Nexus between ICT diffusion and poverty level In Sub-Saharan African (SSA) countries

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DEDICATION

I dedicate this thesis to my late beloved mother Ruramai Mugadziwa, my beautiful wife Rachael Mateko, our intelligent daughter Faith Munyasha Mateko, the Sub-Saharan Africa economies, and the Bretton Woods Institutions.

DECLARATION

I declare that this thesis titled:

Nexus Between ICT Diffusion and Poverty Levels in Sub-Saharan African Countries is my own work, and that all the resources used have been fully acknowledged by means of in-text references and the reference list, and that I have not previously submitted the thesis for degree purposes at any other university or academic institution.

…….

Freeman Munisi Mateko

ABSTRACT

This empirical quantitative research focuses on examining the nexus between diffusion and poverty levels in all Sub-Saharan African countries from 1989-2019. The study's main goal is to figure out how ICT can help countries in Sub-Saharan Africa reduce poverty. A Panel Vector Autoregressive model and Generalised Method of Moments were employed in the research methodology. Panel data was obtained from the World Bank and the International Telecommunication Union. In addition, a number of diagnostic tests were carried out in the study. Empirical results suggested that information and communication technology is useful in poverty reduction. Primary research findings showed a long-run relationship between information and communication technology usage (fixed telephone, mobile telephone and internet usage), foreign direct investment, development aid, primary school enrolment, real GDP per capita, remittances, and private domestic credit. Fixed effects and random effects results showed that an increase in information and communication technology leads to a decrease in poverty levels in the Africa region. Causality tests depicted bidirectional causality between information and communication technology and real gross domestic product per capita. Results from the Vector Error Correction estimates revealed that changes in impact real gross domestic product per capita. Results from the Generalised Method of Moments and the Panel Vector Autoregressive model suggest that an increase in the usage of information and communication technology can lead to reduction in poverty levels. These findings show that in Sub-Saharan Africa, every expansionary activity in information and communication technology leads to higher living standards and/or higher real gross domestic product per capita. In terms of policy recommendations, it is suggested that Sub-Saharan African countries should increase their investment in information communication technology sector, create a conducive environment for investment attraction, and as well as the liberalize the sector to ensure that meaningful gains materialise that ultimately reduce poverty.

Key words: poverty, information and communication technology, economic growth, unemployment, human development index, diffusion, economic development.

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ABBREVIATIONS

AUDA	African Union Development Agency
ATM	Automated Teller Machine
APS	Average Propensity to Save
CGT	Classical Growth Theory
DRC	Democratic Republic of Congo
DA	Development Aid
DAC	Development Assistance Committee
EMR	Electronic Medical Record
PARSET	Education Sector Reform Project
FE	Fixed Effects
FAO	Food and Agriculture Organisation
FDI	Foreign Direct Investment
GMM	Generalised Methods of Moments
GDP	Gross Domestic Product
HIV	Human Immunodeficiency Virus
HPI	Human Poverty Index
ICT	Information and Communication Technology
IDCJ	International Development Center of Japan
IMF	International Monetary Fund
ITU	International Telecommunication Union
JICA	Japan International Cooperation Agency
MPS	Marginal Propensity to Save
MRS	Medical Record System
MPI	Multidimensional Poverty Index

NGT	New Growth Theory
NEPAD	New Partnership for Africa's Development
ODA	Official Development Assistance
OECD	Organisation for Economic Co-operation and Development
PVAR	Panel Vector Autoregressive
PSE	Primary School Enrolment
PDC	Private Domestic Credit
RE	Random Effects
RCIP	Regional Communications Infrastructure Program
REM	Remittance
SMES	Small to Medium Enterprises
SOS	Societas Socialis
SADC	Southern African Development Community
SAMAF	South African Microfinance Apex Fund
SIDA	Swedish International Development Cooperation Agency
PTS	Swedish Post and Telecom Authority
SPIDER	Swedish Program for ICT in Developing Regions
UN	United Nations
UNCTAD	United Nations Conference on Trade and Development
VAT	Value Added Tax
VAR	Vector Auto Regression
VEC	Vector Error Correction
WHO	World Health Organisation
ZIMRA	Zimbabwe Revenue Authority

CHAPTER 1: THE PROBLEM AND ITS SETTING

1.1 INTRODUCTION AND BACKGROUND TO THE STUDY

Poverty is a global problem that has serious effects on the livelihoods of the general population. Large entities such as United Nations (UN), International Monetary Fund (IMF) and the World Health Organisation (WHO) to mention but a few, embarked on diverse initiatives to eradicate poverty worldwide (World Bank, 2010:3). Globally, in 2015, a total of 736 million people lived below the international poverty line (United Nations, 2020). The United Nations formulated sustainable development goals in a bid to address global poverty levels (Johnston, 2016). Furthermore, a number of organisations were formed to address global poverty. For example, the United Nations Food and Agriculture Organisation (FAO), and their Development Program (UNDP) among others. However, poverty levels vary within regions in the global village, and Sub-Saharan Africa remains the region worst affected by high poverty levels (Azzarri & Signorelli, 2020).

The battle to eradicate poverty continues to rage on. Some initiatives introduced to eradicate poverty in Sub-Saharan Africa (SSA) are health care and information and communication technology (ICT) programs (Amega, 2018). The use of ICT can be important in poverty reduction as adequate information can reduce the ignorance that forms the larger quantum factor of poverty in SSA. The use of ICT has proved to be efficient in enhancing quality of life through diverse mechanisms. For example, ICT can be used to improve healthcare facilities, education services delivery, and can support innovation in the industrial sector (Grossman, Platas and Rodden, 2018). More needs to be done to improve ICT usage in SSA in sectors such as the education and manufacturing sectors, which will help in poverty reduction, as poverty encompasses aspects such as education, health, food, shelter and others. In SSA, many educational institutions lack financial and material human resources, such that the per student spending is low (Majgaard and Mingat, 2012).

The International Trade Centre (2018) examined the competitiveness of SMEs in Africa. The study found that SMEs in Africa generate 80% of jobs, although investment still lacks in the region and substantial job losses are experienced (International Trade Centre, 2018: 3). Job losses are experienced due to economic shocks and structural changes. Thus, investment in ICT is critical to ensuring that more jobs are created in Sub-Saharan Africa, and sound ICT investment policies are essential (Fachbereich and Wirtschaftswissenschaften, 2018). ICT is often associated with innovation in the industrial sector. More innovation enables more firms to open, and such firms demand labour. Thus, ICT helps in employment creation. From this vantage point, an increase in ICT investment may create job opportunities, particularly for SMEs, and thus raise the standard of living. People are exposed to high levels of poverty due to a lack of employment. From a supply-side perspective, ICT can be used by entrepreneurs to create jobs, thereby reducing poverty levels (Morris, Santos & Neumeyer, 2020).

In 2019, 440 million people in low income economies, especially in Africa, were living below the global poverty line and the number may rise due to serious problems being faced on the continent such as increased war, disease and crime (Alkire ,2019: 8). The need to eradicate abject poverty is a key priority for both developing and developed economies. Poverty can be defined as the complete absence of opportunities, coupled with high levels of undernourishment, hunger, illiteracy levels, lack of access to education, financial incapacitation and weak socioeconomic and political mobility physical and mental diseases, and socio-economic instability (Beegle *et al.*, 2016: 6). From this definition it follows that poverty can be attributed to the exclusion of people from social, economic and political opportunities, which are essential for uplifting standards of living. The exclusion is perceived as a result of lack of information spread, due to the huge distances between African communities. However, with adequate deployment of ICT devices, information barriers could be tackled.

It is essential to define the term ICT, as it plays a role in poverty alleviation. Information and communication technology (ICT) refers to an umbrella term that incorporates any communication device or application, television, radio, cell phones, computers, network software and hardware satellite systems that enhance the

information knowledge sharing that is required for economic revival (Constantine, 2014: 39). The fact that ICT can be useful in poverty reduction does not necessarily guarantee that ICT is the only useful tool in ending poverty, especially in Sub-Saharan Africa. This implies that ICT itself does not reduce poverty but can be viewed as a useful tool or channel.

Mannheim and Niebel (2014: 14) researched ICT and economic growth for developing, emerging and developed economies. From the research it was discovered that investments in ICT positively impacted developed economies, while for emerging and developing economies the benefits were quite meagre. This implies that massive investment in ICT can be a catalyst that enables economies to leapfrog the development stages (Adeleye & Eboagu, 2019: 22). The disparities or heterogeneity in these results between the specified economies could be attributed to diverse factors. For example, developed economies tend to have sound ICT policies, while some developing and emerging economies may have poor ICT policies (Adeleye & Eboagu, 2019: 22).

ICT can be channelled towards key sectors such as health, education, entrepreneurial as well as social sectors (Morris, Santos & Neumeyer, 2020) . Some of the ways ICT can be channelled are through information dissemination and invention of machinery for use in production sectors. For example, developed economies are benefiting from ICT inventions in fighting the global pandemic of coronavirus (British Broadcasting Corporation 2020). ICT has been channelled towards contact tracing for coronavirus patients (Mbunge, 2020). Globally, the United Nations Educational, Scientific and Cultural Organization (UNESCO), is working on the development of artificial intelligence (AI) mobile app solutions to help the fight against coronavirus (UNESCO 2020), and Rwanda has developed robots for use in the battle against the virus (WHO 2020).

South Africa started using artificial intelligence in a bid to solve the coronavirus pandemic (United Nations University, 2020). The use of AI technology has enabled the South African government to provide health advice and recommendations to the masses (United Nations University 2020). AI is a useful tool for drug research that can help SSA in drug development (Vaishya *et al.*, 2020).

Conversely, some developing economies especially in Africa, face difficulties in offering excellent healthcare. For example, Zimbabwe has insufficient medical equipment to address health issues in the country (Mugwagwa, 2017: 2). This implies that there are still some gaps in understanding how ICT can be effectively transmitted to ensure that poverty levels decline in Sub-Saharan Africa.

ICT is crucial in the health sector as it aids in diagnosis, heath research and treatments (Ayanlade, Oyebisi & Kolawole, 2018a). There is evidence in the literature to suggest that there is a link between ICT and poverty (Lydia Jebet, Odero & Agalo, 2018: 244). ICT is regarded as a tool that can be used in diverse sectors of an economy to increase production, improve quality of life and foster job creation (Pradhan, Mallik & Bagchi, 2018). There are different indicators that are linked to poverty. For example, foreign direct investment and foreign aid, among others, are linked to poverty (Dunga, 2014: 3). This research seeks to examine how ICT can be used as a channel for poverty reduction in Sub-Saharan Africa.

1.1.1 Brief profile of Sub-Saharan Africa

Sub-Saharan Africa (SSA) has 1.078 billion people and in 2018, the region recorded a GDP of 1. 714 trillion dollars (World Bank, 2020: 5). SSA is made up of 48 economies and the average life expectancy is 60.88 years and a gross enrolment ratio at tertiary level of 97.83 % (World Bank, 2020: 8). The global burden of human immunodeficiency virus (HIV) infection in SSA accounts for 71% of this burden (Kharsany & Karim, 2016). Sub-Saharan Africa suffers from extreme poverty levels with an estimated 59 million children between the ages of 5 and 17 under child labour (Societas Socialis, 2020). Access to healthcare for the SSA general population is a basic necessity but a number of SSA economies have dilapidated healthcare infrastructure (Phirinyane, 2015: 7). The region is plagued with high poverty levels, civil wars, institutional fragility and natural disasters, coupled with economic meltdown for a number of economies (Myovella, Karacuka & Haucap, 2020). Studies show that 413 million people in Africa are living in extreme poverty (Ferreira, 2020: 6; World Bank, 2019). In addition, the African continent at large made significant changes in fighting poverty that caused a drop from 54% in 1994 to

41% in 2015 (World Bank 2020: 3). Nwachukwu and Jacinta (2017) discovered that corruption, political instability and poor governance adversely impacted the adoption of ICT in SSA, and that these could impact on improving standards of living (poverty reduction).

SSA has made some progress in reducing poverty through diverse poverty reduction strategies that have been launched over the past years. New Partnership for Africa's Development (NEPAD) launched an e-school program that targeted 600,000 schools in Africa (Mutaizibwa, 2005: 5). This ICT initiative was targeted at introducing ICT literacy skills at grassroots levels. Huawei in 2018 introduced an ICT program in SSA countries in a bid to improve usage and access to ICT in order to curb illiteracy that had the potential of improving marginal productivity and increase household incomes (Khomas, 2018: 9).

