

Information and Communication Technology, International Monetary Fund Credit and Economic Growth: The Case of EAC Selected Countries

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Abstract—This paper investigated the effect of information and communication technology (ICT) and International Monetary Fund credit on economic growth of selected East Africa Community (EAC) countries using data for the period 1990-2022. Panel data was used with the fixed and random effects models. Through the Hausman's test results, the fixed effects model was preferred. The ICT indicators which significantly determined economic growth of the EAC countries were internet use and mobile cellular subscriptions. Internet use was found to boost economic growth while mobile cellular subscriptions significantly reduced economic growth of the EAC selected countries. The control variables that significantly boost economic growth of the sample countries include female male labour ratio, government consumption expenditure, financial development, capital expenditure and foreign direct investment. Testing of non-linear relationship between ICT and economic growth, revealed that there exists non-linear (inverted U-shaped) effect of ICT on economic progress of the sample countries. Further, the results from this study provide evidence that there is a strong positive relationship between International Monetary Fund (IMF) credit and economic growth of the EAC countries. Similarly, there exists non-linear (upward U-shaped relationship) impact of IMF credit on economic growth of the selected EAC countries. The results of this paper are important for policy making in the EAC countries. The policy makers need to design policies that are friendly to ICT investment especially on internet connections. The governments of the sample countries needs to improve and enhance internet connections to all sectors and individuals as these will contribute positively to economic growth. IMF credit was also found to significantly boost economic growth of the EAC selected countries. The policy implication for this result is that with good management and appropriate policies, EAC member countries continue increasing the use of IMF credit as this will accelerate their respective economic growths.

Keywords— Information and communication Technology, Economic growth, IMF credit, panel data, EAC countries, Fixed effects method. *JEL Classification:* E00 , O33 , C23, E01, O11, F33

I. INTRODUCTION

Several studies have revealed that economic progress of countries is determined by several factors. Some of the factors that have been confirmed include trade openness, foreign direct investment, labor, population, financial development, human capital, and inflation. Information and communication technology (ICT) has been identified as the modern and indispensable factor that accelerates economic growth of both developed and developing countries (Myovella *et al.*, 2020).

Information and communication technology (ICT) has revolutionized all economies of both developed and

developing countries leading to digitized economies. All sectors including agricultural, education, health, trade, public, entertainment, weather forecast banking, infrastructure, and manufacturing have been revolutionized by the growth of ICT. In various sectors of the economy innovations such as e-commerce, e-business, e-trading, e-citizen and e-banking have emerged which have improved information access, reduced travel costs, and discovery of new market. These ICT developments promote economic growth of individual countries and drive globalization. ICT has become a key and a modern factor determining economic growth especially in developed countries (Majeed and Ayub, 2018, Myovella *et al.*, 2020, World bank 2012). The industrial revolution called Industry 4.0 confirms that ICT is the engine of development (Purnama and Mitomo, 2018). ICT has also been considered to be very crucial in reducing poverty, inequality and in achieving sustainable development in various countries (Maneejuk, P., & Yamaka, W. 2020; Saba, *et al.* 2023).

ICT includes use of computers, telecommunications, internet of things, electronics, networking, broadband internet and information media. ICT improves the functioning of individuals, businesses and the entire economy (Majeed and Ayub, 2018). ICT has improved efficiency of allocation of the factors of production, reduced the costs of production, communication costs, and enhanced investment in all sectors of the economy (Pradhan *et al.* 2015). Larger utilization of ICT has made it easy to do business, connecting customers, suppliers, manufacturers within the economy and across countries (Kumari, & Singh, 2023). ICT has increased the flow of information and knowledge, led to several innovations including use of mobile phones to transfer money, do business and information sharing. The growth and use of ICT especially the use of internet and mobile technology has networked all countries in the whole world, increasing information flow among the countries and individuals. Governments have also benefited much from growth of ICT as they are able to provide their services faster electronically such as tax collection, payments of various services, and general government operations done through e-citizen platform. All these benefits of ICT growth in business, information, factor allocation and government operations, boosts the country's economic performance.

