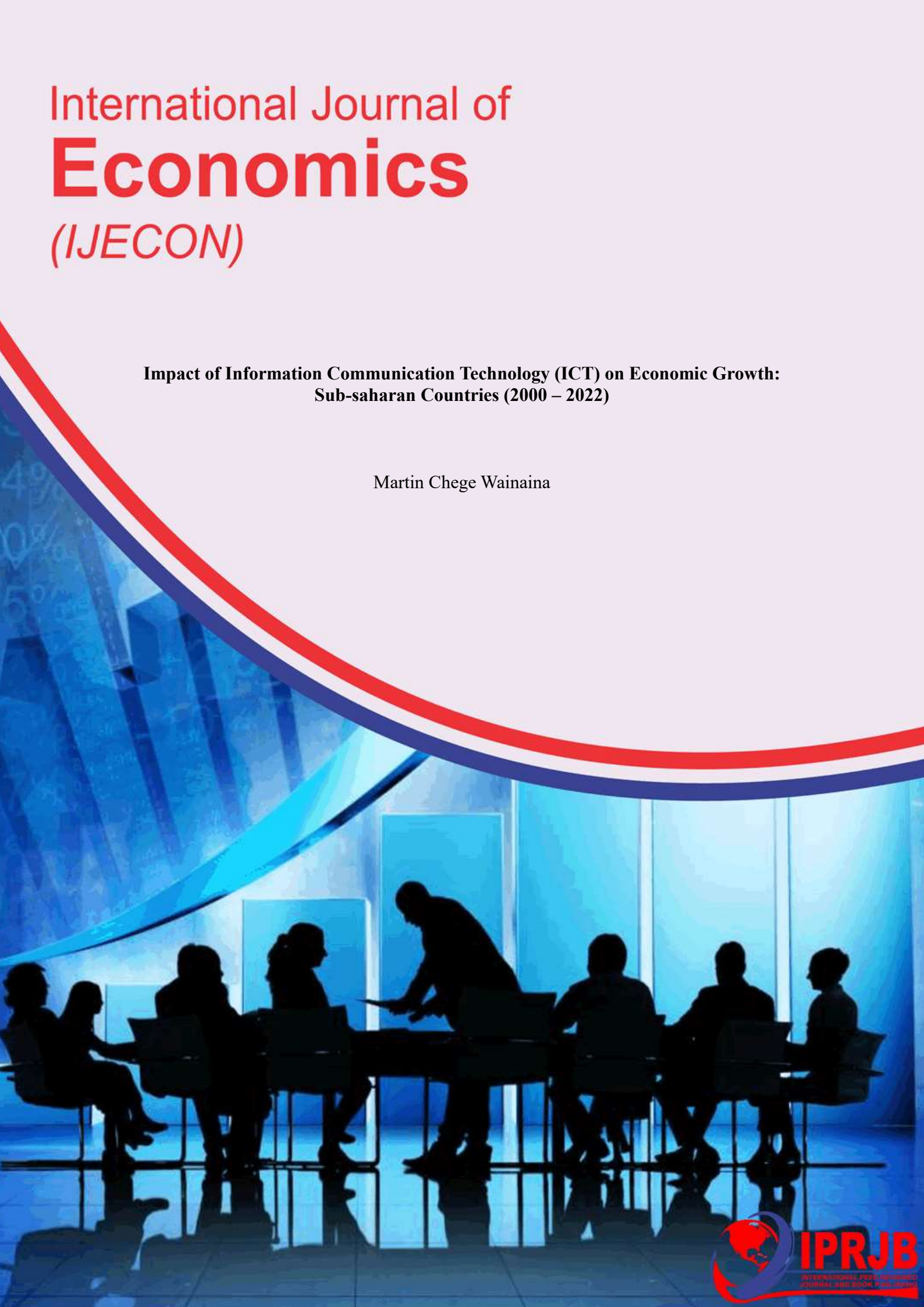
International Journal of
Economics
(IJECON)

Impact of Information Communication Technology (ICT) on Economic Growth: Sub-saharan Countries (2000 – 2022)

Martin Chege Wainaina



IPRJB

International Journal of Economics
ISSN 2518-8437 (Online)
Vol.10, Issue 1, No.41. pp 1 - 38, 2025

www.iprjb.org

Impact of Information Communication Technology (ICT) on Economic Growth: Sub-saharan Countries (2000 – 2022)

Martin Chege Wainaina

Article History

Received 5th November 2024

Received in Revised Form 10th December 2024

Accepted 6th January 2025

How to cite in APA format:

Wainaina, M. (2025). Impact of Information Communication Technology (ICT) on Economic Growth: Sub-saharan Countries (2000 – 2022). *International Journal of Economics*, *10*(1), 1–38. https://doi.org/10.47604/ijecon.3149

Abstract

Purpose: In the 21st Century, the global economy has experienced significant technological changes, with the recent integration being Artificial Intelligence. In Subsaharan countries, information communication technology is highly adopted across almost all key economic sectors. The significant ICT diffusion in these SSA countries has enhanced economic growth. The study investigates the impact of Information and Communication Technology on economic growth in Subsaharan countries.

Methodology: The study analyzed panel data from 46 SSA countries over the 2000–2022 period. It collects panel data between 2000 and 2022 from 46 SSA countries. It employs a fixed-effects model to explore the relationship between Information and Communication Technology indicators, including mobile phone penetration, broadband subscriptions, internet usage, and real Gross Domestic Product.

Findings: Study findings reveal that mobile phone subscribers per 100 people exhibit a statistically significant impact on economic growth, with a 1% increase associated with a 14.9% rise in real GDP. Also, fixed-broadband subscriptions have a significant positive association with real GDP. Fixed telephone subscriptions reveal a negative relationship, signaling a shift from traditional telephony to mobile technology. However, the percentage of persons using the Internet shows a positive but statistically insignificant impact on economic growth. Foreign direct investment shows a significant positive relationship with real GDP. Moreover, gross fixed capital formation demonstrates a significant positive impact on real GDP, underlining the importance of investment in physical infrastructure for economic growth in SSA. Conversely, trade openness exhibits a statistically significant negative relationship with real GDP, highlighting the impact of trade liberalization.

Unique Contribution to Theory, Practice and Policy: Policymakers in SSA should prioritize investments in digital infrastructure, particularly in broadband and mobile technologies, to foster economic growth. Strategies to attract Foreign Direct Investment in ICT sectors are crucial for enhancing productivity and innovation. Governments should address the challenges of trade openness by implementing policies that support domestic industries while encouraging balanced trade liberalization. Lastly, efforts to improve digital literacy and bridge ICT accessibility gaps are vital to fully harness the potential of ICT in driving inclusive growth in the region.

Keywords: *Information Communication Technology (ICT), Economic Growth, Mobile Phone Penetration, Broadband Subscriptions, Internet Usage, Fixed Telephone Subscriptions, Real GDP, Foreign Direct Investment (FDI), Gross Fixed Capital Formation, Trade Openness, Panel Data Analysis, Fixed Effects Model, ICT Policies, ICT Diffusion, Telecommunication Infrastructure, Inflation, Digital Literacy, Productivity, Financial Inclusion*

JEL Classification Codes: *O33, O40, C23, F43, L96.*

INTRODUCTION

In the 21st Century, the global economy has experienced tremendous technological advancement. The widespread adoption of information and communication technology (ICT) has resulted in a profound shift towards an information-based society. With the advancement of ICT infrastructure, including mobile phones, fixed-line telephones, the Internet, and broadband services, individuals, businesses, and governments now enjoy vastly improved access to information, knowledge, and insights on a larger scale, broader scope, and more incredible speed than ever.

The most recent integration of artificial intelligence (AI) technologies into various industries and sectors catalyze unprecedented levels of efficiency, innovation, and productivity, thereby driving significant economic Growth in Subsaharan Africa and the global economy (Mhlanga, 2021). According to the GSMA report (2022), mobile subscribers and penetration in Subsaharan Africa was 43%. Additionally, 23% of the population in the SSA region was connected to the Internet in 2022 compared to 57% global mobile internet penetration rate and the least among CIS 67%, Latin America 62%, Asia Pacific 49%, and 51% in MENA regions. Moreover, the report indicated that 86% of the SSA population had a SIM connection, projected to hit 99% in 2030.

This diffusion of ICT in the SSA has significantly enhanced the efficiency of resource allocation, lowered production costs, and stimulated increased demand and investment across all economic sectors in Subsaharan Africa (Vu, 2011; Lee et al., 2012). In 2022, 8.1% of total GDP was reported as the total mobile contribution to GDP, indicating ICT's potential to enhance economic growth in the region (GSMA report, 2022).

However, despite the recognized potential of ICT to drive economic growth and improve societal well-being, many countries in SSA continue to grapple with significant disparities in ICT infrastructure, digital literacy, and access to technology (Nwokolo et al., 2023; Mateko, 2022). These challenges hinder the region's ability to fully harness the transformative power of ICT and realize its development goals. Moreover, the gap between ICT policies and their effective implementation further intensifies the issue, posing barriers to inclusive growth and exacerbating existing socio-economic inequalities.

ICT's growing importance in improving the global, national, and cross-country economy has prompted several economists and authors to conduct research to answer the question of ICT's economic impacts. Reviewed theories have indicated a positive relationship between ICT and economic Growth (Solow & Robert, 1956; Schumpeter, 1934; Pyka & Andersen, 2012). However, the reviewed empirical literature has revealed mixed results (Vu, 2011; Sassi & Goaied, 2023). In the developed countries, the reviewed literature confirmed that ICT infrastructure and diffusion play a pertinent role in enhancing economic development and Growth (Dewan & Kraemer, 2000; Papaioannou & Dimelis, 2007; Yousefi, 2011; Vu et al., 2020). On the other hand, some studies portrayed a negative impact of ICT on economic Growth (Aghion & Howitt, 1998; Freeman & Soete, 1997).

In most of the reviewed studies in developing economies, the results deduced were not conclusive, and there was no standard argument on whether ICT has a substantial impact on economic Growth (Nasab & Aghaei, 2009; Andrianaivo & Kpodar, 2011; Sassi & Goaied, 2013; Pradhan et al. 2015, 2018; Aghaei & Rezagholizadeh, 2017). Secondly, these studies employed different econometric models from cross-sectional, panel, and time series models,

which yielded mixed results, especially for developing countries, indicating the need for more exploration. The mixed results from prior studies warrant this research because they highlight the lack of consensus on the relationship between ICT and economic growth in developing economies. Variations in findings often stem from differences in econometric models (cross-sectional, panel, and time series) and contextual factors unique to developing countries, such as disparities in ICT infrastructure, digital literacy, and economic conditions. These inconsistencies create a gap in the literature, underscoring the need for further exploration.

In response to the aforementioned, this study addresses this gap by employing a fixed-effects model to provide a more robust and comprehensive analysis of ICT's impact on economic growth in Sub-Saharan Africa. The study will also integrate the country-specific impact of ICT on economic growth. Focusing on a region with significant ICT adoption and economic potential, it aims to clarify the mechanisms through which ICT influences growth and identify policy-relevant insights tailored to the region's unique context.

The paper will be structured as follows: Chapter 2 will present a comprehensive review of relevant literature around the study subject, which encapsulates theoretical and empirical literature. Chapter 3 will present the study methodology, which will involve the data source, model specification, variables to be used in the study, and the software for the data analysis. Chapter 4 presents the study findings and discussion of results, while chapter 5 will present the conclusions.

Problem Statement

Sub-Saharan Africa (SSA) has experienced significant advancements in Information and Communication Technology (ICT) over the past two decades, with mobile phone penetration, broadband subscriptions, and internet usage steadily increasing. Despite these developments, the region continues to grapple with disparities in ICT infrastructure, digital literacy, and accessibility, which hinder its ability to fully leverage ICT for economic growth.

While existing studies have established a potential link between ICT adoption and economic development, findings remain inconclusive, particularly in the context of developing economies. Previous research presents mixed results, often influenced by variations in econometric models, regional contexts, and data limitations. For instance, some studies highlight the transformative potential of ICT in fostering economic growth, while others indicate a lack of significant impact or even negative outcomes. This inconsistency creates uncertainty for policymakers and stakeholders seeking to harness ICT for sustainable development in SSA.

