of the population)	885	9.84	0.005	79
Inflation of consumer prices (%)	903	10.50	-9.61	557.20
Foreign Direct Investment (FDI) (% of GDP)	968	4.65	-11.19	103.33
Labor force rate (% of the population aged 15-64)	940	68.37	42.39	90.34

Source: Authors computation (2022); N= Number of observations

The robustness test of the data was conducted to determine the extent to which the data could be trusted. The robustness test followed four (4) steps as follows: on the first step, data were checked for the internal consistency of the statistical results, which were found to be consistent. The second step was followed by re-analyzing the data using the original analytical strategy to check if the results were reproducible, the re-analysis results were constancy since had a consistent p-value. The third step was to check if the results were robust to alternative analytical choices. The robustness test at this step included removing one variable that was seemingly arbitrary covariate, the results p-value >0.05, by re-analyzing the following reported procedure, the p-value was < 0.05, by including the outliers that were removed, the p-value was >0.05, this was similar to when excluded the last observation. The fourth step of the robustness test was to perform a replication study on a new sample. The robustness test at this stage indicated that the results could be replicated. Based on the robustness test results, the data were trusted.

### 3. Results and Discussion

Table 1 summarizes descriptive statistics of variables for 48 countries (see Appendix 1) in sub-Saharan Africa (SSA) from 2000 to 2020.

As indicated in Table 1, the mean GDP per capita in 48 SSA countries is approximated to be US\$2120.85 while the mean telephone subscriptions are 233,299.9. Internet use is 9.84% while in the SSA countries, the internet use indicates Seychelles (79%), South Africa (70%), and Mauritius remains to be the top countries with the highest internet use while Eretria (1%), Comoros (8%) as well as the Congo Republic, and Burundi

(9%) are countries with lowest internet use (World Bank Indicators, 2021; Ajide and Dada, 2022). The inflation of consumer prices is 10.5% while Foreign Direct Investment is 4.65% and the labor force rate stands at 68.37%. Table 2 shows the fixed and random effect regression estimate for 48 countries in SSA from 2000 to 2020 where the GDP per capita is the dependent variable.

**Table 2: Fixed and random effect regression estimates (Dependent variable = GDP per capita)**

Variables	Fixed effect		Random effect	
	Coefficient	Std error	Coefficient	Std error
Telephone subscriptions	.013	.008	.015*	.008
Internet use (% of the population)	.083***	.003	.083***	.003
Inflation of consumer prices (%)	-.012**	.005	-.012**	.006
Foreign direct investment (% of GDP)	.007	.004	.008	.005
Labor force rate (% of the population aged 15-64)	.260*	.142	.130	.141
Constant term	5.77***	.615	6.267***	.621
	N= 659		N= 659	

Note: N= Number of observations used in regression

The asterisks\*\*\* p<0.01, \*\* p<0.05, \* p<0.1

This study aimed to examine the effect of ICT innovations (internet use and telephone subscriptions) on economic performance with a focus on 48 SSA countries using World Bank Development indicators from 2000 to 2020 while controlling for inflation consumer prices, FDI, and labour force participation rate. All variables are transformed into a natural logarithm to reduce heteroskedasticity and have a common variance in the data. Our results are based on fixed and random effects models. The findings (Table 2) demonstrate that ICT innovations (telephone subscriptions and

internet use) have a positive and statistically significant impact on the economic performance of SSA. An increase of 10% in internet users results in a 0.8 percent increase in per capita GDP. Similarly, telephone subscriptions have a positive and statistically significant impact on the region's economy. The coefficient measuring the impact of ICT innovation (internet use and telephone subscriptions) on economic growth is positive, indicating that ICT innovation has a positive impact on the economic growth of the member countries of SSA. In the fixed effect model, the labour force

participation rate has a positive and statistically significant impact on the 48 SSA economy. As expected, inflation has an adverse effect on the economic performance of the SSA economy.

These results are consistent with most studies that mention that ICT innovations have a positive effect on economic performance through telephone subscriptions and internet use (see, Niebel, 2018; Kallal *et al.*, 2021; Haddaji and Ftiti, 2021; Hussain, *et al.*, 2021). The ICT growth theories show that there is a difference in quality standards (Beri *et al.*, 2022) and the use of ICT innovations can promote competition for the development of new products and business-related models. The transfer of information can occur through the acceptance and use of information and communication technologies which influence economic performance (Asongu and Nwachukwu, 2017). Similar effects on economic performance were seen in African nations for fixed telephone subscriptions, mobile cellular subscriptions, internet users, and fixed broadband subscriptions, all indicators of ICT (see, Appiah-Otoo and Song, 2021; Odhiambo, 2022; Asongu and Odhiambo, 2020). Except for fixed telephone subscriptions, the effects of mobile cellular subscriptions and internet usage on income levels in Africa's sub-regions were influenced by real income per capita (Ilias and Yusuf, 2022). ICT innovation has a substantial positive impact on a country's sustainable development dimensions and, consequently, economic performance (Jayaprakash and Radhakrishna Pillai, 2022).