This has had long term economic benefits for poverty reduction. ICT can be used to fight poverty and enhance production in agricultural sectors, which in turn improves economic growth. However, the key point of focus should not be based on achieving economic growth using ICT skills, but that the achieved growth should be inclusive, equitable and sustainable.

1.1.2 ICT in Sub-Saharan Africa

ICT has been used in the SSA region to counter corruption and promotion of good governance (Verkijika & De Wet, 2018). This is since e-governance systems enable the tracking of transactions. For example, the Zimbabwe Revenue Authority (ZIMRA) has a technological system that allows monitoring of all financial transactions. As such, this has allowed for revenue collection from Value Added Tax (VAT). However, the main drawback of the e-governance system is that there is no proper disbursement of the tax collected (Samoilenko & Osei-Bryson, 2019).

If e-government systems are effective in SSA, many benefits such sound governance and reduced corruption can be attained. Thus, having a digital economy is important for poverty reduction, although SSA at large still suffers from a digital divide (United Nations University, 2020). A digital economy refers to the use of computing technologies for business purposes and the digital economy is also

supported by internet access (World Bank, 2019). However, but only 27% of Africa's population has access to the internet (World Bank, 2019) . Research has proved that the use of computing technology for business purposes can help reduce the poverty headcount ratio by 0.7% annually (World Bank, 2019: 4). To achieve this, it is essential to ensure that monopolies in the telecommunications industry are abolished, as they do not promote competition and efficiency. For example, Ethiopia has a monopoly in their telecommunications sector, and is thus lagging behind technologically (World Bank, 2020). This shows the extent to which ICT is germane to poverty reduction.

ICT has been deemed useful in reducing carbon dioxide effects on the environment (Asongu & Le Roux, 2017) due to ICT technology being energy efficient and that it produces minimal industrial pollution, so it can be safely used in industry (Ferrari et al., 2018). In addition, SSA agricultural sector farmers have benefited from information dissemination and knowledge sharing through radio and interactive ICT (Hudson *et al*., 2017).

1.2 PROBLEM STATEMENT

The reduction of poverty in Sub-Saharan Africa is a key issue of concern. Different economies in the SSA have been carrying out diverse programs to alleviate poverty . South Africa launched the South African Microfinance Apex Fund (SAMAF), which provided loans of up to R10 000 to households and micro-entrepreneurs, in a bid to address poverty in the country (Mbuli 2008). This was successful as the programme benefited over 61 000 households and micro-entrepreneurs, and a total of R76 million was disbursed (Coleman, 2010). However, it remains unknown if those 61 000 beneficiaries managed to set up sustainable businesses. If not, it means that the SMAF initiative only suppressed poverty. Should those businesses not be operating efficiently or if they have closed down, then the beneficiaries might be exposed to poverty again.

Malawi implemented the Poverty Reduction Strategy (Dunga, 2014: 4).The strategy aimed at addressing high poverty levels, life expectancy and infant and maternal mortality (lMF, 2012). There were some positive breakthroughs in Malawi due to this strategy. In 2004, the poverty headcount reduced by 8%, life expectancy increased

to 43 years from 39 years, infant mortality rates per 1000 children reduced to 90 from 104, and the maternal mortality rates per 100000 births reduced to 800 from 1120 (IMF 2012). However, the Malawi poverty reduction strategy lacked a clear overview of the ICT transmission mechanism needed for poverty reduction. As such, the economy is still battling with high poverty levels of 70.3% (World Bank 2020).

Constantine et al. (2014) conducted research on poverty eradication and discovered that the harsh environment, high levels of illiteracy, and high technology costs were major barriers to the use of ICT in poverty reduction. It is clear from this research that there is no clear path to follow for overcoming the barriers to poverty reduction. Dunga (2014) investigated poverty alleviation in Malawi and discovered that access to loans, education, and input subsidies were the main drivers of poverty reduction. Because the previous study was limited to Malawi, the current study's goal is to look into how poverty reduction can be achieved in the SSA region through the use of ICT. The goal of this study is to look at ICT and poverty issues from a regional standpoint.

Omilola (2015: 31) also examined the effects of agricultural technology on poverty alleviation, and found that specific agricultural technologies are needed to alleviate poverty, in the form of increased productivity and improved information dissemination to farmers on best way to use the technology. However, the study lacks how such technologies should be harnessed against poverty alleviation, and is silent on how technology adoption can be channelled towards poverty alleviation. This present study therefore seeks to examine the nexus between ICT diffusion and poverty in SSA.

Furthermore, according to Beegle et al. (2016: 247), sub-Saharan economies have abundant natural resources at their disposal, but a lack of technology and technical know-how to exploit the resources for value addition and improving people's living standards. According to May (2011) and Samoilenko and Osei-Bryson (2019), there is a positive correlation between ICT use and economic growth. This means that by utilizing ICTs, Sub-Saharan Africa can increase GDP while also lowering poverty levels. This is justified by the fact that, in general, higher GDP levels are associated with lower poverty levels (Housseini & Alkire, 2014).

Higher GDP can be achived when more companies employ the additional labour necessary for producing a higher output. The more workers employed, the lower the unemployment rate. Such workers receive an income and this helps in improving living standards.

The Multidimensional Poverty Index (MPI) is widely used to show the number and severity of poverty (Housseini & Alkire, 2014). The MPI has a subset of the poor, who are classified as destitute (Housseini & Alkire, 2014). In 2014, 200.3 million people in SSA were classified as destitute (Housseini & Alkire, 2014). This statistic calls for action towards poverty alleviation in the region.

The key determinants of poverty such as socio-economic issues (dealing directly with household land, labour and capital), demographic factors (household size and fertility), and health issues (household morbidity and mortality), and the relationship between information and communication technologies, is explored in the study. Due to poor health infrastructure in some SSA economies, many people die and their remaining family members are often classified as destitute (Housseini & Alkire, 2014). In 2017, SSA recorded 2.7 million deaths of children under the age of five years (Van Malderen *et al.*, 2019: 3). The factors responsible for this are malnutrition, disease and illness (for example pneumonia), and birth complications (WHO, 2020). This means that access to healthcare must be improved in SSA so as to minimize mortality rates. ICT could therefore be used as a mechanism for poverty alleviation in SSA.

Poverty reduction efforts have proven to be successful in Asia. In 1981, 1.95 billion Asians were poor (Asian Development Bank 2014: 3). However, by1990 the poverty numbers were reduced to 1.48 billion, a decrease of 24.1% (Asian Development Bank 2014: 3). In 2005, the Asian region recorded a new poverty level of 26.5% (Asian Development Bank 2014: 3). Poverty alleviation programs were again started in Asia around the same time they were started in SSA, however there is a clear indication that the Asian programs were implemented differently (World Bank, 2018).

Hong Kong, Singapore, South Korea and Taiwan are referred to as the “Asian Tigers”. These economies recorded colossal economic growth levels between 1965 to 1995 (Mascelluti, 2015: 19). Key factors that promoted such economic growth

were substantial investments in the education sector, the application of Confucianism, increased foreign and direct investment, and the use of technology (Mascelluti, 2015: 25). Use of technology improved the usage of inputs, and more output was produced in Asia.

In terms of corruption, the levels were reduced for the Asian-Tigers (Kaufmann, 1997: 2). For example, in 2020, the Corruption Perceptions Index (CPI) for South Korea was at 39 points (WorldData, 2021). Taiwan is also member of the Asian Tigers, and in 2020, the country's economy had a CPI of 28 points (Transparency International, 2021). At that time, Hong Kong was affiliated to the Asian Tigers. It was ranked 11 out of 180 economies on the Corruption Perceptions Index 2020, and was regarded as the least corrupt economy globally (Transparency International, 2021). Currently, the corruption level is at 23 points and the country has maintained corruption levels below 30 points for a number of years (WorldData, 2021). Singapore, which is the fourth country of the Asian Tigers, ranks in the top five countries that have the lowest corruption levels gobally. Currently, it has a Corruption Perception Index score of 85 points (Hirschmann, 2021). Corruption This high corruption score was mainly due to the speeding up of business transactions that translated into increased economic growth, as more companies were established (Kaufmann, 1997: 8). This implies that although Singapore corruption levels are now very low, corruption played an oil effect on these economies. The oil effect in this case means that corruption helped in enhancing economic growth.This is supported by the fact that the Asian Tigers' economies recorded significant growth rates of real per capita gross domestic product of 6% between the years 1960-1995 (Toma, 2019).

The African Partnership Forum (2008) posited that inadequate and uneven distribution of ICT infrastructure fuels the increase in poverty levels in the SSA. From This study shows that no research has yet been done that focuses on how ICT can be channelled towards poverty reduction in SSA. The study therefore examines how various forms of ICT can be channelled to reduce the poverty that exists in a multidimensional context.

Lay (2020) examined the effects of ICT on economic development for Organisation for Economic Co-operation and Development (OECD) economies. Research findings showed that the development of ICT infrastructure and its associated technological skills, helps to improve economic development (Lay, 2020: 21). Developed economies often have lower rates of poverty *ceteris paribus.* However, the research is silent on how economically developing economies can develop their ICT infrastructure and ICT skills. Thus, the interests and ICT needs of the SSA region were not captured the Lay (2020) study, and a research gap exists.

Min, Liu and Huang (2020), investigated the effects of ICT on rural economic transformation in China. Research output showed that the use of smartphones by farmers enabled economic transformation (Min, Liu & Huang, 2020: 12). However, SSA is engulfed in poverty, and while the purchase of smartphones may be desirable, it is unattainable. However, although smart phones are far too expensive for some in SSA, they are vital to poverty reduction. Therefore what can be done to ensure that especially farmers in the agro-based SSA have access to such modern technology? The answer lies in this research.

No studies that have clearly investigated the differences in approach between Asia and SSA, but one conspicuous area is how Asia adopted the use of ICT. Why it was not possible for SSA to move at the same pace, and what are the underlining prerequisites for faster ICT adoption? There have been studies that show the importance of ICT in economic growth and development, but these questions are not clearly answered in the literature. Hence a huge gap exists in terms of the nexus of ICT and poverty reduction in SSA economies. The need to understand this link cannot be overemphasized.

1.3 Research Questions

- What is the direction of causality between ICT diffusion and poverty levels in SSA?
- What is the influence of ICT diffusion on poverty levels in SSA countries?
- What is the long-run and short-run equilibrium of ICT diffusion on poverty levels in SSA countries?

- What is the reaction of ICT diffusion and poverty levels to possible shocks from each other?

1.4 OBJECTIVES OF THE STUDY

1.4.1 Primary objective

The main aim of the study is to determine how ICT can be channelled towards poverty reduction in Sub-Saharan African economies.

1.4.2Theoretical objectives

The following theoretical objectives were devised in order to achieve the primary goal of this study:

- To provide a background of ICT and poverty in Sub-Saharan Africa.
- To provide a background of poverty in Sub-Saharan Africa.
- To review the literature on ICT and poverty in Sub-Saharan Africa.
- To review the literature on the link between ICT and the channels of potential impact, which are economic growth, education levels, poverty alleviation, employment and agricultural production.

1.4.3 Empirical objectives of the study

The following empirical objectives were formulated:

- To determine the direction of causality between ICT diffusion and poverty levels in SSA.
- To investigate the influence of ICT diffusion on poverty levels in SSA countries.
- To ascertain the long-run and short-run equilibrium of ICT diffusion on poverty levels in SSA countries.
- To determine the reactions of ICT diffusion and poverty levels to possible shocks from each other.

1.5 STATEMENT OF THE HYPOTHESES

The following hypothesis will be used for objectives 1, 3 and 4, respectively.

H_0= **(Null Hypothesis)**: There is no causal relationship between ICT and poverty.

H_1= **(Alternative Hypothesis**): There is a causal relationship between ICT and poverty.

H_0 = **(Null Hypothesis)**: There is no long-run and short-run equilibrium between ICT diffusion on poverty levels in SSA countries.

H_1= **(Alternative Hypothesis**): There is a long-run and short-run equilibrium between ICT diffusion on poverty levels in SSA countries.

H_0**(Null Hypothesis)**: There is no dual reaction between ICT diffusion and poverty levels to possible shocks from each other.

H_1= **(Alternative Hypothesis**): There is a dual reaction between ICT diffusion and poverty levels to possible shocks from each other.