Furthermore, there is limited empirical evidence specific to SSA that comprehensively examines the relationship between various ICT indicators—such as mobile phone penetration, broadband access, and internet usage—and key economic variables like real GDP. The lack of region-specific studies addressing both time- and country-specific factors exacerbates the knowledge gap.

This research seeks to address these challenges by investigating the impact of ICT on economic growth in SSA, employing a fixed effects model and comprehensive panel data spanning 2000–2022. The findings aim to clarify the relationship between ICT and economic performance in SSA, providing actionable insights for informed policymaking and strategic investment in the region.

LITERATURE REVIEW

The world has experienced enormous technological advancements in recent decades across all sectors. However, whether technology drives economic growth has sparked heated debate among several economists, prompting an in-depth exploration of the impact and effect of Information Communication Technology (ICT) on the general growth of developing and developed economies.

Contemporary theories, such as the neo-classical growth theory suggested by Solow, demonstrated a significant and positive correlation between economic growth and advancements in ICT (Solow & Robert, 1956). Similarly, neo-Schumpeterian theories (Schumpeter, 1934; Pyka & Andersen, 2012) indicated a positive and significant relationship between ICT and economic growth. According to these theories, ICT improves production by deepening capital and fostering technological and labour force quality advances. It also enters the economy as an input in the form of capital. Thus, ICT improves productivity and spurs economic growth at the national level by generating added value at the firm and sectoral levels (Quah, 2002; Aghaei & Rezagholizadeh, 2017). Despite the positive significant results demonstrated by the theories in the previous section, findings from different scholars have indicated mixed results.

ICT Policies in Subsaharan Africa

Technological changes have proven to be a key pillar of achieving economic growth in developed and developing economies. However, policies regarding Information and Communication Technology in Subsaharan Africa vary across countries due to differences in governance structures, economic conditions, technological capacities, and developmental priorities. Several countries within the region have recognized the transformative potential of ICT in driving socio-economic development and have thus implemented various policies to harness its benefits.

In Subsaharan Africa (SSA), Kenya is a frontrunner in implementing Information and Communication Technology (ICT) policy. Kenya has spearheaded initiatives such as the National ICT Master Plan and the Kenya ICT Authority, which are designed to develop ICT infrastructure and foster digital innovation within the country (moict, 2020). Kenya's success story includes the widespread adoption of mobile money services like M-Pesa, which has played a pertinent role in enhancing financial inclusion and expanding access to digital services across various population segments (Domingo et al.., 2023). This success is attributed to Kenya's enabling policy environment, robust regulatory framework, and public-private partnerships (Domingo et al., 2023). The replicability of Kenya's model in other SSA countries would require similar institutional support, digital literacy initiatives, and stakeholder collaboration.

Moreover, Nigeria has established a robust National ICT Policy to harness technology for economic growth. Central to this policy are objectives focused on improving ICT infrastructure accessibility and fostering digital skills development. Nigeria has further demonstrated its commitment to supporting local content development and startups through initiatives such as the National Information Technology Development Agency (NITDA) and the Presidential Enabling Business Environment Council (PEBEC) (McCulloch et al., 2017; Essien et al., 2024). However, replicating this approach in other countries would necessitate robust institutional capacity and targeted investment in digital entrepreneurship.

South Africa's efforts, including the South African Connect policy, aim to bridge the urban-rural digital divide by expanding broadband access. Initiatives like Broadband Infraco and the Universal Service and Access Obligation Fund (USAO) focus on enhancing connectivity in underserved areas. The country's successes are underpinned by its relatively advanced infrastructure and governance mechanisms (Mwapwele et al., 2019). While the policy offers a replicable framework, its scalability depends on a country's ability to mobilize resources and sustain long-term infrastructure projects.

Additionally, Rwanda exemplifies ICT-driven innovation with strategies such as the Smart Rwanda Master Plan and Kigali Innovation City. Investments in fibre-optic networks, e-governance, and digital skills training have positioned Rwanda as a knowledge-based economy leader (Ntakirutimana et al., n.d; Burns, 2021). Rwanda's success stems from its strong political commitment, efficient implementation of policies, and focus on human capital development. Replicability in other SSA nations would require similar political will and alignment of policies with national development goals.

Ghana has made significant strides in leveraging technology for socio-economic development through its National ICT for Accelerated Development (ICT4AD) Policy Framework (Kubuga et al., 2021). Initiatives like the National Information Technology Agency (NITA) and the Ghana Investment Fund for Electronic Communications (GIFEC) have been instrumental in expanding ICT infrastructure and promoting digital inclusion across the country (NTIBREY, 2012; Kubuga et al., 2021).

Uganda's National ICT Policy and National Broadband Policy aim to enhance ICT access, affordability, and innovation (Oughton et al., 2022). Projects such as the National Backbone Infrastructure (NBI) and the Uganda Communications Commission (UCC) demonstrate Uganda's commitment to improving ICT infrastructure and regulatory frameworks to drive socio-economic development (Ssempebwa & Lubuulwa, 2011).

The ICT investment policies aim to improve economic growth in several ways, such as increased connectivity, financial inclusion, market expansion, and creating demand across the countries. Despite the efforts made by SSA countries in formulating ICT policies to drive socio-economic development, significant disparities persist in terms of policy implementation and ICT adoption rates. However, addressing these disparities requires a sustained investment in ICT infrastructure, human capital development, and policy reforms to unlock the full potential of ICT as a catalyst for inclusive growth and development across the region.

While countries like Ghana and Uganda have made notable progress through their ICT4AD Policy Framework and National Broadband Policy, significant disparities in ICT infrastructure, policy execution, and adoption rates persist across the region. For instance, Ghana's achievements in digital inclusion through initiatives like NITA and GIFEC highlight the importance of localized solutions tailored to specific challenges (Kubuga, Ayoung & Bekoe, 2021). However, limited funding and uneven capacity to implement these policies hinder scalability in less-resourced nations.

Similarly, Uganda's focus on enhancing ICT access and affordability through projects like the National Backbone Infrastructure (NBI) faces challenges in addressing rural connectivity gaps and ensuring affordable services (Ssempebwa & Lubuulwa, 2011). Addressing these barriers would be critical for replicating Uganda's policies in other SSA countries.

ICT Diffusion and Economic Growth

Most countries in Subsaharan Africa (SSA) have experienced a wave of technological advancement through internet usage, mobile phones, broadband adoption, or fixed telephones (Cariolle, 2021 & Michel, 2005). However, ICT diffusion in Subsaharan Africa is far from homogenous, showcasing heterogeneous ICT adoption and experience (Agyire-Tettey, 2015). While mobile phone penetration remains the most adopted technology, other forms of ICT vary in the SSA region.

Financial Inclusion and Economic Productivity

Mobile money platforms like M-Pesa in Kenya and EcoCash in Zimbabwe have transformed financial services by offering accessible and secure transactions, even for unbanked populations. These platforms have significantly boosted productivity, especially in rural areas with limited formal banking systems. For example, in agriculture, mobile money enables farmers to receive payments promptly, access microloans for inputs, and invest in better farming techniques (Albiman & Sulong, 2016). These developments have led to increased crop yields and better market participation, highlighting mobile money's role in bridging financial gaps and fostering economic productivity.

Agriculture

ICT adoption in agriculture, such as Uganda's m-Farmer and Ghana's Esoko, has revolutionized the sector by connecting farmers with markets, providing real-time agricultural data, and offering solutions to enhance productivity. These platforms deliver weather forecasts, pest control tips, and price information, empowering farmers to make informed decisions. For instance, Esoko has been shown to reduce post-harvest losses by enabling farmers to align production with market demands, thus increasing income and reducing wastage (Gyan, 2016). The replicability of such initiatives across SSA would require robust mobile network coverage and targeted training programs for farmers.

Healthcare

ICT has made substantial inroads in improving healthcare access and outcomes in SSA. Telemedicine initiatives in Rwanda and m-Health platforms in Zambia facilitate remote consultations and health education, particularly in underserved regions (Ariani et al., 2017). By reducing the physical barriers to healthcare access, these innovations improve health outcomes, which, in turn, contribute to labor productivity and economic growth. However, challenges such as poor infrastructure and digital literacy gaps hinder the scalability of these solutions across the region.

Education

ICT integration in education, as seen in Rwanda's Irembo platform and Senegal's "Classe Numérique," aims to bridge the digital divide in learning environments (Ahishakiye & Pacifi Nizeyimana, 2024). These initiatives provide access to digital learning materials, enhance teacher-student interactions, and improve learning outcomes. While promising, uneven access to devices and connectivity in rural areas remains a barrier to equitable educational benefits.

E-Commerce

E-commerce platforms such as Jumia in Nigeria and Kenya have created new market opportunities, enabling sellers to reach broader audiences and buyers to access goods and services conveniently (Badran, 2021). This has been particularly beneficial for small and

medium enterprises (SMEs), which often face limitations in traditional markets. The expansion of e-commerce has boosted trade volumes and facilitated job creation in logistics, delivery, and related services.

Telecommunication Infrastructure and Economic Growth

The relationship between telecommunication infrastructure and economic growth has drawn significant attention from economists, scholars, and policymakers. In an era where connectivity is increasingly recognized as a fundamental driver of economic development, understanding the dynamics between telecommunication infrastructure and growth becomes paramount (Xia, Baghaie & Sajadi, 2023). Investments in telecommunication infrastructure, including broadband networks, mobile technologies, and digital communication platforms, play a pivotal role in influencing economic growth across various sectors in Sub-Saharan Africa (Kouladoum, 2023).

Several studies have examined the impact of telecommunication infrastructure on economic growth, highlighting unique challenges faced by SSA countries. Lee et al. (2012) explored the relationship between telecommunication investments (mobile phones and landline telephony) and economic development in 44 SSA countries between 1975 and 2006. The findings revealed that mobile phone expansion is a critical determinant of economic growth, particularly in regions with low fixed-line penetration. This underscores the reliance on mobile technology in SSA, where fixed-line infrastructure remains limited due to high installation costs and challenging geographical conditions.

Aghaei et al. (2017) analyzed ICT investment's impact on economic growth using dynamic and static panel data for the Organization of Islamic Cooperation (OIC) countries between 1990 and 2014. Their results showed that a unit increase in ICT investment raised economic growth by 0.52 percent, underscoring the transformative potential of ICT. Similarly, Abeka et al. (2021) demonstrated that telecommunication infrastructure enhances the effect of financial development on economic growth in SSA economies, further emphasizing the region's reliance on mobile and broadband technologies to bridge gaps left by inadequate fixed-line infrastructure.

Awad and Albaity (2022) investigated the effect of ICT transmission channels on economic growth in 44 SSA countries from 2004 to 2020. Their findings suggested that ICT contributes directly to growth, with domestic investment, openness, and education acting as critical channels through which ICT penetration indirectly promotes GDP per capita growth. These insights reflect SSA's unique challenge of leveraging ICT in an environment characterized by low fixed-line penetration and uneven access to digital resources.

Chavula (2013) examined the economic impact of telecommunication across 49 African countries. The results highlighted that while telephone main lines and mobile telephony significantly impact living standards in Africa, internet usage contributes less substantially to economic growth, particularly in low-income SSA countries. The study found that mobile phone penetration is the most impactful telecommunication variable in lower-income SSA countries, emphasizing its role in bypassing traditional fixed-line systems to provide connectivity and economic opportunities. This highlights the importance of mobile technology as a tool for bridging infrastructural gaps and driving economic growth in SSA.

Theoretical Framework

This study is best aligned with Endogenous Growth Theory, which emphasizes internal factors such as technology, innovation, and human capital as key drivers of economic growth. This theory highlights the critical role of technology and innovation in enhancing productivity and sustaining long-term growth (Romer, 1986). The study's findings demonstrate how ICT variables, including mobile phone penetration and broadband adoption, positively influence GDP, aligning with the theory's focus on technology as a driver of growth.

Furthermore, ICT fosters knowledge dissemination and innovation, consistent with Endogenous Growth Theory's view of knowledge as a non-rival good that generates increasing returns to scale. The policy recommendations on investing in ICT infrastructure and digital literacy align with the theory's emphasis on targeted investments to sustain growth. Additionally, the theory explains sustained economic development through continuous technological advancements, reflecting the study's findings on ICT's transformative impact over the 2000–2022 period.