Growth of ICT facilitates trade and regional integration such EAC, cross border communication and financial

transactions within the country and across countries (Majeed and Ayub, 2018). ICT leads to discoveries of new local and internal markets, new businesses, including new goods and services. All these leads to the growth of e-commerce and e-business which facilitates online transactions with customers contributing positively to productivity, sales financial development and economic growth of the respective countries. ICT has been found to boost bilateral trade and economic growth (Were, 2015).

Considering the importance of ICT to the economy, the whole world and human beings, countries have set up National Information, Communication and Technology policies to enable development of infrastructure for ICT growth including internet connections, participation in the global economy, enhance use of ICT services and products, enhance research and innovations in ICT among other objectives. For example, Kenya introduced a national ICT policy in 2019, Uganda in 2014 and Tanzania in 2016.

Countries all over the world have increased their investment in information and communication technology (ICT). For example, worldwide available data shows that individuals using internet expressed as a percentage of the population has increased from zero percent in the year 1990 to 63 percent in the year 2021. In the same period mobile users per 100 people increased from zero to 108. Fixed broadband subscriptions per 100 people increased from 0.84 in the year 2001 to 18.43 in the year 2022 (World Bank, 2023).

For the selected East African Community (EAC) countries (Kenya, Uganda, Tanzania and Burundi) individuals using internet as a percentage of the total population increased from 0 % to 143.8 %, while mobile cellular subscriptions per 100 people increased from 0.0745 to 363.4 over the period 1990 and the year 2022 (World Bank, 2023). With this massive increase in ICT development and considering its importance in the economy, it was of interest to investigate whether and to what extent ICT impacts economic growth of the EAC countries, and how the results can be used for policy formulation in the EAC countries. Additionally, there are very few studies which have been done using the latest data for the EAC countries. Studies that have been done to investigate the effect of ICT on economic growth have used several measures of ICT development, this study used internet connections, mobile use, fixed telephone connections and fixed broadband connections. This study hypothesized that ICT promotes economic growth of EAC countries.

This paper also looked at the effect of International Monetary Fund (IMF) credit on economic growth of the EAC countries. The main functions of IMF is to implement international monetary cooperation, promote financial stability especially during economic crisis or when a country is faced with balance of payment problems, facilitate international trade, promote sustainable economic growth and employment creation, and reduce poverty all over the world (IMF, 2013). The working of IMF aims at temporary access to credit especially during a crisis such during depression and structural reforms to raise economic growth of member countries. There are several ways IMF affects economic growth of countries: by providing loans to member countries, providing policy

conditions on IMF programs, monitoring the whole world, and works as insurance for investors. The second objective of this paper was to investigate the effect of IMF credit on economic growth of selected EAC countries.

In the year fiscal year 2022, the World Bank IBRD/IDA gave out 70.8US dollars to member countries in the form of credit, loans and grants. Out of these amounts, Eastern and African countries received the largest share which was approximately 26% of the total loans. The IBRD lending in the 2022 fiscal year totaled to 33.1 US billion dollars of which Eastern and Southern Africa received 14% of the total. With this massive loans and mixed empirical results, it is important to evaluate the effect of the World Bank lending to economic growth using data for the EAC countries. This paper expected that IMF credit boosts economic growth of EAC member countries.

The result from fixed effects model suggest that the ICT indicators affect economic growth of the sample countries. Internet use was found to significantly and positively drive economic performance while mobile use was found to reduce economic progress. IMF credit was also found to significantly boost economic growth. Further results show that there is a non-linear relationship between ICT and economic growth and similarly IMF credit has a non-linear impact on economic growth of the EAC selected countries.

This paper is arranged as follows: section 1.0 presents introduction, section 2.0 provides the literature review, section 3.0 presents sample, data and methodology, section 4.0 provides empirical results and finally section 5.0 presents the conclusions of the study.