1.6 SIGNIFICANCE OF THE STUDY

This research will help Sub-Saharan Africa economies to adopt policies that enable the use of ICT as a mechanism for poverty alleviation. Of great importance is the fact that these research findings can be used by international organisations such as the International Monetary Fund (IMF), World Bank, and the United Nations (UN) in devising policies to tackle poverty in Sub-Saharan Africa. This is because these entities have engaged in research in an effort to reach effective solutions to address poverty in SSA. Moreover, other private research institutes and think tank organisations could benefit from the study outcome because this area has not been fully examined, and these organisations are craving for tailor-made solutions that aid poverty alleviation. These organisations may also benefit from the research findings in that they can craft policies to address poverty using ICT as a mechanism. Based on the results, not only will the study be able to tell whether ICT reduces poverty in SSA, but it will be able to further tell which specific ICT components have the most poverty reducing effects and that should be the components which policymakers should focus on the most. Finally, the research will benefit the general populace, as

they will become well-informed on the best ways to use technology to eradicate the gruesome burden of poverty.

1.7 OUTLINE OF THE STUDY

This study comprises the following chapters:

Chapter 1: The problem and its context, the research background, problem statement, objectives and questions, and a brief overview of the research hypotheses were presented in this chapter.

Chapter 2: Poverty and ICT in Sub-Saharan Africa. The focus is on investment in ICT and how it has reduced poverty.

Chapter 3: Review of the relevant literature– theories connecting ICT, development, poverty and growth, recent studies on ICT, country-specific poverty on regional levels, and global studies.

Chapter 4: Research Methodology – theoretical framework, adopted or adapted models, models for empirical estimations.

Chapter 5: Based on stylised fact analysis, descriptive statistics, data related to ICT, poverty, economic development, and employment in SSA.

Chapter 6: Based on empirical results, analysis and estimated results, discussion of the results and deduction of new knowledge from the results.

Chapter 7: This chapter presents the study's conclusions and recommendations based on the research findings.

1.8 CONCLUSION

Chapter 1 has presented key aspects on ICT diffusion and poverty reduction in Sub-Saharan Africa. The problem statement clearly shows that more needs to be done to ensure that ICT helps in poverty alleviation in SSA. A number of theories were discussed. The main thrust on all these theories was poverty alleviation, and how ICT can be used as an alleviation mechanism. All research objectives and questions as well as the hypotheses were outlined in this chapter. It was discovered that SSA

economies can use ICT in a variety of sectors such as health, education, manufacturing, and agriculture, all of which have a positive impact on poverty reduction. Data used in the study was from 1989 to 2019 and was obtained from the International Telecommunication Union (ITU) and the World Bank. The following chapter deals with poverty and ICT in Sub-Saharan Africa. Specific focus is on investment in ICT and how it has reduced poverty.

CHAPTER 2: POVERTY AND ICT IN SUB-SAHARAN AFRICA

2.1 INTRODUCTION

This chapter presents connections between poverty and ICT in Sub-Saharan Africa in which the importance of ICT to poverty reduction is central to the discussion. The focus is on investment in ICT and how it has reduced poverty. An empirical analysis on poverty and ICT in Sub-Saharan Africa is shown in this chapter. Challenges in the investment of ICT in Sub-Saharan Africa are discussed, and the possible benefits of ICT in Sub-Saharan Africa are outlined. An individual country's investment in ICT is presented and there is a discussion on ICT programmes and policies in SSA. Furthermore, a continental analysis and an overview of the benefits of ICT investment for poverty reduction is presented.

2.1.1 ICT IN SUB-SAHARAN AFRICA

ICT diffusion is still lagging in Sub-Saharan Africa, though research has shown that the usage of ICT can yield positive results in improving productivity and achieving high economic growth (Cirera, 2016: 2). However, some economies have been advancing in ICT diffusion, although at a slower rate, a good example being Kenya (Cirera, 2016: 2). However, some economies suffer a myriad of challenges relating to the usage and diffusion of ICT. All these obstacles must be resolved to ensure that Sub-Saharan economies benefit from ICT diffusion. These benefits include: increased productivity, increase in economic growth, employment opportunities, economic development, increases in tax revenue from corporate tax and personal tax, reduced poverty, and improved living standards, to mention but a few. Figure 2.1 shows Internet penetration in SSA.

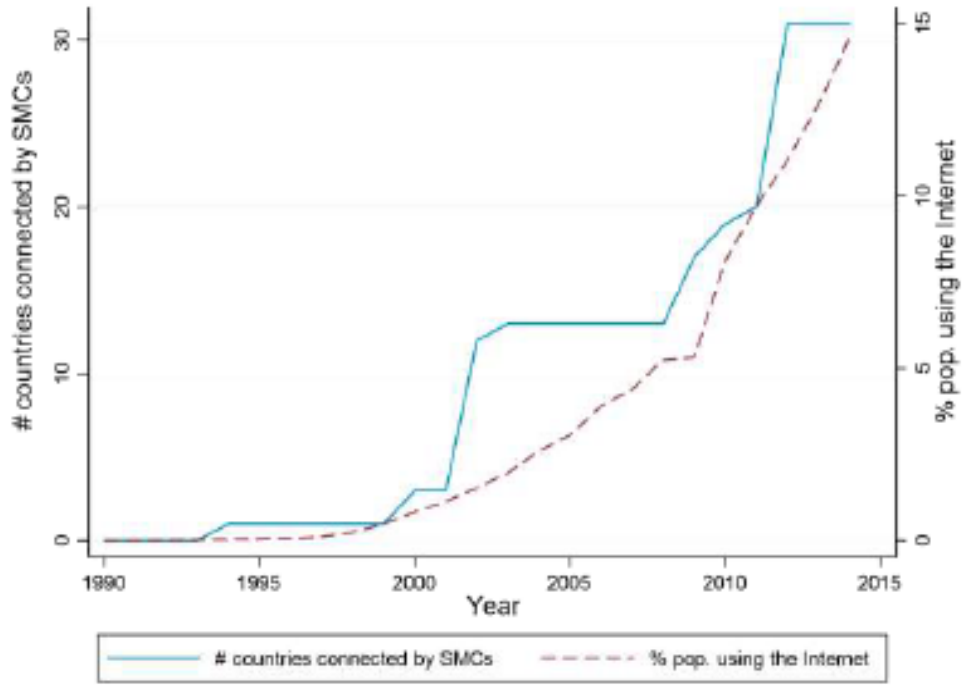

Figure 2.1: Internet penetration in Sub-Saharan Africa (1990-2015)

Source: Cariole (2020: 12)

The above figure shows the slow progress of internet penetration in SSA, from 1990-2000. However, from 2009 to 2015 there was steady increase. Internet penetration rose from 7 to 30 countries from 2000 to 2015. The overall population that had access to the internet rose from 2% to 15%. In 2015, SSA had a total population of 995 458 478. From this entire population only 15% (149 318 771) had access to the internet in all 48 countries in SSA. This shows that the diffusion of ICT (using internet penetration as a proxy) has been low. For analysis purposes, Figure 2.2 below shows the mobile penetration rates in Sub-Saharan Africa.

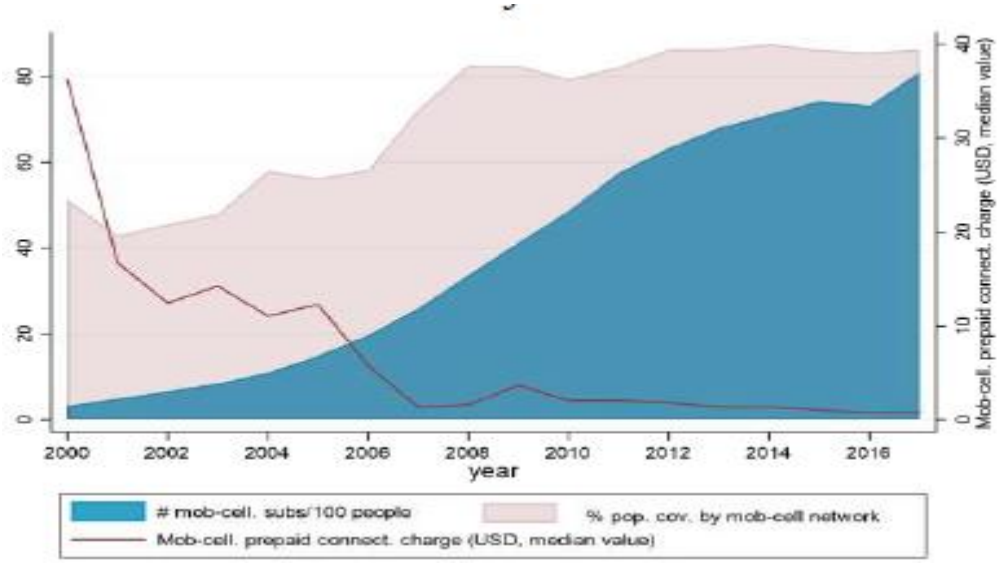

Figure 2 2: Mobile penetration rates in Sub-Saharan Africa (2000-2016)

Source: Cariole (2020:13)

Figure 2.2 depicts an exponential increase in the number of mobile phone subscribers from the year 2000 up to 2016 from about 2% to 37%, and shows that SSA is catching up with the digital era. However, access to the use of mobile phones should be channelled towards poverty alleviation in the region. This is the missing link in Sub-Saharan Africa. This research therefore seeks to examine how ICT (measured by mobile phone penetration, internet penetration and fixed telephone line subscription) can be used as a mechanism for poverty alleviation in SSA.

2.1.2 Individual country investment in ICT

This section is based on a discussion of individual countries' investment in ICT in SSA. A discussion on the specific sub-ICT sector each country invested in is presented below.

Angola

Angola has a total population of 31.825 million people (World Bank 2021). It is the third largest economy in SSA. In 2012 the country had 12.5 million mobile phone subscribers (Ferreira, 2017: 2). Despite having the highest numbers of mobile phone subscribers, the oil rich country has a colossal poverty level of 56.3% (World Bank, 2020). The use of technology (access to mobile phones) should lead to poverty

reduction, however, this is not the case in Angola. Policy wise, the government developed a Telecommunications white paper and the Information Society's National Plan in a bid to address its ICT needs (Ferreira, 2017).

The Telecommunications white paper advocated for a third telecommunications operator to improve efficiency and quality service delivery, but the nation is still under a duopoly. Currently, only two mobile operators run the telecommunications industry (Lancaster, 2020). This shows the failure of the Telecommunications white paper policy**.** The Information Society's National Plan has also suffered drawbacks, as there has been no meaningful ICT infrastructure development, despite it being the Plan's main objective (Lancaster, 2020).

In 2007, Angola introduced an online government portal for improving service delivery and transparency (United Nations, 2008). The Angolan energy sector uses ICT systems, and the nation has invested in submarine cable connectivity in an effort to improve broadband connectivity, although internet penetration is low, at 26% (Xu, 2020). The financial sector in Angola has better ICT infrastructure. However, the education sector still lacks the relevant ICT technology to enable e-learning (Bunga, 2019). In the health sector, there is a need for massive investment in ICT to improve diagnosis of ailments, research and development of drugs, and improving efficient data management on related health issues such as record-keeping of patient information (CEML, 2020).

Benin

Benin has a total population of 12.2 million (World Bank, 2020). As of 2018, this West African country had poverty levels of 46.4% (World Bank, 2020). Although Benin was the first in West Africa to have internet access, it lags behind in terms of ICT usage for poverty alleviation, as the nation still battles with poverty World Bank (2020). In the education sector, Benin has invested funds to ensure that primary schools cater for connectivity bills (Agyeman, 2007).

At the tertiary education level, only two universities had internet access in 2007, while other vocational colleges only had computers without internet access (Agyeman, 2007). However, the main drawback affecting full development and

usage of ICT in Benin is weak technological entrepreneurship (Ambi, 2020), however, the use of technical equipment in Benin's health sector has improved healthcare quality World Bank (2020). The country needs to ensure that it channels ICT towards ending poverty.

Botswana

Botswana has a total population of 2.252 million people (World Bank, 2020).The country has a poverty rate of 16.3% (Statistics Botswana, 2020). ICT is being used in the health sector for improving quality healthcare (Ndlovu *et al.*, 2014). The government of Botswana introduced computers to many of its learning institutions but ICT usage at large remains very low at 41% (World Bank, 2020). Furthermore, the state of Botswana introduced an e-government system, though the quality of service needs improvement (Nkwe, 2012).

Significant progress has been noted in the mining sector where the bulk of key players use ICT for mining (Churu, 2015). Although the country boasts a low poverty ratio, it does not mean that the effects of poverty are minimal, as a number of families are still facing food insecurity (Michael *et al.*, 2012). Nationally, over 500 000 people are living below the poverty datum line (Statistics Botswana, 2020). Of that population, a total of 206 360 people in rural areas still live below the poverty datum line, and this must be addressed through the use of ICT (Statistics Botswana, 2020).