Endogenous Growth Theory provides a robust framework to interpret the study's results and guide evidence-based policy formulation by framing the relationship between ICT adoption, productivity gains, and economic performance. This alignment underscores the importance of integrating technological advancements into economic strategies to drive inclusive and sustainable growth in SSA.

Despite these sector-specific successes, ICT diffusion's overall economic impact remains heterogeneous across SSA. Developed countries within the region, often benefiting from better infrastructure and governance, have leveraged ICT more effectively for economic growth. In contrast, underdeveloped areas face challenges such as high costs of ICT adoption, limited internet penetration, and inadequate policy frameworks. Studies such as those by Bahrini and Qaffas (2019) and Andrianaivo and Kpodar (2011) highlight the significant positive effects of mobile phone penetration and broadband adoption on economic growth. Conversely, other studies indicate that ICT's benefits are concentrated in developed nations due to favorable environmental factors, such as supportive policies and robust infrastructure (Dewan & Kraemer, 2000). In SSA, the gap between policy design and effective implementation further exacerbates these disparities, calling for tailored solutions.

ICT's impact on economic growth in SSA varies across sectors and countries. While initiatives like mobile money, agricultural ICT platforms, and e-commerce demonstrate substantial benefits, replicating these successes requires addressing systemic challenges such as infrastructure gaps, affordability, and digital literacy. A sector-specific approach, combined with targeted investments and supportive policies, is essential to unlock the full potential of ICT in driving inclusive growth in the region.

METHODOLOGY

The study's primary objective was to investigate the impact of ICT on economic growth in Subsaharan Africa.

Variables, Data Type and Sources

According to the United Nations' definition, the study used panel data for 46 subsaharan countries. It used two sets of variables: variables measuring the ICT and, secondly, the control variables. Moreover, the dependent variable was economic growth, measured using the real

Gross Domestic Product (GDP). The variable's description and data sources are demonstrated in the table below;

Variable	Dependent Variable	Source
rgdp	Economic Growth Measured Using Real GDP	World Bank
	Independent Variables	
	1. Variables Measuring ICT	
mps	Mobile phone subscribers per 100 people	
fts	Fixed Telephone subscriptions per 100 people	
fbs	Fixed-broadband subscriptions per 100 inhabitants	
ppui	Percentage of persons using the Internet	
	2. Control Variables	
inf	Inflation rate	
gdfc	Gross domestic fixed capital formation	
fdi	Foreign Direct Investment	
unemplr	Unemployment rate	

To measure the impact of ICT on economic growth in the SSA, a production function was employed, as demonstrated in the following equation;

$$Y_t = A_t f(C_t, K_t, H_t, L_t) \qquad (1)$$

Where; Y_t denotes the economic output at time t, H_t denotes human capital, C_t denotes the technology use, L_t denotes labour, K_t denotes the physical capital invested, and finally, A_t denotes the technology level in the Hicks neutral or output Augmenting form (May & Denny, 1979). However, assuming the above production function assumes a Cobb-Douglas production function, equation (1) will be presented as;

$$Y = AC^{\gamma_c} K^{\gamma_k} H^{\gamma_h} L^{\gamma_l} \qquad (2)$$

Applying natural logarithm on equation (2) above linear, Moreover, taking the derivative of the variables in equation (3) with respect to time, we get the rate of change or growth rate of each it yields the following equations.

$$ln\, Y = ln\, A + \gamma_c \ln\, C + \gamma_k ln\, K + \gamma_h ln\, H + \gamma_l \ln L \qquad (3)$$

$$\dot{Y} = \dot{A} + \gamma_c \dot{C} + \gamma_k \dot{K} + \gamma_h \dot{H} + \gamma_l \dot{L} \qquad (4)$$

Sample and Sampling Technique

The sample for this study consisted of 46 Sub-Saharan African countries, selected based on the United Nations' regional classification of Sub-Saharan Africa. The countries included in the sample were chosen to provide a comprehensive representation of the region, ensuring that various economic conditions and ICT development levels were covered. The selection of these countries was based on the availability of reliable and consistent data for the relevant variables over a period of time.

The sampling technique used was a non-probability purposive sampling method, where countries were included in the study based on specific criteria: availability of panel data for the relevant variables over the study period and consistent reporting of economic and ICT-related statistics by credible sources such as the World Bank. This sampling technique was chosen

because it allows for a focused analysis of the Sub-Saharan region while ensuring data completeness and consistency across the selected countries.

Econometric Model

Based on the above equations (equations (3) and (4)), the fixed, random, pooled effects model and dynamic model can be estimated. The general panel model is presented as follows;

$$y_{it} = \gamma_{it} + \beta_{it}x_{it} + \delta_{it} \qquad (5)$$
$$\forall\, i = 1,2,\dots,n \;\; and \;\; t = 1,2,\dots,T$$

Where i denotes the specific country, t denotes the time variable, and δ_{it} denotes the random error at time t in country i. Assuming that the homogeneity assumption of the error term is met, the resulting standard pooled model is presented as follows;

$$y_{it} = \gamma + \beta x_{it} + \delta_{it} \qquad (6)$$
$$given\ that;\ \gamma_{it} = \gamma, \forall\, i = 1,2,\dots,n \;\; and \;\; t = 1,2,\dots,T$$
$$\beta_{it} = \beta, \forall\, i = 1,2,\dots,n \;\; and \;\; t = 1,2,\dots,T$$

Moreover, in modelling for country-specific, the disturbance term is split into two terms. Where one of the error terms is country-specific, which is time-invariant. The equation is presented as follows;

$$y_{it} = \gamma + \beta x_{it} + \delta_{it} + \mu_{it} \qquad (7)$$

Where μ_{it} Denotes the time-specific effect.

Similarly, by modelling time-specific effects, we yield the following model;

$$y_{it} = \gamma + \beta x_{it} + T_{it} + \delta_{it} \qquad (8)$$

Where T_{it} Denotes the time-specific effect.

Combining both the time and country-specific effect in the same model, we yield the following model, where the disturbance term is split further into two terms as presented in the following equation;

$$y_{it} = \gamma + \beta x_{it} + T_{it} + \mu_{it} + \delta_{it} \qquad (9)$$

The choice between fixed effects and random effects models depends on the correlation structure between the individual-specific component and the regressors (Brüderl & Ludwig, 2015). The fixed effects model is appropriate if the individual-specific component is correlated with the regressors (Brüderl et al., 2015). On the other hand, if the individual-specific component is uncorrelated with the regressors, the random effects model is used (Ebbes, Böckenholt & Wedel, 2004). However, a Hausman test is used to choose between the fixed and random effects model. If the test indicates that there is no significant difference, the random effects estimator is typically preferred due to its efficiency. However, if the test suggests a significant difference, the fixed effects estimator is preferred to the random effects model.

The primary objective of the study was to investigate the impact of ICT on economic growth in the SSA region. The study was pegged on the null hypothesis that there is no significant positive impact of ICT on economic growth against the alternative hypothesis of a significant positive impact of ICT on economic growth.

The following panel mode was used to investigate the impact of ICT on economic growth (EcG). The study employed control variables (CV) assumed to have an impact on economic

International Journal of Economics
ISSN 2518-8437 (Online)
Vol.10, Issue 1, No.1. pp 1 - 38, 2025
www.iprjb.org

growth. Assuming a Cobb-Douglas production function and taking natural logarithm, the following two equations are yielded;

$$EcG = \gamma\, ICT_{k,i,t}^{\beta_1} CV_{l,i,t}^{\beta_2} \quad (10)$$

$$\ln \text{EcG} = ln\,\gamma + \beta_1 ln\, ICT_{k,i,t} + \beta_2 ln\, CV_{l,i,t} \quad (11)$$

Where the EcG (economic growth) is measured using the real gross domestic product (rgdp), ICT is measured using the following proxies: Mobile phone subscribers per 100 people (mps), the percentage of households with a broadband Internet connection via home computer (fts), Fixed-broadband subscriptions per 100 inhabitants (fbs), and finally, the percentage of persons using the Internet (ppui), the variables are picked based on the existing reviewed literature. On the other hand, the control variables include inflation rate (inf), Gross domestic fixed capital formation (gdfc), Foreign Direct Investment (fdi), Trade Oppeness (to), and Unemployment rate (unemp). Substituting the coded variables in equation (11);

$$\ln \text{rgdp} = ln\,\gamma + \beta_1 \ln fts_{it} + \beta_2 \ln fbs_{it} + \beta_3 \ln ppui_{it} + \beta_4 mps_{it} + \beta_5 \ln \text{inf}_{it} + \beta_6 \ln gdfc_{it} + \beta_7 \ln fdi_{it} + \beta_8 \ln unemp_{it} + \beta_9 \ln to_{it} + \delta_{it} \quad (12)$$

However, controlling for time-specific and individual (country) specific-effect, the following equation is estimated;

$$\ln \text{rgdp} = ln\,\gamma + \beta_1 \ln fts_{it} + \beta_2 \ln fbs_{it} + \beta_3 \ln ppui_{it} + \beta_4 mps_{it} + \beta_5 \ln \text{inf}_{it} + \beta_6 \ln gdfc_{it} + \beta_7 \ln fdi_{it} + \beta_8 \ln unemp_{it} + \beta_9 \ln to_{it} + \delta_{it} + \varepsilon_{it} + T_{it} \quad (13)$$

Where ε_{it} and T_{it} are country-specific and time-specific effects, respectively.

RESULTS AND DISCUSSION

Preliminary Testing Results

The study sought to investigate the impact of ICT (using proxies) on economic growth (proxied by real GDP) in the Subsaharan countries between 2000 and 2022. Panel data was collected from the ITU and World Bank databases. However, before conducting the analysis, preliminary tests were performed to ensure the results deduced were not spurious. The normality test demonstrated in Appendix 1 indicated that the estimated P-value for all variables, p<0.001, is less than .001, implying strong evidence against the null hypothesis of normality. However, the problem of normality was remedied using the log transformation of the variables. Log transformation helps resolve normality issues by stabilizing variance and making the distribution more symmetric (Knief et al., 2021). Additionally, log transformation can help make a skewed distribution closer to normal. Skewed data, especially with a right tail, tends to become more symmetric after applying the log function, as it compresses the larger values and stretches the smaller ones (Gupta et al., 2013). This makes the data more appropriate for parametric tests that assume normality. Moreover, log transformation reduces the effect of outliers. Compressing the range of data brings extreme values closer to the rest of the observations, making the dataset more stable and reliable for analysis (Gupta et al., 2013).

Moreover, the multicollinearity test conducted by running a correlation matrix (Appendix 2) for the independent variables indicated the absence of a high correlation coefficient between the predictor variables, indicating that the independent variables do not suffer the problem of multicollinearity.

Descriptive Statistics Results

Table 1: Summary Statistics of Study Variables

Total	mean	max	min	skewness	sd
realgdp (Billion)	68.23	136.00	8.94	0.10	38.85
mps	32.48	67.37	0.16	-0.45	20.82
fbs	0.17	0.55	0.00	0.61	0.17
fts	0.64	1.35	0.26	0.98	0.30
ppui	11.17	32.60	0.00	0.65	12.71
inflation	43.99	325.00	0.00	2.94	71.79
fdi (Billion)	-0.87	10.03	-7.40	0.39	4.18
gdfc (Billion)	18.30	37.39	0.00	0.08	11.37
unemployment	16.29	16.77	14.48	-2.52	0.48
trade openness	79.53	122.45	0.00	-1.04	32.87

Source: Author's Computation using Data Collected from the World Bank and ITU database (2000 – 2022)

Table 1 above presents the summary statistics of all study variables in the Subsaharan countries between 2000 and 2022. The average real GDP is estimated at 68.23 billion, indicating moderate economic activity across the countries. However, the data also reveals significant variation, with the maximum reaching 136.00 billion and the minimum dipping as low as 8.94 billion. On average, there are 32.48 mobile phone subscribers per 100 people. The maximum observed value is 67.37, suggesting a high penetration rate in some countries, while the minimum value of -0.45 raises concerns about data accuracy.