Internet use has increased the form of data processing led to increased productivity of business organizations that use ICT innovations (Kahouli and Chaaben, 2022; Abdulqadir and Asongu, 2022). The economic benefits of ICT innovations can be influenced by a change in labour and its requirements (Oladipo *et al.*, 2020). Similar to the findings of this study, there is a strong correlation between ICT and economic growth in developed and developing nations (Beri *et al.*, 2022). Furthermore, Appiah-Otoo and Song (2021) study reveals that, increased economic growth is a result of ICT innovation that boosts economic growth (Odhiambo, 2022). Digitalization has a statistically significant favourable link with economic growth, where the biggest production sensitivity is found in telephone subscriptions (Adeleye and Eboagu, 2019). When comparing the advanced economies, ICT innovation was found to have a positive significant impact on the performance of the advanced economies unlike the emerging economies due to low rate of use (Nguyen and Doytch, 2022). ICT as explained by mobile telecommunication, internet connectivity, and fixed broadband, increase economic growth in poor and rich countries (Appiah-Otoo and Song, 2021) provided there is sufficient use. In addition, the adoption of ICT innovations was positively correlated with economic growth over the long term (Odhiambo, 2022), with internet users having the most noticeable effects, followed by mobile and landline phone subscriptions (Hussain *et al.*, 2021). Similarly, ICT innovation is a gauge for economic growth in sub-Saharan African nations using the prevalence of mobile phones, fixed

telephones, and internet use (Akinlo and Dada, 2022). On the contrary, Nabi *et al.* (2022); Saba and Ngepah (2022) concluded that the long-term economic performance of N11 countries is significantly negatively impacted by the spread of ICT innovation including fixed telephone lines, handheld wireless access, and the internet.

Currently, ICT innovations are expanding more quickly than other telecommunication metrics to affect economic development and growth in Africa (Oladipo and Wynand, 2020; Huang and Khan, 2022). The advancement in ICT innovation has contributed to China's economic growth and productivity (Wu and Yu, 2022). With Foreign Direct Investment (FDI), mixed growth effects of the variables reveal a positive and significant effect on the economic growth of the countries (Okwu *et al.*, 2020) whereby the expansion of ICT positively affects FDI inflows in the Asia Pacific emerging economies. Similar results on the positive relationship between ICT innovation and FDI as influences the economic performance were revealed by Sinha and Sengupta (2022). FDI is heavily modulated by internet and telephone usage to produce overall favourable net effects on economic growth dynamics (Asongu and Odhiambo, 2020). Telecommunication seems to be crucial to daily life as boosts general economic activity since the results corroborate those indicated by growth theories (Awad and Albaity, 2022). Furthermore, the negative relationship between inflation and economic growth was revealed by Karahan and Çolak, (2020). Surprisingly, Kouam and Asongu (2022), revealed that every 1% rise in fixed broadband

connection results in a 2.58% decrease in economic development. On the other hand, the rise of internet use has considerably aided economic expansion (Wang *et al.*, 2022; Akinlo and Dada, 2022), where for every unit gained in internet development, the economic growth level rises.

ICT innovation has an impact on economic performance and is linked with the labour force rate where total ICT spending and productivity of workers follow the same trend hence influencing labour productivity (Erman, *et al.*, 2022). Mobile broadband speed and labour productivity are correlated, meaning that an increase in mobile broadband speed rise in labor productivity (Edquist, 2022). Additionally, the labour productivity of the service sector as well as general labour productivity is significantly impacted by telephone and broadband subscriptions (Laddha *et al.*, 2022). ICT innovation contributes to economic performance in different ways, these include the facilitation of financial flows (Bilan *et al.*, 2019) reducing financial exclusion for the unserved and underserved, and increasing local content on the global network (Haftu, 2019). ICT innovation has reduced the costs of transportation goods and services (Bahrini and Qaffas, 2019) and influenced the efficiency of knowledge spillover by enhancing interactions, communication, and the transfer of factors of production (Kurniawati, 2021). ICT innovation fosters technology penetration and helps firms and households in making effective decisions, enhancing the demand and supply of productive factors (Solarin *et al.*, 2021).



#### 4. Conclusion and Recommendation

This study examines the impact of ICT innovation on the economic performance of 48 countries in sub-Saharan Africa from 2000 to 2020, controlling for telephone subscriptions, internet use, inflation rate, FDI, and labour force rate using both fixed and random effect models. The findings show that ICT innovation has a positive and statistically significant impact on the performance of the sub-Saharan African economy. This means that an increase in ICT innovation raises the economic performance of SSA countries. Furthermore, the rise in the inflation rate decreases economic growth. The attainment of sustainable development goals will probably be aided by increased internet penetration and telephone use in SSA countries by 2030. Sub-Saharan African countries should provide priority to ICT innovation techniques and their related policies to guarantee the availability of digital tools to support internet use and phone subscriptions, increase investment in ICT innovations, and labour force participation, reduce the inflation rate, attract FDIs and enhance users' ICT skills.

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### **Appendix 1: List of countries involved in the analysis**

Angola, Benin, Botswana, Burundi, Cameroon, Burkina Faso, Cape Verde, Central African Republic, Chad, Comoros, Democratic Republic of Congo, Cote d'Ivoire, Equatorial Guinea, Eritrea, Ethiopia, Gabon, Ghana, Gambia, Guinea, Guinea-Bissau, Kenya, Lesotho, Liberia, Madagascar, Malawi, Mali, Mauritania, Mauritius, Mozambique, Namibia, Niger, Nigeria, Rwanda, Sao Tome and Principe, Senegal, Seychelles, Sierra Leone, Somalia, South Africa, Sudan, South Sudan, Tanzania, Togo, Uganda, Zambia, Zimbabwe.