Burkina Faso

Burkina Faso has a population of 20,321,378 (World Bank, 2020). A meagre 15% of the entire population has access to the internet (World Bank, 2020), which is limited due to poor ICT infrastructure and high costs (Zahonogo, 2010).

The country has implemented e-school projects and ICT training to educational institutions with an aim of enhancing quality education service delivery (Zahonogo, 2010). Despite such strides, the economy is still affected by high poverty levels of 40.1% (World Bank, 2020). The country is in desperate need of ICT technologies to address a variety of issues, including drought and poor agricultural output (International Crop Research Institute for the Semi-Arid Tropics, 2020). This

research therefore seeks to examine the possible ways in which ICT can be channelled towards poverty reduction in Burkina Faso.

Burundi

Burundi is a low-income country with a GDP of US$3,012 billion and a total population of 11,530,580 (Word Bank, 2020). The nation suffers an extreme poverty level, which was at 65% in 2013 (World Bank, 2020). Only 6.6 million people have access to the internet and this country has one of the worst poverty-stricken economies in Sub-Saharan Africa (World Bank, 2020). Burundi has a mobile subscriber penetration rate of around 60% (Aster, 2020).

E-learning systems are being introduced in Burundi although the rate is very slow (Sahinguvu, 2016). This slow pace has been caused by high ICT costs, lack of ICT experts, a poor legal framework and low levels of income (Vagnone, 2018). In the health sector, Burundi has launched a government e-health project for improving quality healthcare (Lancaster, 2020).

The country's retail sector has managed to maximize an increase in international bandwidth by tapping into foreign markets. International bandwidth refers to the maximum quantity of data transmission (rate) from any country in the global village (International Telecommunication Union, 2020). This reduced prices for consumers on selected baskets of goods (Lancaster, 2020), and shows that such an increase in international bandwidth (ICT usage) helps to reduce poverty.

Low prices help to improve the accessibility for products, especially for low-income earners in Burundi. If such benefits can be reaped simply by an increase in international bandwidth, what more can be in store for the nation of Burundi when ICT diffusion is increased? If all the ICT obstacles faced by Burundi could be solved, and ICT was channelled towards employment creation and the support of entrepreneurs among other aspects, a reduction in poverty could be realized, *ceteris paribus.* This research seeks to provide a clear way to show how ICT could be channelled towards poverty alleviation in Burundi, and for all other economies in SSA.

Cameroon

Cameroon's economy is agrarian-based. The country's population stands at 25,876,380 (World Bank, 2020). For the year 2014, the total number of poor people in the nation stood at 8.1 million (World Bank, 2020).

ICT is used in Cameron by smallholder farmers, which has increased both agricultural output and knowledge-sharing among the farmers (Ngaleu, 2019). Cameroon has built ICT universities, for example the ICT University in Yaoundé, the capital city (Nana, 2012). In the health sector, Cameroon uses digital health technology although health illiteracy is a stumbling block still to be addressed (Bonaventure, 2019). Poverty is a multidimensional aspect in the country; it includes access to quality healthcare, shelter, and sanitation among other things. If Cameroon suffers from health illiteracy, it implies some people will be exposed to poverty. Therefore, a solution is required to address health illiteracy. This study seeks to examine how ICT can be used to address multidimensional poverty.

Cabo Verde

In 2019, Cabo Verde had a population of 549 935 and in 2015, the poverty headcount ratio stood at 35% (World Bank, 2020). The nation implemented an e-government system in 2014 to improve efficiency in all spheres of governance (Santos, 2016). According to research, Cabo Verde was able to create a conducive environment for business to thrive, resulting in the formation of 250 new companies by 2020, with 320 jobs created in the ICT sector (Aide Mémoire cleared by Michel Rogy, 2019: 4). However, as of 2020, the contribution of ICT to gross domestic product was a meagre 5% (Aide Memoire, 2019: 5).

Although there is significant progress in ICT development in Cabo Verde, poverty is still an anathema affecting the nation. As such, gains from ICT must be channelled towards poverty alleviation to ensure that lives of the poverty- stricken improve. ICT is being used in Cabo Verde's education sector as well, although the key barrier to full ICT usage is the high cost of the internet (Parsuramen *et al.*, 2007). Access to education can help improve people's quality of life, which helps in poverty reduction. That given, Cabo Verde suffers from high internet costs, which shows that the benefits of ICT in the country's education sector are limited. As such, poverty levels

must be eradicated through ICT being diffused through diverse sectors. This research seeks to examine how ICT can be used for poverty alleviation in SSA.

Central African Republic

The Central African Republic has a population of 4,745,185 and has a high poverty ratio of 87% (World Bank, 2020). The country has one of the world's ten impoverished economies, and young people have little or no access to quality healthcare or education, and other basic necessities (Khan Education Services & the Aga Khan Foundation, 2018). The United Nations Program For Development collaborated with Central African Republic in developing ICT policies for use in the education, health and government sectors (Fall, 2007).

In the Republic, political instability over the past years has caused enormous destruction of ICT infrastructure, limiting its full usage. The country's poor fiscal position and the substantial costs required in the acquisition of ICT equipment, continue to impede ICT diffusion (Fall, 2007).

Chad

Chad registered a decline in poverty from 55% to 47% between 2003 and 2011 (World Bank, 2020). Despite its poverty reduction strategies, the country is ranked last on the World Bank Human Capital Index (World Bank (2020). Despite being oil rich, Chad has an estimated 6.3 million (66.2%) people affected by poverty and severe poverty (World Bank, 2020; World Bank Food Security Program, 2020). Chad has a total population of 15,946,846 (World Bank, 2020). In terms of humanitarian aid, the World Bank Food Programme supports 1.4 million Chadians with food (World Bank Food Security Programme, 2020). A total of 6.5% of the population have access to the internet (World Bank, 2020).

Chad has implemented ICT in their universities for enhancing research and education; however, the country lacks a robust ICT policy (Farrell, 2007). The main challenge affecting Chad is that the rural areas lack internet access (United Nations Educational, Scientific and Cultural Organization, 2018). Chad needs to harness ICT in oil exploration, and channel the returns into poverty alleviation programmes.

A number of programmes have been implemented to end poverty in Chad. For example, the Gavi Alliance, meant to address health issues such as vaccinations, provision of food vouchers through Emergency Agriculture Production Support Projects, provision of education through Chad Education Sector Reform Project (PARSET), reducing of water scarcity through the ResEau Project, and the Bharti Airtel ICT training programme (African Developement Bank Report, 2013).

Although these have all helped in poverty alleviation, some of them are not sustainable. For example, food vouchers provided under the Emergency Agriculture Production Support Project are a short-term panacea for poverty reduction. Once these vouchers are stopped, people in Chad will again be exposed to poverty and hunger. Therefore, ICT should be blended into all poverty alleviation strategies to ensure that long-lasting solutions are provided for poverty. This study therefore seeks to examine ways in which ICT can be used for poverty alleviation.

Comoros

Comoros has a population of 850,886 people (World Bank, 2020). Despite the Comoros Poverty Reduction strategy of 2010, the country is still battling with high poverty levels and has an estimated poverty level of 44.4% (World Bank, 2017). Key issues causing poverty in Comoros are lack of education, large family sizes, and high dependence on agriculture (World Bank, 2017: 56). The Gini coefficient (gap between the rich and the poor) is at 45% (World Bank, 2017: 61).This inequality is caused by differences in education and employment. ICT-wise, only a meagre 8% of the total population has access to the internet (World Bank, 2020). Research has proven that ICT is a necessary tool that can be used for reducing inequality in a society (Adams & Akobeng, 2021). The most important aspect for the SSA region lies in increasing ICT diffusion, to ensure that poverty and any forms of inequality are addressed.

Isaacs and Ngombo (2007) posit that Comoros uses ICT in its education sector throughout the country, but still faces challenges in developing sound ICT infrastructure. The country is not in a position of autarky, as it is dependent on donor funding (Isaacs & Ngombo, 2007: 7). The nation is also characterised by poor healthcare systems (World Health Organisation, 2020). The country need to channel

ICT towards poverty alleviation. ICT can be used in Comoros in many different sectors, such as education, health, agriculture, the fishing industry and the manufacturing sector. The country is rich in natural resources such as forests, arable land and water among others, but a large part of the population is not wealthy (World Bank, 2020). To help poverty alleviation, more ICT needs to be diffused into economic exploration of the abundant natural resources of Comoros.

Congo

Congo has a total population of 5 380,508 and a poverty level of 40.9% (World Bank, 2020). Despite the fact that the country is the third largest oil producer in Sub-Saharan Africa, a large proportion of the population lives below the poverty line (World Bank, 2020). The main cause of poverty in Congo is corruption.

In terms of ICT, the country abolished a monopoly in the telecommunication industry in 1997, but it is still battling with improving ICT infrastructure and quality service delivery to the ICT sector (Fall, 2007b). As such, low ICT usage affects the quality and delivery of education in Congo (Fall, 2007). Despite efforts by the Swiss QualiLearning Company in setting up e-learning facilities in Congo, more needs to be done in terms of ICT diffusion (Fall, 2007: 6). Key challenges that need to be addressed are high costs of acquiring ICT equipment, poor ICT policies, and lack of qualified ICT experts (Fall, 2007).

Furthermore, technology entrepreneurs in Congo were given a boost to start projects that could help improve the economy (Da Silva, 2015). The aid provided by Silicon Valley to Congo was in the form of internet and communication facilities.

Other organisations such as MTN have invested in building libraries in Congo in a bid to promote educational access (Da Silva, 2015). However, although such an initiative is good, it would have been better if ICT had been blended into the development of libraries. This would have ensured that all those libraries had digital connections and that students could access e-learning materials from diverse repositories. Thus, ICT still needs to be used as a tool in the education sector of Congo, and should be extended to the health sector as well. The Congolese health sector has 0.28 physicians and 1.91 nurses and midwives per 10,000 people (World

Health Organisation, 2020). ICT therefore needs to be channelled towards the improvement of health care in Congo. This research seeks to examine how ICT can be diffused for the purpose of poverty alleviation in Congo.

Democratic Republic of Congo

The country has a human capital index score of 0.37% and a population of 8,956,000. This implies that children born today in the DRC will be 37% less productive than children who have received full access to education and proper health care (World Bank, 2020). A total of 72% of the population live in severe poverty in the North-West and Kasaï regions of the Democratic Republic of Congo (DRC) (World Bank, 2020). High poverty levels in DRC have been caused by raging Ebola epidemics, high corruption levels, poor exploitation of natural resources and political conflicts, among other factors (Kalenga *et al.*, 2019).

In terms of ICT, only 8% of the total population have access to the internet World Bank (2020). In the education and health sectors, the use of ICT is very limited (Ngoma, 2010). Ngoma (2010) posits that ICT is the much-needed engine for economic growth in DRC. However, there has not been any plan to diffuse ICT into diverse sectors of the economy for purposes of poverty alleviation. Less than 1% of the Congolese lack access to banking systems and thus access to credit (World Bank 2018: 46). If ICT were diffused countrywide, the health sector would improve and pave the way to address Ebola, which has plagued the country since 1976, as well as other ailments that affect the country (World Bank, 2018: 63).

Côte d'Ivoire

The Côte d'Ivoire has a total population of 25,716,544 with a 44.4 % poverty level (World Bank, 2020). The country has partnered with Huawei in the development of their Digital Economy, which is called *Côte d'Ivoire Numérique 2030* (ITC & Telecom, 2020). Thirty-six per cent of the population uses the internet (World Bank, 2020).

Research has shown that the country is the first in Africa to use internet applications *(*Fall, 2007a). Although several educational institutions use ICT, the economy still faces challenges in developing more efficient ICT policies, high costs in acquiring ICT equipment, and political turmoil that affects ICT infrastructure development (Fall

2007). The country has a poor health infrastructure owing to previous armed conflict (United States Agency for International Development, 2020). ICT need to be channelled to all sectors to ensure that poverty is alleviated.

Djibouti

Djibouti has of a total population of 973 560, and a poverty rate of 22% (World Bank, 2020). Fifty-five per cent of the total population have access to the internet, World Bank (2020). The use of ICT in the education sector is fairly good, although the nation faces ICT obstacles such as high cost of connectivity and lack of sound ICT policies (Glen, 2007). The health sector has improved, though it faces obstacles such as poor facilities and limited use of ICT (Campos, 2013). ICT needs to be diffused in all sectors of the economy to ensure that poverty is alleviated.