II. LITERATURE REVIEW

2.1: ICT and Economic growth

Several studies done on the relationship between ICT and economic growth provide evidence of positive impact of ICT on economic growth (Adeleye & Eboagu, 2019; Appiah-otoo & Song, 2021; Ukwoma, 2019; Habibi & Zabardast 2020; Shodiev *et al.* 2021; Ward and Zheng 2016; Bahrini and Qaffas 2019; Erumban & Das, 2016). However, studies from developing countries are very few.

Appiah-Otoo and Song (2021) examined the role of ICT in the economic growth of both the poor and the rich countries. A total of 123 countries were covered using panel data for the period 2002-2017. The study results showed that ICT impacts positively to economic growth for both rich and poor countries; however, the poor benefit more from ICT as compared to the rich countries. A positive effect of ICT on economic growth for both developed and developing countries was similarly found by Papaioannou and Dimelis (2007). However, the highest impact was observed in developed countries than developing countries.

Aghaei and Rezagholizadel (2017) assessed the role of ICT on economic growth of the OIC countries using data over the period 1990-2014. The study used dynamic and statistical panel data. The research results revealed that ICT has a significant impact on the economic growth of the countries covered by the study.

Adelege and Eboagu (2019), explore the ICT impact on economic growth of 54 African countries using data over the period 2005 to 2015. The study used pooled regression, random effects, fixed effects and GMM methods. The ICT indicators that were considered in this study included internet use, mobile subscribers and fixed telephone subscribers. The control variables in these models were inflation and trade openness. Results revealed that ICT has significant positive impact on economic growth. Further results supported the leapfrogging hypothesis and mobile subscribers had the highest impact across all models.

Ukwuoma (2019), using data for Nigerian economy over the period 2008-2018, assessed the impact of ICT using internet users as a proxy for ICT. The study findings show that ICT impact positively on economic growth. Akinwale, *et al* (2018) using data for the period 1997-2016 for the same Nigerian economy carried a study on the role of ICT on economic growth. The ARDL model results indicated existence of cointegration between ICT and economic growth while in the short-run only secure internet server per 1 million and mobile cellular subscriptions per 100 people had positive impact on economic growth.

Shodiev, *et al.* (2021), using data for the period 2000-2018 for Central Asia countries carried out causality analysis between ICT and economic growth. The results from the study supported positive significant effect of ICT on economic growth for these countries.

2.2: IMF Credit and Economic Growth

Generally, most of the literature available suggests that IMF credit does not stimulate economic growth of the recipient countries (Fidrmuc and Kostagianni (2015) or have negative impact on economic growth (Dreher, 2006). Few studies reveal that IMF credit accelerates economic growth.

Carlos. (2021), investigated the impact of IMF credit lending and its conditions on economic growth of 12 South African countries using data over the period 1990-2022. The fixed effects approach was implemented to find the effect of IMF lending and its conditions on economic growth. The empirical results show that there is no statistical significance of IMF lending on economic growth. However, when some conditions are met, GDP responds positively.

Turan, *et al.* (2023), examined the impact of IMF programs on economic growth of 110 countries. Using the GMM estimation, the results indicated that the IMF programs and general conditionality do not have a significant effect on economic growth. However, dividing the programs into concessional and non-concessional, revealed that concessional do not have any significant effect on economic growth, but the non- concessional impact positively and significantly on economic growth.

Kilman and Olsson (2013) , using data over the period 1983-2010 for 86 developing countries, found that IMF programs accelerate economic growth. The OLS and 2SLS results revealed that IMF credit promote economic growth of Asia and South America. The study found two lending arrangements (the stand-by arrangements and the extended

credit facility) to boost economic growth in the sample countries. Overall IMF enhances economic growth.

Dreher (2006) using panel data for 98 countries investigated if IMF involvement impacts on economic performance in program countries. The study findings gave evidence that IMF programs reduce economic growth. Further evidence indicated that compliance with the conditionality reduce the negative effect of IMF on economic growth. The overall results suggest the IMF loans have no statistically significant effect on economic growth.