Moreover, the average number of fixed-broadband subscriptions per 100 inhabitants is relatively low, hovering around 0.17. The maximum value reaches 0.55, indicating a higher adoption rate in some countries than in others. The minimum value of 0.00 suggests a lack of fixed-broadband infrastructure in at least one country. Also, the results indicate that the average number of fixed telephone subscriptions per 100 people is 0.64, highlighting a potential shift towards mobile communication. The maximum observed value is 1.35, suggesting a continued reliance on fixed lines in some regions, while the minimum value of 0.26 points towards a lower penetration rate in other countries. The average percentage of people using the Internet is 11.17%, which might indicate limited access to the Internet in some countries compared to others. The maximum value of 32.60% suggests a higher internet penetration rate in specific regions, while the minimum value of 0.00 raises concerns about digital accessibility in at least one country.

Moreover, as illustrated in the table below, the study conducted a correlational analysis to determine the directional relationship between the real GDP and Independent variables (ICT and Control variables).

Table 2: Correlation Matrix

Variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
(1) lnrgdp	1.000									
(2) lnmps	0.271	1.000								
(3) lnfbs	0.276	0.705	1.000							
(4) lnfts	-0.020	0.303	0.524	1.000						
(5) lnppui	0.228	0.803	0.769	0.349	1.000					
(6) lninflation	0.132	-0.145	-0.178	-0.104	-0.120	1.000				
(7) lnfdi	0.756	0.286	0.246	0.058	0.207	0.078	1.000			
(8) lngdfc	0.965	0.269	0.272	-0.027	0.213	0.105	0.802	1.000		
(9) lnunemployment	-0.015	0.280	0.281	0.463	0.379	0.101	0.046	-0.013	1.000	
(10) lntradeopenness	-0.243	0.203	0.233	0.486	0.159	-0.144	0.018	-0.145	0.449	1.000

Source: Author's Computation using Data Collected from the World Bank and ITU database (2000 – 2022)

Table 2 above demonstrates the correlation coefficients of the study variables. However, the analysis indicates that, during the study period, the phone subscribers per 100 people (mps), Fixed-broadband subscriptions per 100 inhabitants (fbs), and percentage of persons using the Internet (ppui) are positively related to the real GDP. On the contrary, Fixed Telephone subscriptions per 100 people (fts) negatively affect real GDP. Therefore, the increase in the proxies of ICT, except the fixed telephone subscriptions, would positively impact economic growth in SSA. On the other hand, trade openness and unemployment rate negatively affect the real GDP in the SSA, while foreign direct investment, inflation, and gross fixed capital formation are positively related to the real GDP.

Empirical Results

Fixed Effects Model

The study's objective was to investigate the impact of ICT on economic growth in SSA. However, the study employed a fixed effects model to achieve the objective. The study estimated a fixed effect model for each variable of ICT and a general model involving all ICT variable proxies.

International Journal of Economics
ISSN 2518-8437 (Online)
Vol.10, Issue 1, No.1. pp 1 - 38, 2025
www.iprjb.org

Table 3: Fixed Effects Model

ICT Variable VARIABLES	(ln mps) lnrgdp	(ln fbs) lnrgdp	(ln fts) lnrgdp	(ln ppui) lnrgdp	(ALL) lnrgdp
lnmps	0.138***				0.149***
	(0.00773)				(0.0197)
lninflation	-0.00867	-0.00714	-0.0180*	-0.0103	-0.0114
	(0.00731)	(0.00824)	(0.00917)	(0.00766)	(0.00758)
lnfdi	0.0202***	0.0150**	0.0425***	0.0342***	0.0193***
	(0.00640)	(0.00734)	(0.00828)	(0.00660)	(0.00719)
lngdfc	0.472***	0.514***	0.696***	0.495***	0.437***
	(0.0176)	(0.0191)	(0.0151)	(0.0180)	(0.0205)
lnunemployment	0.0457*	0.0449*	0.0274	0.0363	0.0421*
	(0.0238)	(0.0255)	(0.0289)	(0.0248)	(0.0221)
lntradeopenness	-0.455***	-0.333***	-0.551***	-0.429***	-0.343***
	(0.0298)	(0.0336)	(0.0365)	(0.0348)	(0.0376)
lnfbs		0.0716***			0.0183***
		(0.00609)			(0.00687)
lnfts			-0.0258*		-0.0264*
			(0.0140)		(0.0143)
lnppui				0.118***	0.0132
				(0.00762)	(0.0115)
Constant	13.85***	13.26***	9.518***	13.26***	14.19***
	(0.336)	(0.375)	(0.286)	(0.347)	(0.411)
Observations	681	481	654	649	428
R-squared	0.905	0.834	0.865	0.904	0.885
Number of country_code	40	37	39	40	36

Notes: Standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1

Source: Author's Computation

Table 3 above demonstrates the estimated fixed effects models for the data collected between 2000 and 2022. In model 1, the coefficient of mobile phone subscribers per 100 people (0.138) indicates that, on average, a 1% increase in mobile phone subscribers per 100 people is associated with a 0.138% increase in real Gross Domestic Product. This coefficient is statistically significant at the 1% level, suggesting a strong positive relationship between mobile phone penetration and GDP. The coefficient of inflation (-0.00867) suggests that a 1% increase in inflation is associated with a decrease of 0.867% in real Gross Domestic Product, holding all other factors constant. However, this relationship is not statistically significant, implying that inflation may not be a robust predictor of GDP in this model.

The estimated coefficient of Foreign Direct Investment (0.0202) implies that FDI exhibits a statistically significant positive relationship with real Gross Domestic Product in SSA. The coefficient suggests that a 1% increase in FDI is associated with a 0.202% increase in real Gross Domestic Product, holding other variables constant. The coefficient of Gross Fixed Capital Formation (0.472) indicates that higher levels of gross fixed capital formation are associated with higher real Gross Domestic Product. Thus, as GFCF increases by 1%, the real GDP will increase by 47.2%, ceteris paribus. This coefficient is highly statistically significant, implying a strong positive relationship between capital formation and GDP.

In addition, the estimated coefficient of unemployment (0.0457) suggests that higher levels of unemployment are associated with higher real GDP, which contradicts economic intuition. However, this coefficient is only statistically significant at the 10% level, indicating a less

robust relationship. The estimated coefficient of trade openness indicates a strong negative relationship between trade openness and real GDP. A 1% increase in trade openness is associated with a decrease of 0.455% in real Gross Domestic Product, holding other factors constant. This coefficient is highly statistically significant.

In Model 2, the estimated coefficient of fixed-broadband subscriptions per 100 inhabitants suggests a positive relationship between fixed-broadband subscriptions and real GDP. A 1% increase in broadband subscriptions is associated with a 0.0716% increase in real GDP. This relationship is statistically significant at the 1% level. The estimated coefficient of inflation (-0.00714) suggests that, on average, a 1% increase in inflation is associated with a decrease of 0.714% in real GDP. However, this relationship is not statistically significant at conventional levels ($p > 0.05$). All control variables are statistically significant and positively related to the real GDP except Trade Openness, whose estimated coefficient (-0.333) indicates a negative relationship between trade openness and real GDP. A 1% increase in trade openness is associated with a decrease of 0.333% in real GDP. This relationship is highly statistically significant.

Similarly, in Model 3, all control variables are statistically significant and positively related to the real GDP except Trade Openness and inflation rate. The estimated coefficient of trade openness (-0.551) indicates a negative relationship between trade openness and real GDP. A 1% increase in trade openness is associated with a decrease of 55.1% in real GDP. This relationship is not statistically significant at a 5% significance level. The inflation coefficient indicates a negative impact on real GDP even though it is statistically significant at a 10% significance level.

Results from Model 4 suggest that a 1% increase in inflation is associated with a decrease of 1.03% in real GDP, holding all other factors constant. However, this relationship is not statistically significant at conventional levels ($p > 0.05$). The estimated Foreign Direct Investment (FDI) coefficient of 0.0342 exhibits a strong positive relationship with real GDP. Ceteris paribus, a 1% increase in FDI is associated with a 3.42% increase in real GDP. This relationship is highly statistically significant.

Moreover, the coefficient of (0.495) indicates a strong positive relationship between gross fixed capital formation and real GDP, such that a 1% increase in capital formation is associated with a 49.5% increase in real GDP. This relationship is highly statistically significant. The unemployment coefficient (0.0363) suggests that higher levels of unemployment are associated with higher real GDP. However, this relationship is not statistically significant at conventional levels ($p > 0.05$). Moreover, The coefficient (-0.429) indicates a negative relationship between trade openness and real GDP. A 1% increase in trade openness is associated with a decrease of 42.9% in real GDP. This relationship is highly statistically significant. Finally, the Percentage of Persons Using the Internet coefficient (0.118) suggests a positive relationship between Internet usage and real GDP. A 1% increase in internet usage is associated with an 11.8% increase in real GDP. This relationship is highly statistically significant.

The results of Model 5 in Table 3 above involve an estimation of a fixed effects model on all ICT variables. Based on the analysis, the coefficient of Mobile Phone Subscribers per 100 People suggests a positive relationship between mobile phone subscribers and real GDP. Such that, holding all other factors constant, a 1% increase in mobile phone subscribers is associated with a 14.9% increase in real GDP. This relationship is highly statistically significant. Additionally, the results indicate that a 1% increase in inflation is associated with a decrease

of 1.14% in real GDP, ceteris paribus, although the coefficient is not statistically significant at a 5% significance level ($p > 0.05$). Moreover, foreign direct investment exhibits a positive and statistically significant relationship with real GDP. A 1% increase in FDI is associated with a 1.93% increase in real GDP.

The Gross Fixed Capital Formation coefficient indicates a positive and statistically significant relationship between gross fixed capital formation and real GDP. A 1% increase in capital formation is associated with a 43.7% increase in real GDP, holding all other factors constant. The unemployment coefficient (0.0421) suggests that higher levels of unemployment are associated with higher real GDP. However, this relationship is only marginally significant ($p < 0.1$). Trade Openness indicates a statistically significant negative relationship between trade openness and real GDP. A 1% increase in trade openness is associated with a decrease of 34.3% in real GDP.

Fixed-broadband subscriptions per 100 Inhabitants exhibit a positive relationship between fixed-broadband subscriptions and real GDP. A 1% increase in fixed-broadband subscriptions is associated with a 1.83% increase in real GDP. This relationship is highly statistically significant. Fixed Telephone Subscriptions per 100 People coefficient (-0.0264) suggests a negative relationship between fixed telephone subscriptions and real GDP. A 1% increase in fixed telephone subscriptions is associated with a 2.64% decrease in real GDP. This relationship is statistically significant at conventional levels. However, this negative relationship could be associated with a shift towards mobile phone usage and the declining importance of fixed phone lines. Percentage of Persons Using the Internet coefficient (0.0132) suggests a positive relationship between Internet usage and real GDP. A 1% increase in internet usage is associated with a 1.32% increase in real GDP. However, this relationship is not statistically significant at conventional levels.

In addition, the study conducted a fixed effects model controlling for time-specific effects to investigate whether there has been a gradual change in ICT impact (see Appendix 4 & 5). Based on the analysis, there has been an Economic growth related to ICT between 2000 and 2022. This could be associated with the significant investment in ICT diffusion channels over the years.

Discussion

The study's primary objective was to investigate the impact of Information and Communication Technology (ICT) on economic growth in Subsaharan Africa (SSA) countries between 2000 and 2022. However, data on ICT, economic growth, and control variables were collected from the World Bank and ITU databases to achieve the study's objective. A fixed effect model was employed to estimate the effect size of ICT on economic growth. However, the findings derived from the models and supported by a thorough literature review shed light on the complex interplay between ICT variables and their impact on real Gross Domestic Product.

One of the key findings of the study is the consistently positive association between mobile phone penetration and GDP across all models. This shows the pivotal role of mobile technology in driving economic activity and fostering financial inclusion in SSA. As highlighted in the literature, mobile phones have become universal in the region, enabling access to financial services, facilitating communication, and enhancing productivity (Cariolle, 2021; Burns, 2018). The study's findings validate these observations, emphasizing the transformative impact of mobile technology on SSA's economic landscape.