Equatorial Guinea

Equatorial Guinea has a total population of 1,355,856, and a poverty rate of 76.8% (World Bank, 2020). The country has a mobile cellular subscription rate of 45% World Bank (2020). The country needs to address poor ICT policies, funding for ICT equipment, and better internet access in different sectors (Issacs, 2007). Reuter *et al.* (2014) posit that the health sector of Equatorial Guinea is plagued by a lack of modern facilities, and this affects the quality of healthcare delivery. Given all these challenges to the economy, there is room for ICT to be used in diverse sectors such as the health, education, and petroleum sector, among others. This will help in solving poverty as these sectors have the capacity for expansion, creating more jobs, which improves living standards.

Eritrea

Eritrea has a total population of 3,213,972 World Bank (2020). The country suffers from a high level of poverty, at 53% (World Health Organisation, 2008). In terms of mobile cellular subscriptions, the country has a rate of 20 per 100 people World Bank 2020). The country's health sector performs fairly well in ICT use (State of Eritrea and UN, 2014). However, the country still suffers from poor infrastructure in the health sector (World Health Organisation, 2008).

In the education sector, there is some evidence of ICT usage, but the country suffers from key ICT challenges such as insufficient computers, high costs of acquiring ICT equipment, limited ICT experts, and digital illiteracy levels (Hare, 2007). All these obstacles must be addressed, and ICT channelled to diverse sectors such as the oil and gas sector, banking, and education, among others. In the long run, this will help in poverty reduction as ICT will enable the opening up of more opportunities.

Ethiopia

Ethiopia has a total population of 112,078,730 and a poverty rate of 23.5% (World Bank, 2020). A total of 18% of the Ethiopian population have access to the internet, World Bank (2020). It has a With regards to mobile phone subscriptions of 37 per 100 people (World Bank, 2020). The country uses ICT in its education sector but ICT proficiency levels are low, and there is a digital divide (Alemu, 2017).

Ethiopia has managed to introduce e-commerce, which has enabled people to gain online access to a diverse range of goods and services (Singh, Yadav & Sahu, 2016). Furthermore, ICT has been introduced into the Ethiopian agricultural sector to improve productivity (Daniso & Kabaha, 2017). However, some farmers in rural areas are illiterate and hence are limited in the use of ICT in farming (Daniso & Kabaha, 2017). Poor infrastructure, lack of computers and limited internet access characterises the heath sector of Ethiopia (Asemahagn, 2015). The digital divide in Ethiopia as well as other ICT challenges faced must be solved. There is need for increased usage in ICT, and this should be done towards poverty alleviation.

Gabon

Gabon has made significant progress in ICT development (Hebga, 2017). Due to sound ICT policies, the nation has realized a drop in internet costs from US$18 to US$2.80 for the period 2010-2012, which has produced a seven-fold increase in the number of internet subscribers over the period (Hebga, 2017). This shows positive development in ICT access, (Hebga, 2017). Gabon is the sixth best performer in the African region in terms of ICT, and in 2017 it climbed ten spots on the Internet Development Index (World Bank, 2020).

Gabon launched the E-Gabon platform in collaboration with the International Bank for Reconstruction and Development (World Bank, 2017). The platform seeks to address health information aspects in Gabon. However, 33.4% of the total population of 217 2579 people in Gabon wallow in poverty (World Bank, 2020). Are the gains in ICT being channelled towards poverty reduction? More needs to be done in Gabon so that the high ICT usage is diffused towards poverty reduction.

Gambia

Gambia has a total population of 2,347,706 people, and a poverty rate of 48% (World Bank, 2020). Nineteen per cent of Gambians use the internet (World Bank, 2020). The mobile cellular subscription rate is at 110. (World Bank, 2020). Although ICT is used in educational institutions in Gambia, the people still struggle to gain access to computers and educator training (Ivongbe *et al.*, 2010).

Although the economy benefited from the World Bank's World Links for Development of ICT initiative, which is aimed at improving education quality through ICT, research has shown that the project was not successful in Gambia, due to the aforementioned factors (Ivongbe *et al.*, 2010). Poor funding in the health sector has affected its development, and the system is dependent on donor funding (Ministry Of Health Gambia, 2014). The banking sector in Gambia uses ICT, but the economy still struggles with high poverty levels (UNDP, 2020). There is a strong need for ICT to be channelled towards the country's productive sectors for poverty alleviation. This research explores the transmission mechanism used for ICT.

Ghana

As of 2016, Ghana had a total population of 30 417 856 and a poverty rate of 23% (World Bank, 2020). Thirty-seven per cent of the entire population has access to the internet (World Bank, 2020). The mobile subscription rate for Ghana is at 130 (World Bank, 2020). The agricultural sector of Ghana adopted the use of ICT for improving productivity (Munthali *et al.*, 2018a), and while the education sector uses ICT, there is a need for fuller utilization to improve the quality of education (Araujo, 2015). However, some educational institutions lack access to computers (Laary, 2015). This shows that ICT adoption rates may be still low, and this must be corrected for

poverty alleviation. Ghana has the fastest data penetration rate in SSA and boasts an efficient mobile money market (Oxford Business Group, 2020). This has contributed to higher economic growth as well as financial inclusion (World Bank, 2020).

However, the growth of technological firms in Ghana has been crippled by taxes and spectrum costs (Oxford Business Group, 2020). The country has seen the benefits of ICT in terms of poverty reduction and as such, taxes and spectrum costs must be reviewed to allow technological companies to expand, employ more people and produce more output, which in turn will help poverty alleviation.

Guinea

Guinea has a total population of 12.4 million (International Development Association, 2018) and has a poverty rate of 36% (World Bank, 2020).

In 2014, a total of 57% of all health facilities were classified as sub-standard (World Health Organization (WHO), 2014). In the education sector, some institutions use ICT but the country still suffers from low literacy rates (Fall, 2007a). Resource-wise, the country has abundant bauxite, gold, diamonds and other minerals (Sidiki, 2019), but despite this, citizens still suffer from absolute poverty.

In the financial sector, the use of mobile money is well developed (International Monetary Fund, 2020), and some banks use modern ICT infrastructure (International Monetary Fund, 2020). To increase production and economic growth, which will help poverty reduction in the long run, there is a need for more ICT to be channelled into the mining sector. This is because Guinea's mining sector is vast, and the country has many resources. All other sectors need ICT diffusion and this should lead to the creation of entrepreneurial opportunities, jobs, and higher economic growth. This Through the multiplier effect this could be prolific in poverty alleviation.

Guinea-Bissau

According to the World Bank (2020), Guinea-Bissau has a population of 1,920,922 and a poverty rate of 69%. Three per cent of the population has access to the internet (World Bank, 2020). The country lacks a robust national ICT policy and

sound ICT infrastructure, but there is proof of ICT usage in the education sector (Parsuramen *et al.*, 2007).

In the health sector, more ICT is needed to ensure the support of research and development on drugs as well as for machinery (NHRC, 2013). The country has rich deposits of petroleum, limestone, granite and other resources such as timber and fish, but the citizens continue to suffer dire poverty. There is a need for ICT diffusion for the exploration of all the aforementioned resources, and the agricultural sector requires digital technology for better output. In the long run, if implemented this will help in poverty alleviation. This study presents the way in which ICT can be used as a mechanism for poverty reduction.

Kenya

Kenya has a population of 52,573,973 and a poverty rate of 37% (World Bank, 2020). A total of 22% of the population has access to the internet (World Bank, 2020). The country has made significant changes in its digital sector, and this has benefited them in getting high output in the agricultural sector (Omulo & Kumeh, 2020).

The education sector performance has improved greatly due to digitalisation, and many entrepreneurs are taking advantage of ICT implementation to engage in profitable ventures (Piper *et al.*, 2016). For example, a lot of mobile money applications such as M-Pesa have been introduced to ensure ease of access to financial services (Ndemo, 2020). The health sector of Kenya adopted e-health systems to improve the quality of healthcare delivery (Osoti *et al.*, 2017). Research has shown that the technologically advanced mHealth programme has helped to reduce poverty in the country (Salte, 2014: 14).

However, according to (Salte, 2014), the country still faces some ICT challenges such as lack of skilled ICT experts and financial resources to purchase ICT equipment. If Kenya managed to reduce poverty through the MHealth ICT initiative, why are other Sub-Saharan African economies not tapping into ICT for poverty alleviation? If all the ICT challenges faced by Kenya are addressed and ICT is

channelled towards entrepreneurship and other sectors, the poverty levels would fall significantly.

Lesotho

Lesotho has a total population of 2 125 268 and a poverty rate of 49% World Bank (2020). Only 29% of the entire populace has access to the internet (World Bank, 2020). Gillwald, Deen-Swarray and Mothobi (2017) posit that the country suffers from limited capacity to install fixed network infrastructure, that it lacks broadband policies, has poor broadband penetration and an oligopolistic telecommunications industry. This implies that only a few players in telecommunications can bring more competition, which would drive prices down. Possibilities of tacit collusion exist in the industry, which has caused substantial price increases. In the education sector, very few people use the internet but some use mobile phones to access e-government services and banking services (Gillwald, Deen-Swarray & Mothobi, 2017).

In 2017, the adoption rate of online education was 30%, and access to electronic books in the education sector was 22% (Gillwald, Deen-Swarray and Mothobi, 2017). The country also managed to launch an e-governance system in an effort to improve public sector service delivery (African Development Bank, 2013) In the health sector, the country struggles with a poor health system but has benefited from World Bank funding to improve the sector (World Bank, 2016). The ratio of doctors to the population is 0.9 per 10,000 people (UNICEF, 2017). There is a need for ICT diffusion in all sectors of Lesotho's economy for poverty alleviation.

Liberia

Liberia has a population of 4,937,374 and a poverty ratio of 50% (World Bank, 2020). Only 7% of the population has access to the internet (World Bank, 2020). The country is making effort to introduce ICT into the education sector, but the usage rate is very low (Parsuramen *et al.*, 2007). In the health sector, there is evidence of ICT use, but the country is still struggling to deal with the consequences of disease and other problems such as power outages, which affect quality healthcare delivery (Gerrard, 2019); World Health Organisation, 2003).

Liberia has rich oil and gas reserves but lacks a well-developed industry for exploration of these resources (International Trade Administration, 2020). From this perspective, if ICT is used to modernise the oil and gas industry as well as other sectors, more jobs would be created and output would increase, *ceteris paribus.* This could help in poverty reduction as more jobs would enable people to live better lives and give them access to basic necessities. ICT diffusion is the way forward.

Madagascar

Madagascar has a population of 26,969,307 and a poverty rate of 70% (World Bank, 2020). Four per cent of the population has access to the internet and 40% own mobile cell phones (World Bank, 2020). In terms of fixed telephone subscription, the country has a rate of 0.26% (World Bank, 2020). These statistics show that rates of ICT usage in Madagascar are still very low, and there is a possibility of increasing ICT diffusion to help poverty alleviation. In the education sector, some institutions uses ICT for education services delivery (Isaacs, 2007). Many Malagasy people still face challenges in accessing quality healthcare, as facilities are sparsely located (Barmania, 2015).

The country has made efforts to bridge the digital divide in its rural areas by constructing 68 telecommunication towers. This was enabled through World Bank funding and funding from other stakeholders (World Bank, 2020). The initiative enabled farmers to contact clients via the internet, and some small businesses were developed due to the ICT initiative (World Bank, 2020). This is proof that ICT can turn things around in a society, and that it helps poverty alleviation. However, such initiatives should be extended to all sectors of the Malagasy economy to ensure that the 70% poverty level is reduced.

Malawi

Malawi has a total population of 18,628,747 and a poverty rate of 50% (World Bank, 2020). A meagre 13% of the entire population has access to the internet (World Bank, 2020). An estimated 47% Malawians own and use mobile phones (World Bank, 2020). Academic libraries in Malawi uses solar powered computer labs (Schweik *et al.*, 2020).

Rural schools have access to e-libraries through modern technology (Mikeka *et al.*, 2014). The use of renewable energy (solar) is desirable as it is environmentally friendly and helps environment protection (Liu *et al.*, 2020). The Malawian population remains one of the most poverty-stricken populations in Sub-Saharan Africa (World Bank, 2020). The country suffered colossal losses due to cyclone Idai in 2019. Infrastructure and property was destroyed, and 975 600 people badly were affected (Concern WorldWide, 2020).

The Malawian economy is based on agriculture, and a higher output could be achieved if ICT were channelled towards this sector and others. Key ICT challenges affecting Malawi are lack of skilled expertise and the high costs of internet and of acquiring ICT technology (One Young World, 2020). These challenges must be solved so that ICT can be diffused into diverse sectors for increased economic growth and to reduce poverty.

Mali

Mali has a total population of 19 658 031 and a poverty rate of 50% (World Bank, 2020). The number of people using the internet in Mali totals 12% (World Bank, 2020). This shows that very few people in Mali have access to the internet. With regard to mobile cellular subscription per 100, the rate is 1255 (World Bank,2020.)