The studies reviewed on IMF credit and economic growth show mixed results with majority of the studies suggesting that IMF credit has a negative effect on economic growth. Authors give several reasons for the negative effect of IMF lending on economic growth of the recipient countries. The stabilizing effect of IMF credit is said to be not enough to accelerate economic growth, secondly most of the recipient countries have low rates of compliance with the IMF policy conditions accompanying the credit given and that IMF focuses on monetary and fiscal discipline of the recipient countries while most of the developing countries suffer from structural problems which hinder them from experiencing high economic growth even after receiving IMF credit (Dreher 2000; Prezowski & Vreeland 2000). The studies are not conclusive. This study will provide further insight on the existing knowledge on IMF credit and economic growth using data for selected EAC member countries over the period 1990-2022.

III. METHODOLOGY

This study investigated the impact of ICT and IMF credit on selected EAC countries using panel data covering the period 1990-2022. The sample covered four selected EAC countries: Kenya, Uganda, Tanzania and Rwanda. Data for the sample countries was obtained from World Development Indicators 2023. (World Bank, 2023).

The variables included in the study include GDP percapita which is the dependent variable and a proxy for economic growth; the ICT indicators considered in this study were internet use, fixed telephone line subscription, fixed broadband and Mobile phone subscribers. However fixed telephone subscription was dropped due to collinearity issue with other ICT indicators. These ICT indicators acted as the independent variables. IMF credit received by the countries acted as the independent variable. The study also considered various control variables which included; the ratio of female to male labor force, government expenditure, domestic credit to the private sector which was taken as a proxy for financial development, trade openness, capital investment, foreign direct investment and inflation.

There are three types of panel data analysis methods: pooled Ordinary Least square regression, panel data analysis using the fixed effects model and random effects model. This study used the fixed and random effects models.

Using the Classical Solow growth model with technology, the Cobb-Douglas production function states that output is determined by labour and capital inputs expressed as:

$$GDP_{it} = AL_{it}^{\beta_1} K_{it}^{\beta_2} e^u \text{ where } \beta_2 = 1 - \beta_1 \tag{1}$$

Where GDP is gross domestic product L, and K are labour and capital inputs respectively, e is the error term assumed to have a normal distribution and a constant variance. ICT enters in the production function as an input to reduce the cost of production or improve the quality of products (Maneejuk, & Yamaka, 2020) which in turn affects output. Availability of IMF credit will enable the economy hire more factors of production, solve balance of payments problems, pay for more raw materials and other inputs in the production process. Incorporating the two variables of interest ICT and IMF credit in model (1) gives model (2) stated as:

$$GDP_{it} = \alpha L_{it}^{\beta_1} K_{it}^{\beta_2} ICT_{it}^{\beta_3} IMF_{it}^{\beta_4} \quad (2)$$

Other control factors which determine economic growth include government expenditure, foreign direct investment (FDI), Trade, financial development, and inflation. Incorporating control factors, equation (2) is expressed as:

$$GDP_{it} = \alpha L_{it}^{\beta_1} K_{it}^{\beta_2} ICT_{it}^{\beta_3} IMF_{it}^{\beta_4} X_{it}^{\beta_5} e \quad (3)$$

Linearising model (3) gives the econometrics model which was estimated for this study (4):

$$\ln GDP_{it} = \beta_0 + \beta_1 \ln L + \beta_2 \ln K + \beta_3 \ln ICT_{it} + \beta_4 \ln IMF + \beta_5 \ln X + v_i + \varepsilon_{it} \quad (4)$$