Moreover, the study highlights the positive impact of ICT variables on real GDP, such as fixed-broadband subscriptions, fixed telephone subscriptions, and internet usage. These findings underscore the transformative potential of ICT in driving productivity gains, fostering innovation, and enhancing connectivity across sectors in SSA. Access to ICT infrastructure enables businesses to access global markets, facilitates knowledge transfer, and empowers individuals with information and digital skills, thereby driving economic growth and development (Awad & Albaity, 2022). The study's findings emphasize the importance of continued investments in ICT infrastructure and digital literacy initiatives to unlock the full economic potential of SSA countries.

Another notable finding is the mixed impact of inflation on real GDP. While some models suggest a negative relationship between inflation and GDP, the coefficients are not statistically significant at conventional levels. This ambiguity regarding the inflation-GDP nexus underscores the complex macroeconomic dynamics in SSA countries. Factors such as exchange rate fluctuations, supply-side constraints, and monetary policy effectiveness may influence the inflation-GDP relationship, warranting further investigation (Verma, Dandgawhal & Giri, 2023).

Furthermore, the study highlights the positive influence of Foreign Direct Investment (FDI) and Gross Fixed Capital Formation (GFCF) on real GDP. These findings demonstrate the importance of foreign capital inflows and domestic investment in driving economic growth and infrastructure development in SSA. Foreign Direct Investment plays a crucial role in financing infrastructure projects, promoting technology transfer, and stimulating job creation, while GFCF contributes to productivity improvements and capacity expansion (Andrianaivo & Kpodar, 2011; Xia, Baghaie & Sajadi, 2023). The study's findings demonstrate the significance of these investment flows in driving sustainable economic development in the region.

Additionally, the study identifies a negative relationship between trade openness and real GDP, suggesting that increased trade integration may lead to decreased GDP in SSA countries. This finding demonstrates the challenges associated with trade liberalization and globalization in the SSA context, where factors such as export concentration, terms of trade volatility, and vulnerability to external shocks may dampen the benefits of trade openness (Sassi & Goaied, 2013). The result finding points that policymakers must formulate trade policies that balance the benefits of market access with protecting and nurturing domestic industries. Strategies such as export diversification, support for small and medium enterprises (SMEs), and promoting value addition to raw materials can help mitigate the adverse effects of trade openness. Additionally, regional trade agreements should be strengthened to ensure equitable gains from trade within the SSA context.

Conclusions and Policy Recommendations

In conclusion, the study provides valuable insights into the relationship between Information and Communication Technology (ICT), telecommunication infrastructure, and economic growth in Subsaharan Africa (SSA). The findings demonstrate the transformative potential of ICT in driving economic development and fostering inclusive growth in the region. Despite the challenges and nuances inherent in the SSA context, such as inflationary pressures, trade dynamics, and investment constraints, ICT enables productivity gains, innovation, and connectivity across sectors.

The positive association between mobile phone penetration, Foreign Direct Investment (FDI), and Gross Fixed Capital Formation (GFCF) with real Gross Domestic Product (GDP)

highlights the importance of investment in digital infrastructure and technology-driven innovation for stimulating economic activity and improving living standards in SSA countries. However, the study also identifies challenges, such as trade openness negative impact on GDP and the mixed effects of inflation, underscoring the need for tailored policy interventions and strategic investments to harness the full potential of ICT for sustainable development.

Based on the study findings, several recommendations can be made to policymakers, investors, and development practitioners seeking to leverage ICT for economic growth and development in SSA. The negative relationship between trade openness and GDP signals the need for cautious trade policy reform. Policymakers should focus on export diversification to reduce dependency on a narrow range of commodities, and support local industries to enhance value addition. Trade facilitation measures should be balanced with protections for nascent industries, ensuring that SSA countries reap the benefits of trade liberalization without compromising domestic economic stability.

Investment in human capital development is another crucial recommendation. Digital literacy programs and vocational training tailored to ICT-related skills can empower individuals to leverage technology effectively, fostering inclusivity and boosting productivity. This aligns with the study's findings that ICT adoption can drive growth when combined with an adequately skilled workforce.

Public-Private Partnerships (PPPs) can accelerate the deployment of ICT infrastructure and foster innovation by leveraging the strengths of both public and private sectors. These partnerships should be encouraged to address funding and resource gaps, particularly in rural and underserved areas.

While the study provides robust insights, further research is necessary to refine these policy recommendations. Longitudinal studies could investigate the sustainability of ICT-driven economic growth, examining trends over extended periods to understand long-term impacts. Future research could also address sector-specific impacts of ICT adoption, analyzing how industries such as agriculture, healthcare, education, and manufacturing are uniquely influenced by technological advancements. This would help uncover targeted strategies to maximize ICT benefits across diverse economic sectors.

REFERENCES

Aghion, P., Howitt, P., Brant-Collett, M., & García-Peñalosa, C. (1998). *Endogenous growth theory*. MIT press.

Ahishakiye, D., & Pacifi Nizeyimana. (2024). Enhancing Digital Literacy Performance in Rwanda Using Machine Learning: A Case Study of Irembo. *Journal of Intelligent Learning Systems and Applications*, *16*(04), 430–447. https://doi.org/10.4236/jilsa.2024.164022

Gupta, M., Gao, J., Aggarwal, C. C., & Han, J. (2013). Outlier detection for temporal data: A survey. *IEEE Transactions on Knowledge and data Engineering*, *26*(9), 2250-2267.

Knief, U., & Forstmeier, W. (2021). Violating the normality assumption may be the lesser of two evils. *Behavior Research Methods*, *53*(6), 2576-2590.

Abeka, M. J., Andoh, E., Gatsi, J. G., & Kawor, S. (2021). Financial development and economic growth nexus in SSA economies: The moderating role of telecommunication development. *Cogent Economics & Finance*, *9*(1), 1862395.

Aghaei, M., & Rezagholizadeh, M. (2017). The impact of information and communication technology (ICT) on economic growth in the OIC Countries. *Economic and Environmental Studies*, *17*(2 (42)), 257-278.

Agyire-Tettey, F. (2015). *Adoption, returns and variation of information and communication technology in sub-Sahara Africa* (Doctoral dissertation, University of Nottingham).

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.

Andrianaivo, M., & Kpodar, K. (2011, April). *ICT, financial inclusion, and growth: Evidence from African countries*.

Ariani, A., Koesoema, A. P., & Soegijoko, S. (2017). Innovative healthcare applications of ICT for developing countries. *Innovative healthcare systems for the 21st Century*, 15-70.

Awad, A., & Albaity, M. (2022). ICT and economic growth in Subsaharan Africa: Transmission channels and effects. *Telecommunications Policy*, *46*(8), 102381.

Badran, M. F. (2021). Digital platforms in Africa: A case-study of Jumia Egypt's digital platform. *Telecommunications Policy*, *45*(3), 102077.

Bahrini, R., & Qaffas, A. A. (2019). Impact of information and communication technology on economic growth: Evidence from developing countries. *Economies*, *7*(1), 21.

Brüderl, J., & Ludwig, V. (2015). Fixed-effects panel regression. *The Sage handbook of regression analysis and causal inference*, 327-357.

Burns, H. (2021). A Smart City Masterplan, Kigali. *Urban Planning for Transitions*, 153-169.

Burns, S. (2018). M-Pesa and the 'market-led'approach to financial inclusion. *Economic Affairs*, *38*(3), 406-421.

Cariolle, J. (2021). International connectivity and the digital divide in Subsaharan Africa. *Information Economics and Policy*, *55*, 100901.

Chavula, H. K. (2013). Telecommunications development and economic growth in Africa. *Information Technology for Development*, *19*(1), 5-23.

Dewan, S., & Kraemer, K. L. (2000). Information technology and productivity: Evidence from country-level data. *Management science*, *46*(4), 548-562.

Domingo, E., Arnold, S., & Apiko, P. (2023). Interoperability of digital payment systems: Lessons from the East African Community.

Ebbes, P., Böckenholt, U., & Wedel, M. (2004). Regressor and random-effects dependencies in multilevel models. *Statistica Neerlandica*, *58*(2), 161-178.

Essien, E. O., Odejide, G. S., & Henrietta, A. (2024). A Paradigmatic Discourse on the Correlation between Investing in Artificial Intelligence, Effective Communication and National Transformation. *Int. J. Adv. Multidiscip. Res*, *11*(1), 1-11.

Freeman, C., & Soete, L. (2009). Developing science, technology and innovation indicators: What we can learn from the past. *Research policy*, *38*(4), 583-589.

GSMA Report. (2023). The Mobile Economy Subsaharan Africa 2023. Retrieved from: https://www.gsma.com/mobileeconomy/wp-content/uploads/2023/10/20231017-GSMA-Mobile-Economy-Sub-Saharan-Africa-report.pdf

Gyan, N. B. (2016). The Web, Speech Technologies and Rural Development in West Africa An ICT4D Approach.

Kouladoum, J. C. (2023). Digital infrastructural development and inclusive growth in Subsaharan Africa. *Journal of Social and Economic Development*, 1-25.

Kubuga, K. K., Ayoung, D. A., & Bekoe, S. (2021). Ghana's ICT4AD policy: between policy and reality. *Digital Policy, Regulation and Governance*, *23*(2), 132-153.

Lee, S. H., Levendis, J., & Gutierrez, L. (2012). Telecommunications and economic growth: An empirical analysis of subsaharan Africa. *Applied economics*, *44*(4), 461-469.

Mateko, F. M. (2022). *Nexus between ICT diffusion and poverty level In Subsaharan African (SSA) countries* (Doctoral dissertation, North-West University (South Africa)).

May, J. D., & Denny, M. (1979). Factor-augmenting technical progress and productivity in US manufacturing. *International Economic Review*, 759-774.

McCulloch, N., Balchin, N., Mendez-Parra, M., & Onyeka, K. (2017). Local content policies and backward integration in Nigeria. *ODI SET Paper. https://set. odi. org/local-content-backwardintegration-in-nigeria*.

Mhlanga, D. (2021). Artificial intelligence in the industry 4.0, and its impact on poverty, innovation, infrastructure development, and the sustainable development goals: Lessons from emerging economies?. *Sustainability*, *13*(11), 5788.

Michel, R. O. G. Y. (2005). Broadband Technologies and Services in Sub Saharan Africa. *Technological convergence and regulation*, 95.

moict. (2020). *Home page*. Ministry of Information, Communications and the Digital Economy. https://ict.go.ke/

Mwapwele, S. D., Marais, M., Dlamini, S., & Van Biljon, J. (2019). Teachers' ICT adoption in South African rural schools: a study of technology readiness and implications for the South Africa connect broadband policy. *The African Journal of Information and Communication*, *24*, 1-21.

Ntakirutimana, T., Aguirre-Bastos, C., & Mugabo, L. R. Home-grown initiatives for sustainable development in Rwanda.

NTIBREY, R. L. L. (2012). MINI PROJECT ICT STRATEGIES OF GHANA–The role of policies and regulations REV. LAMBERT LK NTIBREY.

Nwokolo, S. C., Eyime, E. E., Obiwulu, A. U., & Ogbulezie, J. C. (2023). Africa's Path to Sustainability: Harnessing Technology, Policy, and Collaboration. *Trends in Renewable Energy*, *10*(1), 98-131.

Oughton, E. J., Comini, N., Foster, V., & Hall, J. W. (2022). Policy choices can help keep 4G and 5G universal broadband affordable. *Technological Forecasting and Social Change*, *176*, 121409.

Papaioannou, S. K., & Dimelis, S. P. (2007). Information technology as a factor of economic development: Evidence from developed and developing countries. *Economics of Innovation and New Technology*, *16*(3), 179-194.

Pyka, Andreas, and Esben Sloth Andersen. (2012). Introduction: Long term economic development: Demand, finance, organization, policy and innovation in a schumpeterian perspective. Journal of Evolutionary Economics 22: 621–25.

Quah, D. (2002). Technology dissemination and economic growth: Some lessons for the new economy. *Technology and the new economy*, *3*, 95-156.

Romer, P. M. (1986). Increasing returns and long-run growth. *Journal of political economy*, *94*(5), 1002-1037.