In Mali, the usage of ICT in the farming sector appears to be prolific (Kante, Oboko & Chepken, 2019). However, if ICT is being used in other sectors such as education and health, why is it that the nation still battles a high poverty rate? There is also uneven distribution of private healthcare centres in Mali (World Bank, 2011), implying that access to healthcare is still limited. The rate of ICT diffusion in some sectors is very low, hence exacerbating the nation's high poverty levels.

Mauritania

The Mauritanian population stands at 4 525 696, and the country has a poverty rate of 31% (World Bank, 2020). Twenty per cent of the total population have internet access and mobile cellular subscription stands at 104% (World Bank, 2020). There has been some small progress in ICT usage in the education sector (Parsuramen *et al.*, 2007).

In the health sector, there is also evidence of ICT usage on a low scale, while the nation battles with communicable ailments (World Health Organization (WHO), 2015). However, in the education sector, the country lacks a robust ICT policy, but has managed to launch an e-governance system (Global Initiative for Inclusive ICT, 2020). The economy is agro-based, and there is an opportunity for ICT to be diffused at larger rates, which will ensure poverty alleviation.

Mauritius

Mauritius has a population of 1 265 711, and a low poverty rate of 10% (World Bank, 2020). Sixty-four per cent of the population use the internet (World Bank, 2020). Mauritius has good ICT infrastructure and has an e-governance system in place (Al-Awadhi & Morris, 2009).

In the education sector, there is evidence that the bulk of students use ICT although a smaller proportion have not yet adopted ICT (Vaghjee, 2014). Despite the country's adoption of Electronic Medical Records (EMR) for use in the health sector, there is still room for improvement in their quality of healthcare (Bhola & Beharee, 2016). Overall, the economy has managed substantial gains in its gross domestic product (GDP), due in part to the increase in numbers of ICT firms. The net contribution of ICT to the GDP in 2013 was 6,3% (Powell and Industries, 2015). If Mauritius has managed to use ICT to achieve higher economic growth and a low poverty rate, why not the rest of the Sub-Saharan Africa economies? More on this question will be presented later in the study.

Mozambique

Mozambique has been suffering political crises, especially recent attacks from insurgent groups (Mukeredzi, 2020). This has caused many deaths and high levels of poverty. The 2019 cyclone Idai left thousands of Mozambicans destitute (Salvucci & Santos, 2020). The country's population is 30,366,036 and there is a poverty rate of 46% (World Bank, 2020). Only 20% of the entire population has access to the internet, and the mobile cellular subscription rate for Mozambique is 47% (World Bank, 2020).

Although there is evidence of ICT usage in the education and heath sectors of Mozambique, the country requires massive investment in ICT (Nunes, 2010). In governance sectors, the country has managed to implement a computer-based voter registration platform (Gaster, 2002).

Some ICT is used in the mining of Mozambique's natural gas (Mahumane & Mulder, 2019), but lack of funding and poor ICT policies are the key stumbling blocks affecting full implementation of ICT in the country's diverse sectors (Gaster, 2002). These are still to be addressed, as ICT must be used as a mechanism for poverty alleviation.

Namibia

Namibia has a population of 2 494 530, and a poverty rate of 17%, and the total number of mobile phone subscriptions is at 113% (World Bank, 2020). In the private sector healthcare is generally good, due to it having a reliable infrastructure (SHOPS Project, 2012).

The Namibian government introduced ICT into the education sector for the sole purpose of improving quality education delivery (Book *et al.*, 2007a). The country suffers from extreme inequality gaps, poor water and sanitation, and poor public services. Some of the people living in rural areas are exposed to poverty at various levels (Schmidt, 2009). The economy still has an opportunity to harness ICT and achieve the high economic growth that can help in poverty alleviation. Although the country has relatively low poverty levels compared to other economies in SSA, poverty must still be eradicated.

Niger

Niger has a population of 23, 310 million and a poverty rate of 41% (World Bank, 2020). The country accommodates 221,671 refugees and 196,717 displaced people from neighbouring countries such as Nigeria (World Bank, 2020). Niger's economy is agro-based. Five per cent of the country's entire population has access to the internet, and mobile cellular subscription stands at 40%, with fixed telephone subscription per 100 people at 0.5% (World Bank, 2020).

Frederick (2020) posits that 20% of the Nigerien population suffer from food insecurity. The economy should harness ICT, mitigate the climate challenges it faces, and improve crop production through irrigation schemes. In 2007, the country invested US$50 million for the development of ICT, and this has enabled educational institutions to use ICT (Book *et al.*, 2007b). In the health sector, Niger needs to improve healthcare quality, which can be done through use of ICT (World Bank, 2004).

Nigeria

Nigeria is the largest oil producer in Africa. It has a total population of 200, 963, 599 people and a poverty rate of 38% (World Bank, 2020). The numbers of people who use the internet in Nigeria stands at 7%, and mobile cellular subscriptions total 88% (World Bank, 2020). The country still needs to improve its ICT usage in the banking sector and the oil industry (Ike, 2013).

In terms of ICT, the country is battling with poor ICT infrastructure, which affects the easy operation of businesses (Jeremiah, 2014). In the health sector, some effort has been made to integrate ICT, but the scale of adoption is very low (Ayanlade, Oyebisi & Kolawole, 2018b). There is evidence of ICT usage in the petroleum sector, but more could be achieved in terms of improving economic growth by using ICT (Tob-Ogu, Kumar & Cullen, 2018). In the education sector, ICT implementation has not been fully accepted as key players in this sector have been reluctant to move into the digital era (Olfin & Aniede, 2015). This has limited the use of ICT in the education sector as both teachers and students lack access to computers and other related technology (Ajegbelen, 2016).

Nigerians have been exposed to poverty due to political instability and attacks by Boko Haram (Hamid & Baba, 2014). However, poverty could be alleviated by introducing ICT into the farming sector and other sectors of the economy. Corruption in Nigeria needs to be reduced to ensure that the general populace benefit from all economic activities (Ojeka *et al.*, 2019).

Rwanda

Rwanda has a population of 12 626 950 and a poverty rate of 39% (World Bank, 2020). Twenty-one per cent of the population use the internet (World Bank, 2020). The Rwandan economy is regarded as one of the best that utilises ICT well, particularly in the health sector (Ben-Ari, 2014). It uses a number of ICT models such as the open Medical Records System (OpenMRS) and has established the Treatment and Research AIDS Centre (TRAC) (Ben-Ari, 2014). For governance-related issues, Rwanda developed an e-governance system (Caesar, 2005). This was done to improve public sector delivery and to attend to community needs.

Rwanda boasts the highest internet user growth rates in Africa, at 8900%, which is higher than that of the global village at 444% and that of African continent at 2450%, (Ben-Ari, 2014). Furthermore, Rwanda uses ICT in their education sector, although more needs to be done to ensure that private sector players incorporate ICT (Japan International Cooperation Agency (JICA) and International Development Center of Japan Inc. (IDCJ), 2012). Although the Rwandan economy has made some significant developments in ICT usage, the 39% poverty level needs to be solved. This can be done through the diffusion of ICT into the relevant sectors of the economy.

São Tomé and Princípe

São Tomé and Princípe has a population of 215,000, and is classified as having a low middle-income economy (World Bank, 2020). An estimated 30% of the entire population is poverty-stricken (World Bank, 2020). This is a small nation, but research has shown that it uses ICT in its education sector (Book *et al.*, 2007c). In terms of its health sector, the island has sound infrastructure and provides fairly good healthcare services (UNICEF, 2020).

However, the economy is prone to natural disasters and the need for modern ICT meteorological equipment cannot be over emphasized. This would help in the protection of vulnerable groups, especially children. The 30% suffering from poverty require rescue (UNICEF, 2020). ICT should be proposed as a solution for poverty alleviation in this economy.

Senegal

Senegal has a population of 16 296 364, and a poverty rate of 46%. Twenty-nine per cent of the population has access to the internet (World Bank, 2020). The country managed to get financial support of US$60 million from the World Bank in support of its ICT initiatives (World Bank (2020). A number of education institutions in Senegal use computers, but the computer-student ratio varies (Fall, 2007b).

More needs to be done to ensure universal access to ICT for all students in Senegal. Due to the outbreak of the coronavirus pandemic this has become crucial, as many students do not have the possibility of learning online (Teicher, 2020). In terms of education, Senegal needs to improve healthcare delivery, especially in its rural areas (Monteiro *et al.*, 2014). As Senegal is an agro-based country more ICT is required, especially in the agriculture sector. This will help in the creation of agro-based businesses and thus job creation, which will increase economic growth and poverty reduction.

Seychelles

Seychelles has a small population of 97 625 (World Bank,2020). Microsoft Partners in Learning introduced a training program in the country's education sector, with an aim of improving digital skills (Isaacs &Ngombo, 2007b). The United Human Development Index 2013 rated the Seychelles economy number one in Africa, and it is regarded as a country with exceptional healthcare facilities compared to all other African countries (United Nations Development Programme, 2018).

A total of 58% of the population have access to the internet (World Bank, 2020). This implies that 42% of the population do not enjoy the benefits that come with the internet, for example, job opportunities and e-commerce activities such as buying and selling online. The Seychelles poverty incidence rate for 2019 stood at 11.88% (Multidimensional Poverty Peer Network, 2020).

However, the Multidimensional Poverty Index for Seychelles comprises of four main categories: education, living standards, health, and employment (Multidimensional

Poverty Peer Network, 2020). The 2019 Poverty Index showed that in the Seychelles a significant proportion of the population were deprived of education. This was followed by employment and overcrowding (MPI Report, 2020). Figure 2.3 shows the headcount ratios for Seychelles.

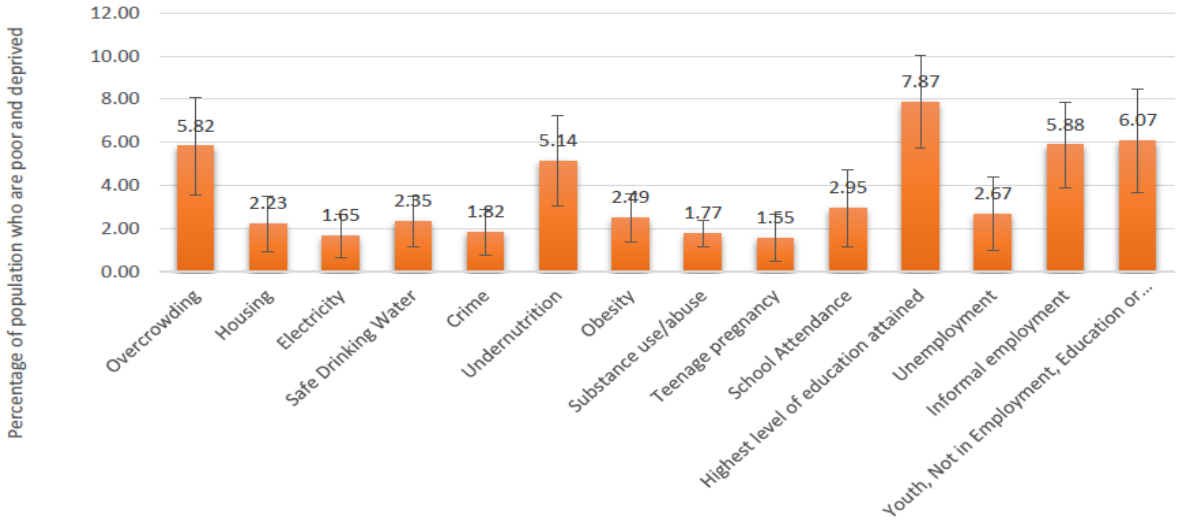

Figure 2.3: Headcount Ratios of Multidimensionally Poor Population, Seychelles (2019)

Source: (MPI Report, 2020:10)

Figure 2.3 shows the percentages of population in the Seychelles who are deprived of education, living standards, health and employment. Education has the highest frequency, followed by overcrowding, unemployment and under-nutrition. This implies that multidimensional poverty exists in the Seychelles and must be addressed. ICT should therefore be channelled into the education and health sectors, and must be diffused in such a way that job creation is guaranteed. This will lead to poverty reduction.

Sierra Leone

Sierra Leone has a poverty rate of 60% and a total population of 7,076,641. Life expectancy is 48 years. The nation has a weak agricultural system, poor

infrastructure, and high unemployment rates (United Nations Development Program, 2020).