GDP is the dependent variable which is gross domestic product per capita a proxy for economic growth in the EAC countries considered in this study over the study period. In this model labor input was divided into two: total labor force and the ratio of female to male labor force. However, due to multicollinearity total labor force was dropped from the model. Therefore, L represents the ratio of female to male labor force. This variable which is not commonly used in the empirical

studies was included to evaluate the impact of female labor force on economic growth of the sample countries. Increases in female labor force reduces gender gap, increases women productivity, increases women wellbeing and finally all these may increase economic growth of the cross sectional units. ICT was proxied by mobile cellular subscriptions, internet use and fixed broadband internet. Variable X stands for control variables which were included in the model to control for their influence in economic growth. These included foreign direct investment, financial development which was proxied by domestic credit to the private sector, trade which was proxied by the ratio of the sum of exports and imports to GDP of each country. Trade variable shows the extent to which each sample country is open. Other control variables include, government expenditure, investment in each country which was proxied by gross capital formation. β_i are coefficients which were to be estimated. Of major interest were the ICT coefficient β_3 which was expected to show the effect of ICT on economic growth of the EAC sample countries over the study period, and β_4 , the coefficient of IMF credit which was expected to be positive. Greater amounts of IMF credit supplied to the EAC member countries was expected to enhance economic growth of the EAC countries while $\beta_1, \beta_2, \beta_5$ are the coefficients for the control variables included in this study, v represents the country specific effects which takes care of the effects of each individual country that are time invariant and finally ε is the error term assumed to be independently and identically distributed with zero mean and a constant variance. Table 1, presents the variables included in the model.

TABLE 1: Variables, Explanation and Source of data

Variables	Measured	Expected effect	Source of Data
Economic growth (GDP)	GDP per capita US dollars at current prices	(dependent variable)	World Bank Development indicators data base (WB 2023)
Ratio of female to male labour force (FM)	(female labour force participation rate /men labour force participation rate *100)	It is was expected that female labor ratio to affect economic growth positively	World Bank Development indicators data base (WB 2023)
Government consumption expenditure (G)	General government final consumption expenditure (Current US\$)	Government expenditure in various sectors of the economy such as education, health, infrastructure enhance economic growth	World Bank Development indicators data base (WB 2023)
FDI net inflows (FDI)	% of GDP	Foreign direct investment was expected to impact positively on economic growth	World Bank Development indicators data base (WB 2023)
Internet use (INTERU)	Individuals using internet expressed as % of the total population	Internet use was expected to enhance economic growth	World Bank Development indicators data base (WB 2023)
Fixed Broadband (FB) subscriptions	Per 100 people	As fixed broadband subscribers increase gross domestic output was expected to increase	World Bank Development indicators data base (WB 2023)
Mobile cellular subscriptions (MOB)	Mobile cellular subscriptions Per 100 people	More mobile cellular subscriptions was expedite to boost economic growth	World Bank Development indicators data base (WB 2023)
Financial development (CRD)	Measured by commercial bank`s credit to the private sector % of GDP	Increase in domestic credit was expected to boost economic growth	World Bank Development indicators data base (WB 2023)
(TRADE)	Trade openness approximated as total sum of exports and imports divided by GDP per capita	Trade openness contributes to transfer of technology and skills which facilitates various production processes in the country. This variable was expected to affect economic growth positively	World Bank Development indicators data base (WB 2023)
Investment (CAP)	Gross capital formation as % GDP	As investment increases it was expected that the economy will respond positively	World Bank Development indicators data base (WB 2023)
Use of IMF credit (IMF)	Current US\$	As per the IMF objective, Use of IMF credit was expected to boost economic growth	World Bank Development indicators data base (WB 2023)
Inflation	Proxied by CPI	There is inverse relationship between inflation and economic growth	World Bank Development Indicators 2023

IV. EMPIRICAL RESULTS

4.1: Descriptive statistics

Before analysis, all data was converted to natural logarithms.

Table 2 presents the descriptive statistics of the variables.

TABLE 2: Descriptive Statistics for the variables.