Sassi, S., & Goaied, M. (2013). Financial development, ICT diffusion and economic growth: Lessons from MENA region. *Telecommunications Policy*, *37*(4-5), 252-261.

Schumpeter, Joseph A. 1934. The Theory of Economic Development. Cambridge: Harvard University Press.

Solow, R. M. (1956). A contribution to the theory of economic growth. *The quarterly journal of economics*, *70*(1), 65-94.

Ssempebwa, J., & Lubuulwa, M. (2011, May). E-government for development: Implementation challenges of Uganda's national backbone infrastructure project and key lessons. In *2011 IST-Africa Conference Proceedings* (pp. 1-9). IEEE.

Vu, K. M., & Asongu, S. (2020). Backwardness advantage and economic growth in the information age: A cross-country empirical study. *Technological Forecasting and Social Change*, *159*, 120197.

Xia, L., Baghaie, S., & Sajadi, S. M. (2023). The digital economy: Challenges and opportunities in the new era of technology and electronic communications. *Ain Shams Engineering Journal*, 102411.

Yousefi, A. (2011). The impact of information and communication technology on economic growth: Evidence from developed and developing countries. *Economics of Innovation and New Technology*, *20*(6), 581-596.

International Journal of Economics
ISSN 2518-8437 (Online)
Vol.10, Issue 1, No.1. pp 1 - 38, 2025
www.iprjb.org

APPENDICES

Appendix 1: Shapiro-Wilk W Test for Normality

Variable	Obs	W	V	z	Prob>z
lnrgdp	1,065	0.986	9.195	5.508	0.000
lnmps	1,066	0.852	98.976	11.408	0.000
lnfbs	701	0.986	6.492	4.564	0.000
lnfts	1,025	0.989	6.807	4.754	0.000
lnppui	1,012	0.969	20.087	7.433	0.000
lninflation	924	0.962	22.144	7.646	0.000
lnfdi	1,024	0.960	25.472	8.025	0.000
lngdfc	894	0.991	4.848	3.891	0.000
lnunemploy~t	1,082	0.968	21.528	7.625	0.000
lntradeope~s	924	0.978	13.099	6.350	0.000

Appendix 2: Correlation Matrix: Test for Multicollinearity

Variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
(1) lnmps	1.000								
(2) lnfbs	0.705	1.000							
(3) lnfts	0.303	0.524	1.000						
(4) lnppui	0.803	0.769	0.349	1.000					
(5) lninflation	-0.145	-0.178	-0.104	-0.120	1.000				
(6) lnfdi	0.286	0.246	0.058	0.207	0.078	1.000			
(7) lngdfc	0.269	0.272	-0.027	0.213	0.105	0.802	1.000		
(8) lnunemployment	0.280	0.281	0.463	0.379	0.101	0.046	-0.013	1.000	
(9) lntradeopenness	0.203	0.233	0.486	0.159	-0.144	0.018	-0.145	0.449	1.000

International Journal of Economics
ISSN 2518-8437 (Online)
Vol.10, Issue 1, No.1. pp 1 - 38, 2025
www.iprjb.org

Appendix 3: Summary Statistics

Total	mean	max	min	skewness	sd
realgdp (Billion)	68.23	136.00	8.94	0.10	38.85
mps	32.48	67.37	0.16	-0.45	20.82
fbs	0.17	0.55	0.00	0.61	0.17
fts	0.64	1.35	0.26	0.98	0.30
ppui	11.17	32.60	0.00	0.65	12.71
inflation	43.99	325.00	0.00	2.94	71.79
fdi (Billion)	-0.87	10.03	-7.40	0.39	4.18
gdfc (Billion)	18.30	37.39	0.00	0.08	11.37
unemployment	16.29	16.77	14.48	-2.52	0.48
tradeopenness	79.53	122.45	0.00	-1.04	32.87
Benin					
realgdp (Billion)	10.29	17.69	3.52	0.00	4.21
mps	55.03	108.97	0.79	-0.37	38.20
fbs	0.26	0.67	0.01	0.69	0.17
fts	0.97	1.84	0.01	-0.17	0.54
ppui	7.95	33.97	0.00	1.33	9.94
inflation	2.22	7.95	-0.79	0.90	2.28
fdi (Billion)	0.13	0.41	-0.04	0.43	0.14
gdfc (Billion)	2.18	6.35	0.56	1.14	1.54
unemployment	1.37	2.65	0.69	0.58	0.57
tradeopenness	50.51	65.27	39.10	0.39	8.02
Botswana					
realgdp (Billion)	12.54	20.36	5.44	-0.15	4.23
mps	98.99	165.30	12.87	-0.40	56.45
fbs	1.46	4.20	0.08	0.87	1.22
fts	6.65	8.41	3.49	-1.15	1.25
ppui	22.89	73.50	0.00	0.90	24.93
inflation	6.81	12.70	1.89	0.10	3.03
fdi (Billion)	0.25	0.52	-0.32	-0.77	0.20
gdfc (Billion)	3.61	5.91	1.64	-0.05	1.28
unemployment	19.29	23.80	15.88	0.49	2.30
tradeopenness	94.69	125.78	77.66	1.11	12.35
Burkina Faso					
realgdp (Billion)	10.79	19.64	2.97	0.02	5.10
mps	43.55	111.66	0.00	0.30	40.00
fbs	0.06	0.09	0.00	-1.15	0.03
fts	0.58	0.97	0.00	-0.14	0.25
ppui	4.35	21.58	0.00	1.69	5.36
inflation	2.50	14.29	-3.23	1.62	3.81
fdi (Billion)	0.12	0.49	-0.10	0.91	0.16
gdfc (Billion)	2.09	3.45	0.43	-0.37	1.06

unemployment	3.98	5.36	2.72	-0.02	0.79
tradeopenness	48.64	64.85	30.37	-0.20	13.33
Burundi					
realgdp (Billion)	1.99	3.34	0.78	-0.18	0.83
mps	25.13	61.67	0.26	0.33	23.38
fbs	0.01	0.04	0.00	0.35	0.02
fts	0.27	0.39	0.12	-0.17	0.09
ppui	1.41	5.80	0.00	1.54	1.40
inflation	9.36	24.43	-2.81	0.50	7.27
fdi (Billion)	0.01	0.12	0.00	2.60	0.03
gdfc (Billion)	0.26	0.45	0.02	-0.60	0.13
unemployment	1.99	3.29	0.91	0.54	0.90
tradeopenness	32.47	47.20	20.96	0.27	8.90
Cabo Verde					
realgdp (Billion)	1.61	2.25	0.54	-0.78	0.58
mps	64.57	112.32	4.31	-0.31	40.99
fbs	2.31	5.75	0.00	0.05	1.83
fts	12.61	14.94	9.32	-0.36	1.87
ppui	28.39	69.76	0.00	0.31	23.68
inflation	1.85	7.93	-2.48	0.63	2.59
fdi (Billion)	0.10	0.21	0.01	0.12	0.05
gdfc (Billion)	0.46	0.92	0.00	-0.41	0.33
unemployment	12.67	14.59	10.67	-0.24	1.06
tradeopenness	94.20	117.82	78.39	0.31	9.47
Cameroon					
realgdp (Billion)	28.62	44.99	10.57	-0.26	10.45
mps	47.97	84.37	0.68	-0.25	32.02
fbs	0.60	2.73	0.00	1.09	0.92
fts	2.49	5.18	0.58	-0.05	1.53
ppui	12.11	45.60	0.00	1.19	14.77
inflation	2.40	6.25	0.23	0.87	1.60
fdi (Billion)	0.51	1.03	-0.01	-0.27	0.32
gdfc (Billion)	5.34	8.16	1.82	-0.32	1.97
unemployment	4.35	7.52	3.06	1.57	1.29
tradeopenness	45.43	56.92	33.74	-0.05	5.75
Central African Republic					
realgdp (Billion)	1.82	2.52	0.92	-0.38	0.52
mps	15.84	34.27	0.00	-0.13	12.43
fbs	0.01	0.04	0.00	2.10	0.01
fts	0.08	0.25	0.00	0.98	0.10
ppui	2.52	10.58	0.00	1.43	2.93
inflation	3.96	14.90	-2.07	1.41	3.39
fdi (Billion)	0.02	0.12	0.00	1.71	0.03

gdfc (Billion)	0.31	0.64	0.07	0.30	0.20
unemployment	5.89	6.81	5.54	1.48	0.33
tradeopenness	41.69	57.14	31.49	0.44	7.92
Chad					
realgdp (Billion)	8.94	13.94	1.39	-0.86	3.90
mps	26.33	68.20	0.07	0.18	21.42
fbs	0.03	0.15	0.00	1.59	0.05
fts	0.17	0.51	0.03	1.11	0.13
ppui	3.44	17.87	0.00	1.79	4.51
inflation	2.86	12.43	-8.97	-0.20	5.29
fdi (Billion)	0.34	0.92	-0.68	-1.17	0.38
gdfc (Billion)	2.30	4.71	0.32	0.30	1.09
unemployment	0.93	1.68	0.63	1.53	0.27
tradeopenness	79.87	126.35	51.57	1.14	14.91
Comoros					
realgdp (Billion)	0.90	1.30	0.35	-0.54	0.29
mps	38.05	103.87	0.00	0.48	34.84
fbs	0.10	0.22	0.00	0.14	0.10
fts	2.49	4.79	0.88	0.32	1.19
ppui	5.89	27.34	0.00	1.80	7.00
inflation	1.80	6.31	-4.29	-0.19	2.51
fdi (Billion)	0.01	0.02	0.00	2.05	0.01
gdfc (Billion)	0.14	0.18	0.06	-0.80	0.04
unemployment	4.80	5.86	4.29	1.46	0.43
tradeopenness	38.29	47.78	33.16	0.89	3.43
Congo, Dem. Rep.					
realgdp (Billion)	28.81	64.72	7.44	0.49	16.71
mps	24.75	50.34	0.03	0.01	18.75
fbs	0.01	0.03	0.00	1.93	0.01
fts	0.02	0.08	0.00	1.12	0.03
ppui	4.51	22.90	0.00	1.70	7.18
inflation	44.85	513.91	0.00	3.08	126.17
fdi (Billion)	1.14	2.89	-0.24	0.20	0.85
gdfc (Billion)	5.65	15.23	0.50	0.50	4.21
unemployment	4.08	5.51	2.95	0.11	0.77
tradeopenness	63.53	95.16	25.04	-0.41	19.78
Congo, Rep.					
realgdp (Billion)	10.89	17.96	2.80	-0.30	5.01
mps	58.98	104.57	0.00	-0.32	41.09
fbs	0.02	0.26	0.00	4.29	0.05
fts	0.32	0.70	0.00	0.26	0.18
ppui	3.11	8.65	0.00	0.42	3.15
inflation	2.45	6.54	-0.88	0.14	1.95
fdi (Billion)	1.06	4.42	-1.98	0.61	1.68