Educational institutions have adopted ICT into their curriculum (Kalokoh, 2020). Key challenges in terms of ICT that affect the economy are that the business sector has little knowledge of the importance of ICT, the high t costs of ICT infrastructure, limited numbers of ICT experts, poor ICT mechanisms to support the health sector, and the lack of ICT in the governance sector (Sierra Leone Government, 2009). Were these challenges to be solved, poverty in Sierra Leone would be reduced.

Somalia

Somalia has a population of 15 442 905 people (World Bank, 2020). Only 2% of the total population use the internet in Somalia and the mobile phone subscription is 50% (World Bank, 2020). These statistics shows that the majority of Somalians are not exposed to the digital world and its associated benefits. The health infrastructure of Somalia remains poor and dilapidated due to on-going political instability (World Health Organisation, 2015).

The lack of a robust ICT legal framework hinders full development of the digital era in Somalia (World Bank, 2020). Large institutions such as the World Bank have implemented ICT connectivity in Somalia in an attempt to end poverty (World Bank, 2020). Despite these efforts, a large number of Somalians continue to suffer absolute poverty. Thus, there is a great need for ICT to be channelled towards the diverse sectors of Somalia such as health, education, the manufacturing sector and others, to alleviate poverty

South Africa

South Africa has a population of 59 552 700, and a poverty rate of 55.5%, and fifty-six per cent of the population have access to the internet (World Bank, 2020). The country was the first in the world to develop Automated Teller Machines (ATMs), in 2017 (Haughey, 2019). South Africa uses ICT in its health sector. In addition, the nation has managed to harness artificial intelligence to fight the coronavirus pandemic (Sivasubramanian, 2020). These efforts were made to ensure that healthcare service delivery improves in South Africa.

The South African government has an e-government platform that offers some short courses online. For example, the Nyukela Public Service Certificate, which is meant to equip those interested in taking senior positions in the public sector (South African National School of Government, 2020). In addition, the South African government launched a *Batho Pele* portal, meant among other things to improve service delivery and the lives of her people (Farelo & Morris, 2006). South Africa uses ICT in its diverse learning institutions (Meyer & Gent, 2016). Some universities use e-learning platforms, for example the University of South Africa. Table 2.1 below shows the extent of internet use in South Africa.

Table 2.1: Internet Use in South Africa

Provinces	Schools with computers	Schools using computers for teaching and learning
Eastern Cape	8.8%	4.5%
Free State	25.6%	12.6%
Gauteng	88.5%	45.4%
KwaZulu-Natal	16.6%	10.4%
Mpumalanga	22.9%	12.4%
Northern Cape	76.3%	43.3%
Limpopo	13.3%	4.9%
North West	30.5%	22.9%
Western Cape	82.4%	56.8%
National	39.2%	26.5%

Source: Mdlongwa, 2012

Table 2.1 shows that South Africa's Western Cape Province has the highest percentage of schools using computers and the internet (56.8%). The lowest percentage was recorded in the Eastern Cape, at 4.5%. This shows that all other provinces in South Africa with low rates of internet usage must be assisted by increasing internet access. This will ensure that quality education delivery is guaranteed. However, those with limited access to the internet may not benefit fully from internet services and may be exposed to a lower quality of education, which is often connected to poverty.

Some Technical Vocational Education and Training (TVET) colleges in South Africa do not have ICT. This implies that some of the students are marginalised in accessing quality education through ICT mechanisms. Although there are significant

ICT developments in the South African economy, poverty levels need to be tackled using ICT. South Africa faces high food poverty levels even in rural areas, and although the country is regarded as a food secure, many households face food insecurity (StatsSA, 2020). Given that rural areas in South Africa lag behind in terms of ICT and are poverty-stricken, there is a need for ICT diffusion for poverty alleviation (SA Human Sciences Research Council, 2020). ICT needs to be channelled to diverse sectors of the economy to ensure that more jobs are created, and that food security is achieved at household level.

South Sudan

South Sudan has been affected by civil war for many years (Blanchard, 2016). This has caused destruction of property, loss of lives, destruction of livestock and farm produce as well as exposure of the Sudanese people to poverty (Sobe Jermano Boyong *et al.*, 2018). Political instability and high poverty levels has also caused many people to migrate to other countries.

South Sudan has a population of 11 062 113, and a poverty rate of 82%. Seven per cent of the population has access to the internet, and the mobile cellular subscription rate is at 33% (World Bank, 2020). These statistics shows that usage of ICT is still very low in South Sudan. Almost all sectors of South Sudan are in a dire condition, and this has been attributed to the protracted civil war (Dylan, 2018). Key ICT challenges in South Sudan are high data tariffs, poor infrastructure, poor digital literacy rates, and poor ICT policies (Amarnath *et al.*, 2018a). ICT must be diffused into the oil exploration sector, and into education, health and all other sectors to ensure that more than half of the population (82%), are rescued from the jaws of poverty.

Eswatini

Eswatini has a population of 1 148 130, and a poverty rate of 58% (World Bank, 2020). Eswatini has serious ICT challenges. For example, the country has poor ICT infrastructure and little government funding for ICT projects (Glen, 2007).

However, telecommunication players in Eswatini such as MTN have introduced a price cut for data in a bid to increase access to all users, and also for the promotion

of entrepreneurial citizens (Moyo, 2020). Given that initiative, it boggles the mind why the poverty levels remain high. Low data costs should act as an incentive for corporates to engage into more e-commerce activities, which in turn helps employment creation and poverty alleviation through the multiplier effect. ICT must be diffused towards poverty alleviation in Eswatini, and this research will present the mechanism that can be used.

Togo

Togo has a population of 8 082 366, and a colossal poverty rate of 55%. The total number of people with access to the internet is 12%, and there are as many as 6 239 183 people who use mobile phones in Togo (World Bank, 2020). The education sector in Togo is still improving in terms of harnessing ICT(Fall, 2007b). Key obstacles that need to be addressed are lack of funding by tertiary institutions to harness ICT, poor ICT policies, and poor government support (Fall, 2007b). Togo faces problems in the health sector, as the technology used is obsolete and dilapidated. This shows that for poverty reduction, Togo needs to increase ICT in the education sector, the health sector, and other sectors.

Uganda

Uganda has a population of 44 269 594, and a poverty rate of 21% (World Bank, 2020). It has an internet penetration rate of 21%, and a fixed telephone subscription per 100 of 0, 43 (World Bank, 2020). These low internet penetration rates imply that those without internet access lose the opportunities that come via the internet. As noted by Masceluti (2015), other regions, for example Asia, have benefited (reduced poverty) from the use of the internet. The Ugandan government has integrated ICT into the education sector and this has helped in improving quality education services delivery (Museveni, 2014).

In the health sector, telemedicine is used in some parts of Uganda, but more still needs to be done to harness modern ICT in the health sector (Litho, 2010). The missing link is how to harnessed ITC to ensure that the Ugandan people living in poverty benefit? This study will further explore this question.

Tanzania

Tanzania has a population of 58 005 463, and a poverty rate of 26.4% (World Bank, 2020). In 1974, the government passed a law banning the use of computers and televisions, but reversed it ten years later (Matsubayashi, Takahashi & Hatta (2007: 5). This implies that if the country had been allowed to adopt ICTat an early stage, it would have developed well and by now the poverty levels would be far lower than they are at present. Increases in poverty can therefore be caused by poor governement policies. The Tanzanian people who were denied access to computers, were effectively denied access to life-changing opportunities such as e-commerce, online jobs, and others. A mere 16% of the entire population of Tanzania currently have access to the internet (World Bank, 2020).

The health sector in Tanzania has implemented an e-health system for improved service delivery(MoHSW, 2013). The Tanzanian economy uses ICT in its education sector, although a number of challenges affect its full utilisation. Some of these challenges are unreliable power supply and poor financial resources to cater for ICT costs (Matsubayashi, Takahashi & Hatta, 2007) Tanzania has a large population and if it was empowered through ICT, poverty levels could reduce significantly. There is a need for the exploration of how ICT can be used as a tool for poverty alleviation, and this research will examine this aspect.

Zambia

Zambia has a total population of 17 861 030, and a poverty ratio of 54%. The nation registered a decrease in the number of people using the internet from 27% in 2017 to 14% in 2018 (World Bank, 2020). More on the causes of this drop can be examined in other research papers. In some farming sectors of Zambia, modern equipment is being used, although this has been blamed for increasing unemployment (Adu-Baffour, Daum & Birner, 2019). Zambia launched an e-health system to provide quality healthcare services to its people (Orbell *et al.*, 2013).

Technology is being used in Zambia for information dissemination to farmers through phones (Souter, 2010). The Linknet project was launched to provide internet to rural

areas (Souter, 2010). In as much as the rural areas have access to the internet, why is it that poverty levels remain high? Is the internet being used for activities that generate wealth? Chances are high that ICT is not being efficiently and effectively channelled towards poverty reduction. The Zambian economy faces ICT challenges especially in acquiring modern infrastructure, due to high costs and the fact that a number of consumers lack ICT skills (Souter, 2010).

Zimbabwe

Zimbabwe is one of the poverty-stricken economies of Sub-Saharan Africa (Phiri *et al.*, 2020). The country has a population of 14 645 468, with a poverty level of 38.9% (World Bank, 2020). Only 27% of the total population in Zimbabwe use the internet (World Bank (2020). Diverse economic quagmires such as high unemployment, low levels of GDP, closure of industries, high inflation, poor healthcare and a poor investment climate among others, have left the masses wallowing in deep mire and absolute poverty (Makoni, 2020).

In terms of ICT, some higher learning institutions have developed e-learning platforms, though some are still lagging behind. Midlands State University, for example, uses an e-learning system, whereas the National University of Science and Technology posted student results on notice boards due to a lack of e-learning technology. Zimbabwe exports raw minerals due to the country's lack of modern technology for further refining (Mabuwa, 2014).

In the agricultural sector, many farmers operate below capacity and little has been gained from these farms since the fast track land reform programme (Chitsike, 2003). More ICT diffusion is needed in most sectors to improve health, education and the general living standards of Zimbabweans. This study seeks to present how ICT can be used for poverty alleviation in Zimbabwe.

2.1.3 Challenges in the investment of ICT in Sub-Saharan Africa

Economies in Sub-Saharan Africa are faced with diverse challenges as far as ICT diffusion is concerned. These challenges are absence of sound ICT policies, high data costs, high capital costs for ICT infrastructure, poor government support, and lack of financial and non-financial resources (Mathevula &

Uwizeyimana, 2014). For example, Zambia faces ICT challenges due to the high costs for ICT infrastructure. This could be alleviated by the government and private players developing sound ICT polices that enable the easy and affordable acquisition of ICT equipment (Souter, 2010). South Africa, for example, suffers from high data costs (Cristea, 2016). This affects the less privileged, as they have limited access to internet services such as e-banking and e-learning services.

2.1.4 ICT programmes and policies in SSA

This section presents the ICT programmes and polices implemented in SSA towards poverty alleviation.

ICT Capacity-building in SSA

This program was implemented by the Swedish International Development Cooperation Agency (SIDA) for ICT in developing regions, and the Swedish Post and Telecom Authority (PTS). SIDA provided the funding for the project. Twenty countries in SSA joined the program, which has been successful. Its key achievements are that rural areas in Kenya have access to broadband services, and Uganda's ICT underground infrastructure is now protected (Swedish Post and Telecom Authority, 2018: 6). However, the other 28 economies of SSA are not part of the programme, and if only 20 nations form part of this ICT program, the rest will remain plagued by poverty. Poverty has no borders and affects everyone.

Regional Communications Infrastructure Program (RCIP)

The World Bank launched the RCIP in 2007 in a bid to address the ICT challenges faced by Sub-Saharan Africa (World Bank, 2013). The World Bank funded the program with US$420 million. The program proved successful, as private investment in telecom infrastructure in SSA increased from $5 billion in 2005 to $7 billion in 2006 (World Bank, 2013: 3).

The SSA total phone penetration rate increased from 13.4% to 24.6%, due to the RCIP. Ghana also benefited from an e-government program that came as a result of the RCIP. The e-government program enabled Ghana to collect more revenue for its

customs department (World Bank, 2013). The SSA economies that benefited from the RCIP, needed to channel such benefits towards poverty alleviation in their countries.

Regional Infrastructure Development Master Plan and the ICT Sector Plan

The Southern African Development Community (SADC) developed the Regional Infrastructure Development Master Plan (RIDMP), which was adopted in Maputo, Mozambique in 2012. The aim of the plan was to reduce costs to telephony and Internet infrastructure in the region. The plan also aimed to ensure that the SADC block would embrace the digital divide by 2027 (SADC, 2012).