	Obs	Mean	Std deviation	Min	Max
GDP	132	7.36	0.564	5.748	8.659
Female Male ratio (FM)	132	4.472	0.082	4.25	4.57
Gort Expenditure (G)	132	21.157	1.088	18.25	23.35
FDI	132	1.285	0.396	0.622	2.188
Internet	132	1.902	0.993	0.693	4.30
Fixed Tel sub	132	11.29	1.124	8.84	13.406
Mobile	132	2.53	1.593	0.693	4.826
Fixed Broadband	132	0.875	0.128	0.729	1.295
Financial Development	132	2.5	0.620	1.0787	3.60
Trade	132	3.378	0.332	2.324	4.00
Capital	132	3.046	0.298	2.30	3.72
IMF	132	22.165	1.56	18.743	24.593
Inflation	132	2.630	0.464	1.276	4.127

Source of data: Estimations by the author using data from World Bank 2023

Kenya's internet use is above all the sample countries over the study period, followed by Rwanda, Tanzania and Uganda. However, in the year 2021, Tanzania was leading followed by Rwanda in terms of the individuals using internet.

Table 3 presents the main results of the impact of ICT and IMF credit on economic growth of EAC countries.

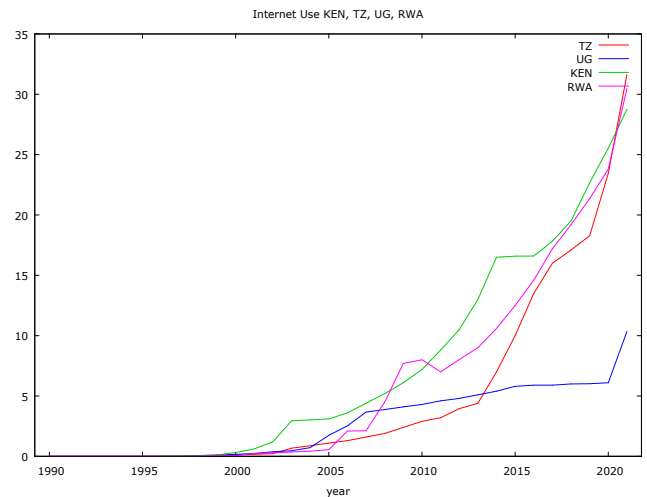


Figure 1: Internet use of the sample countries: 1990-2021
Source of Data: World Development Indicators, 2023

4.2: Panel Data analysis

The main results are presented in Table 3. Panel data was analyzed by fixed effects and random effects models.

TABLE 3: Results of Impact of ICT and IMF on Economic growth of the sample countries of EAC

Panel data analysis, Dependent variable: GDP per capita						
Variable	Fixed Effects			Random Effects		
	Coefficient	T	p-value	Coefficient	Z	p-value
Internet use(INTERU)	0.2586***	7.41	0.000	0.0055	0.18	0.861
Mobile use(MOB)	-0.099***	-4.53	0.000	0.0228	0.90	0.370
Fixed Broad band(FB)	0.1062	1.14	0.258	-0.0344	-0.27	0.789
IMF	0.066**	2.56	0.012	0.00808	0.36	0.719
Female Male ratio(FM)	1.131***	3.92	0.000	0.1789	0.58	0.565
Government Expenditure(G)	0.273***	7.83	0.000	0.3917***	11.83	0.000
Financial Development(CRD)	0.0991**	2.24	0.027	0.2112***	4.26	0.000
Capital (CAP)	0.1914**	2.63	0.010	-0.1235	-1.37	0.170
FDI	0.1384***	3.94	0.000	0.1540***	3.24	0.001
TRADE	-0.055	-1.24	0.218	-0.0169	-0.29	0.775
Inflation(INF)	-0.0127	-0.67	0.506	-0.0162	-0.62	0.533
Constant	-6.0619***	-4.38	0.000	-2.1948**	-2.26	0.024
Model summary						
	R ² =0.75			R ² =0.96		
	F=42.19					
	Hausman =168.63			p-value=0.000		
	Number of Observations =132			132		
	Number of groups =4			4		

Notes:***, **, * represents significant at 1, 5 and 10 % respectively

Results indicate that the explanatory variables explain 75% and 96% of the changes of economic growth in the fixed effects and random effects models, respectively. The F tests also suggest that the fixed effects model is statistically significant. The Hausman's test has a chi-value of 168.63 and a p-value of 0.000. Hausman Test tests the null hypothesis (H0): Unobserved individual effects are not correlated with the explanatory variables; against the alternative hypothesis (H1): There is correlation between unobserved individual

effects and the explanatory variables. Using the Hausman's results the fixed effects model results were preferred. The fixed effects estimator takes into account the time invariant variables and decreases the omitted variable bias. This paper therefore discusses only the fixed effects model results.