gdfc (Billion)	4.41	9.55	0.71	0.30	2.87
unemployment	20.26	22.67	19.20	1.49	0.93
tradeopenness	115.80	156.86	69.31	-0.21	21.65
Côte d'Ivoire					
realgdp (Billion)	39.64	71.81	16.58	0.37	17.10
mps	75.84	174.03	2.82	0.13	56.30
fbs	0.34	1.35	0.00	1.03	0.43
fts	1.30	1.84	0.94	0.68	0.24
ppui	14.59	45.43	0.23	0.78	17.79
inflation	2.37	6.31	-1.11	0.35	1.82
fdi (Billion)	0.53	1.58	0.17	1.71	0.36
gdfc (Billion)	7.92	17.69	2.17	0.39	4.63
unemployment	4.75	7.22	1.90	-0.21	1.84
tradeopenness	55.85	70.30	41.11	-0.01	8.11
Equatorial Guinea					
realgdp (Billion)	12.01	22.39	1.05	-0.08	6.70
mps	28.15	53.34	0.73	-0.30	17.42
fbs	0.10	0.30	0.00	0.89	0.10
fts	0.99	1.27	0.68	-0.16	0.22
ppui	13.25	53.92	0.00	1.35	17.70
inflation	4.19	8.83	-0.10	0.08	2.43
fdi (Billion)	0.65	2.73	-0.79	1.12	0.72
gdfc (Billion)	2.87	9.21	0.00	0.58	2.88
unemployment	8.31	9.19	8.04	2.05	0.28
tradeopenness	85.38	144.67	0.00	-0.98	48.81
Eritrea					
realgdp (Billion)	0.64	2.07	0.00	0.52	0.70
mps	10.83	50.65	0.00	1.72	15.22
fbs	0.02	0.14	0.00	2.23	0.04
fts	1.49	1.98	0.00	-1.77	0.54
ppui	2.36	21.73	0.00	2.73	5.36
inflation	0.00	0.00	0.00	.	0.00
fdi (Billion)	0.03	0.09	-0.06	-0.46	0.04
gdfc (Billion)	0.11	0.27	0.00	0.10	0.11
unemployment	6.01	6.51	5.84	2.13	0.16
tradeopenness	27.85	76.59	0.00	0.39	30.12
Eswatini					
realgdp (Billion)	3.68	4.89	1.43	-0.80	1.10
mps	60.05	122.17	3.20	-0.16	38.42
fbs	0.70	2.58	0.00	1.06	0.89
fts	3.97	6.86	3.09	2.27	0.77
ppui	19.10	58.91	0.00	0.86	19.22
inflation	5.93	12.66	0.00	0.15	3.52
fdi (Billion)	0.05	0.14	-0.06	-0.48	0.06

gdfc (Billion)	0.53	0.66	0.31	-0.95	0.09
unemployment	25.19	28.24	22.54	0.02	1.92
tradeopenness	109.52	175.80	79.67	1.01	31.05
Ethiopia					
realgdp (Billion)	48.04	126.80	7.85	0.63	37.98
mps	18.40	56.02	0.00	0.56	20.07
fbs	0.13	0.53	0.00	1.09	0.20
fts	0.79	1.10	0.00	-1.07	0.28
ppui	5.62	16.70	0.00	0.71	7.06
inflation	13.89	44.36	-8.24	0.76	12.11
fdi (Billion)	1.50	4.26	0.11	0.71	1.52
gdfc (Billion)	13.41	33.82	0.00	0.27	14.26
unemployment	2.74	3.93	2.25	1.01	0.53
tradeopenness	18.10	48.23	0.00	0.20	18.66
Gabon					
realgdp (Billion)	13.44	21.07	5.02	-0.44	4.91
mps	94.72	149.11	9.43	-0.56	49.27
fbs	0.63	3.36	0.00	1.95	0.89
fts	1.75	3.06	0.91	0.35	0.75
ppui	25.30	71.75	0.00	0.67	25.54
inflation	2.12	5.26	-1.41	0.16	1.83
fdi (Billion)	0.74	1.72	-0.10	0.21	0.56
gdfc (Billion)	3.25	6.40	1.11	0.16	1.37
unemployment	19.27	21.43	16.91	-0.31	1.38
tradeopenness	82.10	101.70	70.06	0.33	8.24
Gambia					
realgdp (Billion)	1.34	2.19	0.49	-0.19	0.44
mps	63.78	130.12	0.00	-0.12	46.18
fbs	0.07	0.20	0.00	0.68	0.08
fts	2.32	3.11	0.00	-2.14	0.65
ppui	12.20	32.96	0.00	0.68	10.36
inflation	6.64	17.03	0.84	1.34	3.59
fdi (Billion)	0.08	0.25	0.02	1.92	0.06
gdfc (Billion)	0.25	0.74	0.04	1.10	0.18
unemployment	8.14	10.45	4.04	-0.73	2.41
tradeopenness	49.39	68.86	35.34	0.56	8.09
Ghana					
realgdp (Billion)	39.11	79.52	4.98	0.03	25.29
mps	71.64	132.60	0.66	-0.23	51.28
fbs	0.17	0.62	0.00	1.01	0.15
fts	1.10	1.59	0.59	0.40	0.24
ppui	16.76	68.20	0.00	1.21	20.17
inflation	16.67	41.51	7.14	1.47	9.81

fdi (Billion)	2.01	3.88	0.06	-0.37	1.37
gdfc (Billion)	7.87	15.56	1.20	0.16	5.36
unemployment	5.27	10.46	2.17	0.88	2.20
tradeopenness	79.51	116.05	60.76	0.79	16.50
Guinea					
realgdp (Billion)	8.07	21.00	2.83	1.03	4.72
mps	45.88	104.47	0.00	0.18	41.34
fbs	0.01	0.01	0.00	0.09	0.01
fts	0.13	0.30	0.00	0.07	0.14
ppui	7.49	34.68	0.00	1.34	10.56
inflation	11.46	34.70	0.00	0.82	9.53
fdi (Billion)	0.28	1.62	-0.07	2.00	0.39
gdfc (Billion)	2.07	6.26	0.43	1.25	1.54
unemployment	5.06	6.06	4.55	1.11	0.39
tradeopenness	78.18	115.04	50.44	0.42	19.57
Guinea-Bissau					
realgdp (Billion)	0.96	1.64	0.37	0.16	0.41
mps	47.21	125.93	0.00	0.26	37.84
fbs	0.05	0.22	0.00	1.34	0.06
fts	0.27	0.90	0.00	0.74	0.35
ppui	7.23	35.15	0.00	1.65	9.78
inflation	2.56	10.46	-3.50	0.81	3.37
fdi (Billion)	0.02	0.07	0.00	2.15	0.01
gdfc (Billion)	0.09	0.29	0.00	1.39	0.08
unemployment	3.32	3.81	3.12	1.82	0.19
tradeopenness	45.73	60.85	0.00	-2.09	15.82
Kenya					
realgdp (Billion)	54.20	113.40	12.71	0.31	33.91
mps	57.78	122.79	0.41	0.02	41.56
fbs	0.35	1.49	0.00	1.40	0.50
fts	0.65	1.65	0.12	0.52	0.48
ppui	10.17	28.76	0.00	0.61	8.71
inflation	8.66	26.24	1.96	2.03	4.91
fdi (Billion)	0.49	1.45	0.01	0.82	0.47
gdfc (Billion)	11.00	22.37	1.99	0.11	6.98
unemployment	3.38	5.69	2.62	1.45	1.06
tradeopenness	46.88	64.48	27.24	-0.34	10.93
Lesotho					
realgdp (Billion)	1.93	2.58	0.78	-0.82	0.57
mps	52.13	109.68	1.08	0.04	37.24
fbs	0.10	0.39	0.00	1.14	0.12
fts	1.58	2.69	0.29	-0.42	0.80
ppui	15.21	47.98	0.00	0.79	17.07

inflation	5.03	33.81	-16.86	0.72	8.65
fdi (Billion)	0.05	0.21	-0.01	1.94	0.04
gdfc (Billion)	0.44	0.89	0.00	-0.50	0.32
unemployment	16.32	18.46	15.56	2.09	0.74
tradeopenness	101.04	165.05	0.00	-0.79	68.93
Liberia					
realgdp (Billion)	2.27	4.00	0.75	-0.10	1.12
mps	28.66	79.18	0.00	0.39	26.41
fbs	0.07	0.26	0.00	0.96	0.10
fts	0.12	0.32	0.00	0.19	0.10
ppui	7.18	33.63	0.00	1.33	10.24
inflation	7.80	23.56	0.00	0.51	6.05
fdi (Billion)	0.50	2.31	0.00	1.64	0.77
gdfc (Billion)	0.00	0.00	0.00	.	0.00
unemployment	2.57	4.12	1.93	1.30	0.60
tradeopenness	0.00	0.00	0.00	.	0.00
Madagascar					
realgdp (Billion)	10.14	15.30	4.63	-0.31	3.46
mps	28.01	70.18	0.39	0.04	21.00
fbs	0.06	0.16	0.00	0.23	0.06
fts	0.46	0.88	0.09	-0.03	0.22
ppui	3.86	19.73	0.00	1.81	5.11
inflation	8.56	18.36	-1.70	0.24	4.15
fdi (Billion)	0.47	1.29	0.01	0.60	0.36
gdfc (Billion)	2.07	4.16	0.55	0.16	0.97
unemployment	2.91	5.80	0.60	0.57	1.52
tradeopenness	57.29	74.36	34.03	-0.59	9.72
Malawi					
realgdp (Billion)	8.10	13.16	2.50	-0.19	3.03
mps	24.95	60.13	0.44	0.21	20.41
fbs	0.03	0.07	0.00	0.40	0.03
fts	0.53	1.46	0.05	0.46	0.46
ppui	4.77	24.41	0.00	1.81	6.39
inflation	15.03	29.58	7.41	0.61	7.00
fdi (Billion)	0.16	0.81	-0.01	2.07	0.20
gdfc (Billion)	0.00	0.00	0.00	.	0.00
unemployment	5.04	5.76	4.66	1.33	0.28
tradeopenness	0.00	0.00	0.00	.	0.00
Mali					
realgdp (Billion)	11.22	19.31	2.96	-0.11	5.20
mps	63.56	133.92	0.09	-0.06	52.12
fbs	0.19	1.15	0.00	1.67	0.33
fts	0.80	1.37	0.35	0.54	0.32

ppui	7.54	34.49	0.00	1.31	10.35
inflation	2.16	9.62	-3.10	0.67	3.38
fdi (Billion)	0.33	0.86	-0.01	0.56	0.22
gdfc (Billion)	2.34	4.21	0.51	-0.13	1.10
unemployment	1.68	3.53	1.20	2.07	0.60
tradeopenness	60.08	68.83	50.52	0.02	4.71
Mauritania					
realgdp (Billion)	5.47	9.78	1.75	-0.16	2.47
mps	71.52	141.11	0.57	-0.33	43.82
fbs	0.17	0.42	0.00	0.07	0.13
fts	1.43	2.36	0.70	0.80	0.42
ppui	12.87	58.76	0.00	1.41	18.16
inflation	5.00	12.13	1.47	1.04	2.80
fdi (Billion)	0.45	1.39	-0.88	-0.30	0.50
gdfc (Billion)	2.02	3.75	0.17	-0.16	1.19
unemployment	10.12	11.33	9.14	0.48	0.52
tradeopenness	83.82	110.79	55.32	-0.42	15.20
Mauritius					
realgdp (Billion)	9.97	14.74	4.61	-0.34	3.29
mps	96.74	161.36	14.80	-0.31	47.43
fbs	10.49	25.73	0.00	0.35	9.40
fts	29.80	36.88	23.10	0.52	3.58
ppui	32.29	67.58	0.00	0.25	21.01
inflation	4.63	10.77	0.41	0.73	2.77
fdi (Billion)	0.28	0.59	-0.03	-0.22	0.17
gdfc (Billion)	2.13	2.85	0.96	-0.60	0.59
unemployment	7.75	9.52	6.32	0.21	0.94
tradeopenness	111.46	129.78	85.83	-0.41	11.10
Mozambique					
realgdp (Billion)	12.40	18.41	5.65	-0.30	4.10
mps	30.89	75.01	0.29	0.15	22.77
fbs	0.10	0.24	0.00	0.16	0.09
fts	0.33	0.48	0.09	-0.67	0.09
ppui	4.97	17.37	0.00	1.11	5.34
inflation	6.19	17.42	0.00	0.58	5.51
fdi (Billion)	2.24	6.70	0.12	0.65	2.05
gdfc (Billion)	0.00	0.00	0.00	.	0.00
unemployment	3.32	4.25	2.84	0.73	0.39
tradeopenness	0.00	0.00	0.00	.	0.00
Namibia					
realgdp (Billion)	9.68	13.68	3.35	-0.68	3.35
mps	74.81	123.74	4.51	-0.47	46.11