According to the results in Table 3, the ICT indicators that significantly affected economic growth of the EAC countries included only internet use and mobile cellular subscriptions. Internet use significantly and positively affects economic

growth while mobile cellular subscriptions significantly reduce economic growth of these EAC countries. Among the ICT indicators, internet use has the greatest positive impact on economic growth of the EAC countries. With 1% increase in internet use, economic growth of the EAC member countries will increase by 0.26%, while a 1% increase in mobile use is associated with a decrease of, economic growth by 0.1%. The positive impact of ICT on economic growth agrees with the results found by other previous researchers (Appiah-Otoo & Song,2021; Aghaei & Rezagholizadel, 2017; Ukwuoma,2019; Albiman & Sulong, 2017). This suggests that the EAC will accelerate their respective economic growth by increasing internet connections in their economies and making it more affordable. IMF credit was found to significantly boost economic growth of the EAC countries. If the EAC member countries raise their IMF credit use by 1%, economic growth will increase by 0.07% holding other factors constant. The positive effect of IMF credit on economic growth of EAC countries is not supported by majority of the previous studies that find that IMF credit reduces or has no effect on economic growth of the recipient countries. However, there are very few studies which support positive effect of IMF credit on

economic growth (Kilman &Olsson, 2013). The control variables which were found to significantly boost economic growth of the EAC countries are Female labour ratio, government expenditure, gross capital formation, financial development and foreign direct investment. Among the control variables result, female labor ratio provides very interesting results. Female labour ratio has the greatest positive effect (1.13) followed by government consumption expenditure. The positive effect of female workers on economic growth has been confirmed by other previous researches (Na-Chiangmai, 2018). The results indicate that the higher the proportion of female to male workers, the higher is economic growth. This suggests that female labour force are very crucial in promoting economic progress and play a critical role in achieving sustainable development of the sample countries. The study suggests that the major variables of interest ICT and IMF credit promote economic growth of the EAC countries, it is therefore important for the government to continue receiving IMF credit and use it appropriately and invest more on ICT especially on internet connectivity as the results indicate that they promote economic growth in the sample countries.

TABLE 4: Non- linear effects of ICT and IMF credit on Economic growth

	Model I	Model II	Model III	Model IV
Variable	Coefficient (t-ratio)	Coefficient (t-ratio)		
Internet use(INTERU)	0.189*** (7.69)			
Internet use SQ	-0.008 (-2.69)*			
MOB		0.045* (1.79)		
MOBSQ		-0.0059 (-1.30)		
Fixed Broad band(FB)			-0.34** (-2.53)	
Fixed broad band SQ			0.0049 (0.37)	
IMF				-0.104 (-1.65)
IMF SQ				0.100*** (3.66)
Female Male ratio(FM)	1.69 *** (5.18)	1.147*** (3.3)	1.45*** (4.11)	0.89*** (2.77)
Gort Expenditure(G)	0.268*** (7.29)	0.38 *** (8.71)	0.39*** (13.61)	0.37*** (11.63)
Financial Development(FD)	0.089** (1.93)	0.068 (1.22)	0.056 (1.02)	0.069 (1.36)
Capital (CAP)	0.167** (2.39)	0.186** (2.16)	0.288*** (3.4)	0.10 (1.33)
FDI	0.148*** (4.16)	0.131*** (2.91)	0.116*** (2.61)	0.081** (2.02)
TRADE	-0.088** (-2.04)	-0.073 (-1.37)	0.057*** (3.4)	-0.004 (-0.08)
Inflation(INF)	-0.017 (-0.85)	-0.027 (-1.04)	-0.181 (-0.77)	0.0025 (0.11)
Constant	-6.83 (-4.09)	-6.5*** (-3.75)	-8.03*** (-5.11)	-7.24*** (-5.04)
R ²	0.87	0.915	0.88	0.81

***, **, * represents significant at 1, 5 and 10 % respectively

This paper also tested for the non-linear effects of ICT and IMF on economic growth of the sample countries of EAC. The

results are presented in Table4. The non –linear effects of internet use (model I), mobile use (Model II), fixed broad

band (Model III) and IMF credit (Model IV) were tested separately as presented in Table 4.

According to the non-linear testing results presented in Table 4, most of the ICT indicators have non-linear relationship with economic growth of the EAC selected countries. Internet and mobile use have non-linear (inverted U-shaped relationship) impact on economic performance of the sample countries. As the sample countries increase their internet development, after 19% of use, further use will reduce economic progress. The results suggest that after this threshold a 1% increase in usage of internet will induce a decline in economic growth by 0.008%. The non-linear relationship between ICT and economic growth have been reported by other previous researches (Ishnazarov *et al* 2021, Ali, 2020; Albiman & Sulong 2017). However, with fixed broadband internet there exist non-linear relationships with economic growth but of the normal upward U-shaped relationship. The non-linear relationship of the broadband internet was found to be statistically non-significant. Further, the results provide evidence of existence of non-linear relationship between use of IMF credit and economic growth of the countries considered in this study. The result suggest that as the sample countries continue using IMF credit, economic growth will be negative until when the countries use around 10% of the IMF credit after this point the countries will start experiencing economic progress. After this threshold 1% increase in use of IMF credit will boost economic progress by 0.1 %. This is an upward looking U-shaped relationship between IMF credit use and economic growth of the sample countries.

V. CONCLUSIONS

The main objectives of this study were to assess the effect of ICT, IMF credit on economic growth of EAC countries and whether there existed a non-linear relationship between these variables and economic growth for the case of the sample countries over the period 1990-2022. Results from the fixed effects panel data analysis found that internet technology drives economic growth of the EAC countries. Use of mobile technology was found to reduce economic progress. The study also found that IMF credit boosts economic growth of the sample countries. Other factors that boost economic growth of the EAC countries include female labour ratio, government consumption expenditure, financial development, investment and foreign direct investment. Further findings also revealed that there is non-linear relationship between ICT and economic growth and also that IMF credit has a non-linear effect on economic growth of the EAC countries. Internet and mobile technologies have an inverted U-shaped relationship with economic growth of the sample countries while use of IMF credit has an upward looking U-shaped relationship with economic growth. It can be concluded that internet technology and IMF credit are crucial in determining economic growth of the EAC countries.

The results of this study are important to policy makers. The policy makers need to provide more incentives to investors in ICT technologies especially on the internet infrastructure including adoption of increased use of internet. The policy makers to adopt low interest rates on business

loans, increase grants, tax reductions and subsidies to internet investors, allocate more resources to development of ICT infrastructure and increased training and employment of ICT professionals. As well the EAC countries should increase their intake of IMF credit as this will raise their economic performance. The policy makers should implement policies that enable proper use of IMF loans to their respective economies. These include proper management of the economy especially on fiscal and monetary policies, monitoring of projects especially those funded by IMF, reduction of corruption and repayment of IMF loans. The control variables to be considered in planning for improvement in sustainable development include female male labour ratio, government consumption expenditure financial development, capital investment, and foreign direct investment. Among these control variables female male labor ratio had the greatest positive significant impact (1.131) on economic growth. This finding has policy implication that the governments of the sample countries should design policies that provide more incentives to girl child education, better training, good job opportunities, credit access services, ease their domestic duties such as childcare, and increase female workers in all sectors of their respective economies as these will contribute to economic progress positively.

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