fbs	1.32	3.75	0.00	0.41	1.42
fts	6.74	8.33	3.34	-1.15	1.31
ppui	16.71	52.97	0.00	0.95	17.03
inflation	4.67	9.45	0.00	-0.26	2.59
fdi (Billion)	0.46	1.04	-0.18	-0.14	0.34
gdfc (Billion)	2.15	4.33	0.62	0.29	0.98
unemployment	20.94	23.35	16.77	-0.97	1.51
tradeopenness	93.95	123.76	76.93	0.76	12.51
Niger					
realgdp (Billion)	8.36	15.34	2.24	0.04	4.12
mps	21.28	58.52	0.00	0.41	20.86
fbs	0.03	0.15	0.00	2.02	0.04
fts	0.33	0.77	0.00	0.24	0.20
ppui	3.72	22.39	0.00	1.94	6.93
inflation	2.12	11.31	-2.49	1.25	3.03
fdi (Billion)	0.41	1.07	0.01	0.22	0.33
gdfc (Billion)	2.28	4.35	0.29	-0.18	1.39
unemployment	1.30	3.10	0.32	0.66	0.82
tradeopenness	39.59	51.95	30.83	0.71	5.97
Nigeria					
realgdp (Billion)	333.10	574.20	69.17	-0.45	157.00
mps	52.10	101.69	0.02	-0.26	35.75
fbs	0.02	0.06	0.00	0.36	0.02
fts	0.43	1.17	0.04	0.49	0.38
ppui	17.12	55.36	0.00	0.88	17.38
inflation	12.63	18.87	5.39	-0.05	3.81
fdi (Billion)	3.93	8.84	-0.19	0.44	2.62
gdfc (Billion)	0.00	0.00	0.00	.	0.00
unemployment	4.12	5.63	3.51	1.20	0.64
tradeopenness	0.00	0.00	0.00	.	0.00
Rwanda					
realgdp (Billion)	6.50	13.31	1.97	0.09	3.41
mps	40.41	80.99	0.48	-0.05	33.60
fbs	0.08	0.35	0.00	1.52	0.09
fts	0.24	0.44	0.07	0.14	0.12
ppui	8.61	30.46	0.00	0.87	8.88
inflation	6.69	17.69	-0.39	0.40	5.04
fdi (Billion)	0.16	0.40	0.00	0.23	0.13
gdfc (Billion)	1.47	3.34	0.25	0.18	0.97
unemployment	12.01	15.79	10.76	2.69	1.11
tradeopenness	41.84	61.17	27.48	0.36	10.49
Sao Tome and Principe					
realgdp (Billion)	0.24	0.54	0.00	0.55	0.15

mps	47.84	91.97	0.00	-0.27	34.59
fbs	0.49	2.02	0.00	1.39	0.52
fts	3.44	4.58	1.10	-0.88	1.14
ppui	20.00	51.20	0.00	0.69	11.82
inflation	12.34	31.99	5.25	1.41	6.40
fdi (Billion)	0.03	0.13	0.00	1.81	0.03
gdfc (Billion)	0.00	0.00	0.00	.	0.00
unemployment	14.98	17.63	13.56	0.44	1.20
tradeopenness	0.00	0.00	0.00	.	0.00
Senegal					
realgdp (Billion)	16.63	27.68	6.01	-0.06	6.44
mps	65.80	120.43	2.58	-0.26	44.13
fbs	0.56	1.43	0.00	0.19	0.41
fts	2.15	2.73	1.30	-0.61	0.39
ppui	15.39	58.05	0.00	1.22	16.11
inflation	2.00	9.70	-2.25	1.38	2.63
fdi (Billion)	0.61	2.59	0.05	1.91	0.74
gdfc (Billion)	4.73	12.02	1.35	1.09	2.87
unemployment	6.87	10.36	2.86	-0.08	2.77
tradeopenness	58.07	79.87	48.68	1.35	6.94
Seychelles					
realgdp (Billion)	1.14	1.65	0.65	0.08	0.31
mps	120.90	191.51	32.43	-0.32	49.61
fbs	11.51	38.77	0.00	1.03	11.80
fts	23.03	29.75	17.63	0.01	3.44
ppui	39.79	81.59	0.00	-0.05	24.42
inflation	5.53	36.96	-2.40	2.54	9.53
fdi (Billion)	0.15	0.61	0.02	2.37	0.12
gdfc (Billion)	0.47	0.89	0.08	0.27	0.26
unemployment	0.00	0.00	0.00	.	0.00
tradeopenness	193.83	235.82	149.54	-0.15	25.05
Sierra Leone					
realgdp (Billion)	2.95	5.02	0.64	-0.15	1.34
mps	37.63	97.70	0.00	0.34	36.64
fbs	0.00	0.00	0.00	.	0.00
fts	0.30	0.52	0.00	-0.28	0.19
ppui	4.26	18.00	0.00	1.22	6.23
inflation	7.71	27.21	0.00	0.85	7.14
fdi (Billion)	0.23	0.95	0.01	1.63	0.23
gdfc (Billion)	0.47	1.23	0.01	0.60	0.32
unemployment	4.05	4.74	3.19	-0.33	0.50
tradeopenness	58.48	88.09	35.94	0.49	17.12
Somalia					

realgdp (Billion)	3.57	10.42	0.00	0.41	4.28
mps	23.91	53.48	0.92	0.24	21.73
fbs	0.26	0.72	0.00	0.42	0.31
fts	0.61	1.02	0.00	-0.13	0.27
ppui	0.81	2.00	0.00	0.07	0.72
inflation	0.00	0.00	0.00	.	0.00
fdi (Billion)	0.21	0.64	0.00	0.69	0.20
gdfc (Billion)	0.00	0.00	0.00	.	0.00
unemployment	18.73	19.94	18.29	1.75	0.40
tradeopenness	33.21	95.84	0.00	0.32	39.05
South Africa					
realgdp (Billion)	328.00	458.20	129.10	-0.85	96.36
mps	108.01	168.92	17.81	-0.41	52.58
fbs	1.48	3.25	0.00	0.02	1.11
fts	7.98	10.60	2.19	-1.07	2.69
ppui	30.73	72.31	0.00	0.33	25.70
inflation	5.25	10.07	-0.69	-0.24	2.24
fdi (Billion)	6.02	40.66	0.62	3.59	8.08
gdfc (Billion)	56.17	86.39	19.41	-0.65	18.82
unemployment	22.23	28.84	19.34	0.98	2.83
tradeopenness	53.89	65.97	45.64	0.41	5.46
South Sudan					
realgdp (Billion)	4.90	18.43	0.00	0.74	6.96
mps	12.83	30.48	0.00	0.04	12.20
fbs	0.00	0.00	0.00	.	0.00
fts	0.00	0.02	0.00	2.93	0.01
ppui	1.40	6.50	0.00	1.13	2.14
inflation	40.22	380.00	-6.69	2.98	86.65
fdi (Billion)	-0.02	0.16	-0.79	-4.00	0.17
gdfc (Billion)	0.49	2.10	0.00	1.06	0.75
unemployment	12.65	14.41	12.11	1.52	0.66
tradeopenness	27.34	97.27	0.00	0.82	39.55
Sudan					
realgdp (Billion)	52.65	129.70	12.26	0.72	29.97
mps	47.25	79.20	0.09	-0.48	32.23
fbs	0.05	0.14	0.00	0.41	0.04
fts	1.24	3.57	0.29	1.02	0.93
ppui	5.37	28.40	0.00	1.49	9.63
inflation	47.22	359.09	1.94	3.01	79.10
fdi (Billion)	1.28	2.31	0.39	-0.05	0.54
gdfc (Billion)	8.39	18.24	1.13	0.06	5.10
unemployment	16.28	19.21	13.00	0.04	1.72

tradeopenness	24.10	36.74	2.70	-0.70	9.63
Tanzania					
realgdp (Billion)	37.92	75.73	13.38	0.32	20.03
mps	44.97	91.90	0.32	-0.17	32.22
fbs	0.51	2.06	0.00	1.11	0.77
fts	0.31	0.50	0.11	-0.38	0.12
ppui	7.03	31.63	0.00	1.37	8.78
inflation	6.58	16.00	3.29	1.53	3.25
fdi (Billion)	1.00	2.09	0.32	0.48	0.50
gdfc (Billion)	13.24	31.00	2.34	0.43	8.75
unemployment	2.80	3.47	2.12	-0.38	0.40
tradeopenness	38.43	56.17	23.98	0.34	9.25
Togo					
realgdp (Billion)	4.84	8.44	1.48	-0.14	2.25
mps	41.48	77.30	1.00	-0.12	29.68
fbs	0.32	1.10	0.00	0.68	0.34
fts	1.01	2.79	0.44	1.79	0.57
ppui	7.31	34.98	0.00	1.78	9.44
inflation	2.55	8.69	-0.98	1.00	2.53
fdi (Billion)	0.08	0.73	-0.23	1.58	0.19
gdfc (Billion)	0.96	1.79	0.35	0.13	0.44
unemployment	3.39	4.40	1.98	-0.62	0.85
tradeopenness	68.79	87.01	54.09	0.25	10.26
Uganda					
realgdp (Billion)	23.09	45.57	5.84	-0.10	12.73
mps	36.10	69.99	0.53	-0.29	25.65
fbs	0.06	0.24	0.00	1.12	0.07
fts	0.53	1.40	0.20	0.76	0.35
ppui	3.83	10.34	0.00	0.17	2.66
inflation	6.10	16.56	-0.29	0.92	4.18
fdi (Billion)	0.75	1.53	0.15	-0.03	0.39
gdfc (Billion)	5.78	11.03	1.13	-0.25	3.38
unemployment	3.11	3.81	1.90	-0.84	0.57
tradeopenness	39.34	56.26	31.21	1.31	5.53
Zambia					
realgdp (Billion)	17.52	29.16	3.60	-0.42	8.62
mps	48.67	103.97	1.00	0.01	37.04
fbs	0.15	0.48	0.00	0.96	0.17
fts	0.68	0.86	0.34	-0.68	0.15
ppui	5.92	21.23	0.00	1.08	6.45
inflation	13.44	26.03	6.43	0.51	6.20

fdi (Billion)	0.77	2.10	-0.27	0.48	0.64
gdfc (Billion)	4.72	10.61	0.00	-0.09	4.37
unemployment	9.91	15.90	4.37	0.13	3.58
tradeopenness	69.93	86.21	56.12	0.09	8.26
Zimbabwe					
realgdp (Billion)	14.57	34.16	4.42	0.50	8.77
mps	52.16	100.57	2.25	-0.22	40.69
fbs	0.61	1.35	0.00	0.24	0.56
fts	2.30	3.04	1.52	-0.17	0.45
ppui	11.57	34.81	0.00	0.61	11.27
inflation	45.00	557.20	-2.43	3.30	126.12
fdi (Billion)	0.21	0.72	0.00	0.81	0.19
gdfc (Billion)	1.72	4.83	0.09	0.71	1.40
unemployment	5.90	9.54	4.39	1.44	1.47
tradeopenness	67.88	109.52	47.31	0.80	15.38

Appendix 4: Fixed Effects Model Time-Specific Effects

VARIABLES	(1) lnrgdp
lnmps	0.122***
	(0.0254)
lnfbs	0.00697
	(0.00750)
lnfts	-0.0194
	(0.0150)
lnppui	0.00508
	(0.0159)
lninflation	-0.0204**
	(0.00790)
lnfdi	0.0132*
	(0.00715)
lngdfc	0.428***
	(0.0200)
lnunemployment	0.0438**
	(0.0216)
lntradeopenness	-0.389***
	(0.0374)
2003.year	0.0264
	(0.0858)
2004.year	0.0834
	(0.0822)
2005.year	0.0685
	(0.0709)
2006.year	0.123*
	(0.0729)
2007.year	0.179**
	(0.0741)
2008.year	0.203***
	(0.0774)
2009.year	0.135*
	(0.0797)
2010.year	0.170**
	(0.0833)
2011.year	0.248***
	(0.0856)
2012.year	0.242***
	(0.0874)
2013.year	0.237***
	(0.0891)
2014.year	0.227**
	(0.0911)
2015.year	0.148
	(0.0930)
2016.year	0.186**
	(0.0941)
2017.year	0.256***
	(0.0948)
2018.year	0.267***
	(0.0963)
2019.year	0.242**
	(0.0970)
2020.year	0.203**
	(0.0991)
2021.year	0.281***
	(0.101)
2022.year	0.253*
	(0.149)
Constant	14.61***
	(0.412)
Observations	428
Number of country_code	36
R-squared	0.901

Appendix 5: Time Specific Effects of ICT on Economic Growth