However, more needed to be done to ensure that the aim of the plan materialised, since the state of ICT in Africa at large was poor. This is substantiated by the previous discussion, which showed that even now, many economies still have low internet and mobile phone usage as well as low fixed telephone usage. Equally related to the development of ICT in Africa, SADC implemented an e-SADC Initiative for capacity building (SADC, 2020). However, although at regional level there is an e-platform, a number of countries in SSA do not have e-government platforms that can be used to improve governance and tackle poverty issues. As the member states initiated the idea of a regional e-platform, the same should be done at country level for poverty alleviation.

2.2 White Paper: Harnessing Innovation and Emerging Technologies to Address the Impact of COVID-19 in Africa.

The African Union Development Agency (AUDA-NEPAD) developed the policy. Its aim is to ensure that technology is used to address coronavirus in the region (African Union Development Agency, 2020). This implies that the policy is indirectly aimed at addressing poverty, because lack of access to healthcare is regarded as poverty. The initiative to use ICT in fighting disease is therefore a noble cause, though it must not be limited only to the coronavirus. It will be highly beneficial if ICT is channelled towards fighting diseases affecting SSA such as malaria, tuberculosis and other non-communicable illness.

2.2.1 Lack of financial and non-financial resources

Investment in ICT often requires massive financial and non-financial resources. Non-financially, there is need for ICT experts which are often in short supply. Sub-Saharan economies tend to suffer from poor financial stamina in order to acquire and invest in modern ICT technology. For example, the Beitbridge Boarder Post uses antiquated technology, yet it is one of the busiest border posts that connect Zimbabwe and South Africa.

As some SSA countries offer poor remuneration, they fail to attract skilled ICT personnel and consequently they tend to lag behind in ICT diffusion. Therefore, there is need for economies in Sub-Saharan Africa countries to offer attractive remuneration and source sufficient financial resources for ICT development. Figure 2.4 below summarises the ICT challenges faced by Sub-Saharan Africa.

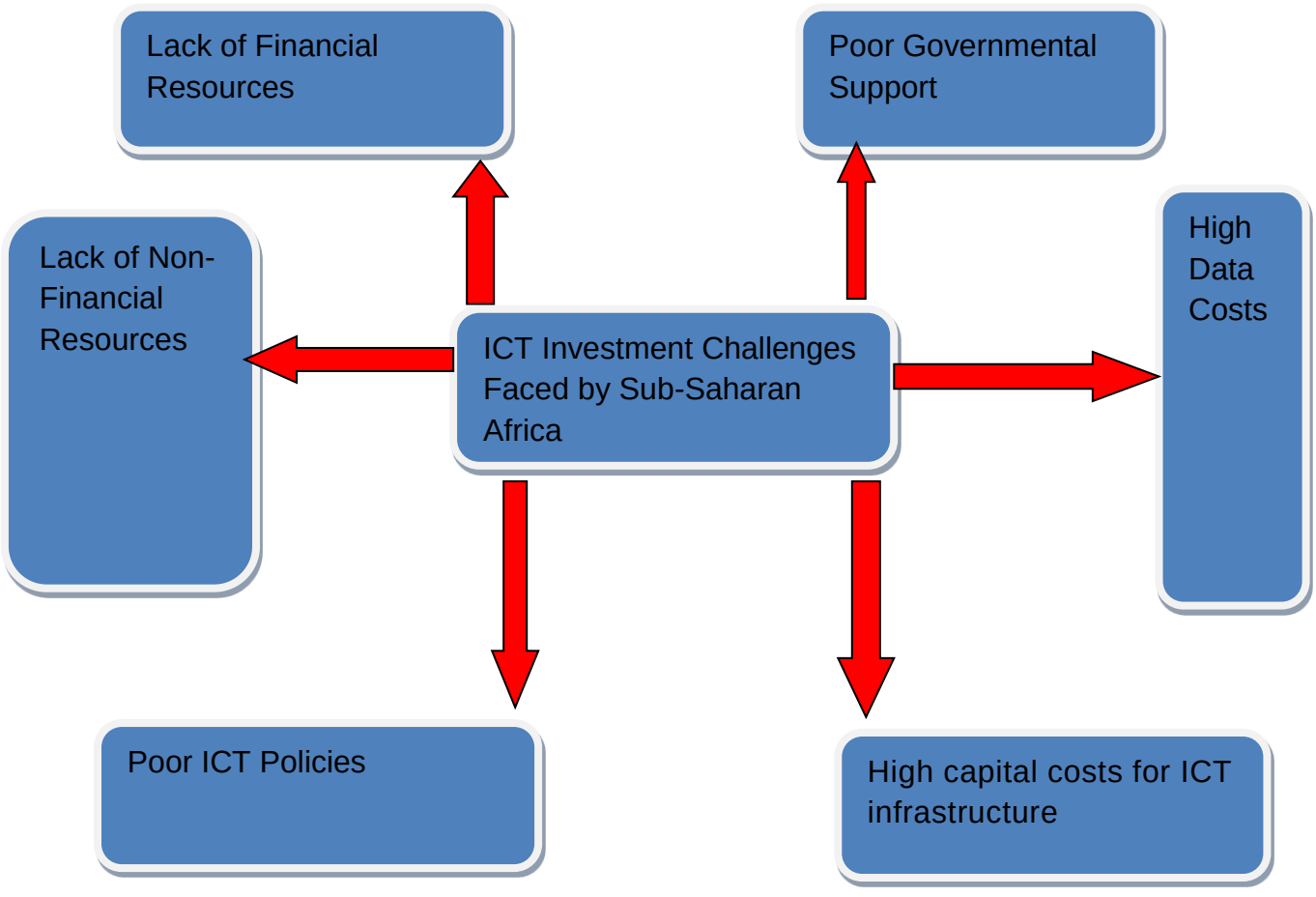

Figure 2.4: ICT Investment Challenges Faced by Sub-Saharan Africa

Source: Researcher's construct

Figure 2.4 shows a summary of the ICT investment challenges in Sub-Saharan Africa. The Figure has been used for illustrative purposes and depicts that Sub-Saharan Africa suffers from high capital costs, poor ICT policies, lack of skilled expertise, lack of financial resources to acquire ICT infrastructure, and poor governmental support. These challenges have resulted in high poverty levels in the SSA region. Some SSA countries suffer from high data costs, which affect their low-income earners.

2.3 POSSIBLE BENEFITS OF ICT IN SUB-SAHARAN AFRICA

Diverse benefits can be enjoyed by economies from ICT diffusion. Some of these benefits can be in the form of job creation, industrialisation, improved economic growth, and a reduction in environmental hazards (Handley *et al.*, 2009). South Africa benefits from ICT through e-learning platforms, which have enhanced the quality of education (Bagarukayo &Kalema, 2015: 13).

In Zambia, mechanistic programs have been found to be beneficial in increasing farm incomes as well as their agricultural output (Adu-Baffour, Daum & Birner, 2019: 10). It can therefore be concluded that the more ICT is used in the farming sector, the more prolific the results will be in Sub-Saharan Africa countries, *ceteris paribus.* The use of ICT has, in some contexts, been productive in poverty alleviation, for example in Kenya (Flor, 2016). Prior research discovered that the youth in Kenya used mobile phones to carry out certain economic activities for which they earned income, hence there was a significant drop in poverty levels in that country (Flor, 2016: 140).

This implies that improvement in quality of life is attributable to the use of technology. As a result, while access to ICT may not reduce poverty in and of itself, the ways in which ICT is used can aid in poverty alleviation. Thus, ICT can be viewed as a driver or a mechanism through which poverty can be reduced.

The role played by ICT in poverty reduction can be direct or indirect. A direct way in which ICT can impact poverty reduction is, for instance, when a group of people have access to mobile phones, which reduce social exclusion by connecting people to network with family and friends. Thus, social capital is increased and vulnerability

is decreased (Flor, 2016: 255). Indirectly, ICT can be used as a tool in reducing poverty. For example, SMEs can use ICT to create jobs. Salaries earned by the workers can be used for income-generating projects at home, such as poultry or even asset acquisition, which in turn improves their physical capital (Flor, 2016).

However, in practical terms, it is essential to ensure that other key macro-economic fundamentals such as inflation and employment are well balanced in order to achieve higher economic growth and help poverty alleviation, because inflation and unemployment adversely affect economic growth (Mohseni & Jouzaryan, 2016: 1). From an environmental perspective, it was discovered that ICT technology can be used for reducing carbon dioxide emissions per head of population (Simplice, 2016: 12). Figure 2.5 below summarises the benefits of ICT in Sub-Saharan Africa.

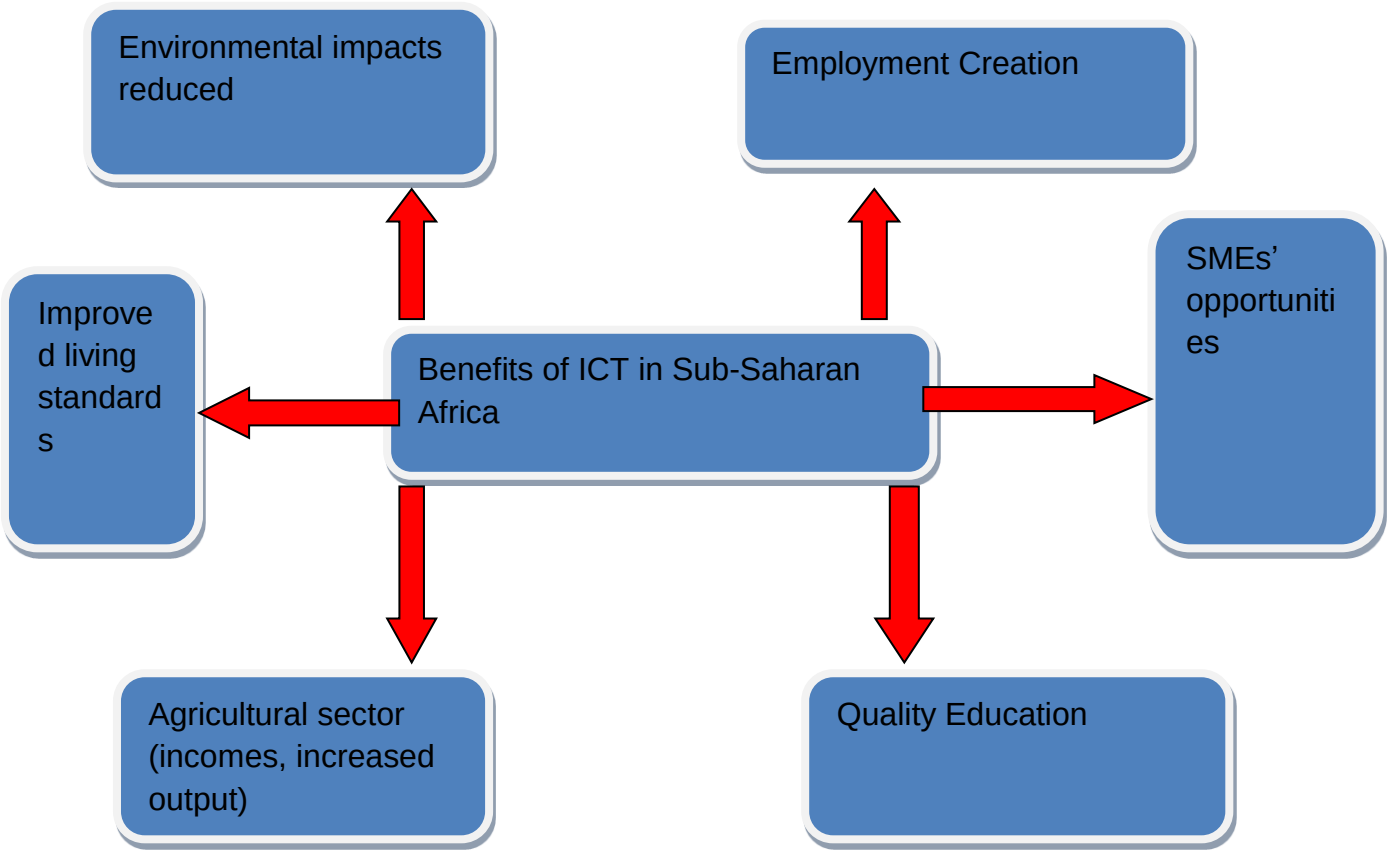

Figure 2.5: Possible Benefits of ICT in Sub-Saharan Africa

Source: Researcher's Construct

Figure 2.5 summarises the key benefits of ICT in Sub-Saharan Africa. However, more needs to be done to ensure that SSA countries maximize the usage of ICT and

that they produce sound policies that promote ICT diffusion to ensure that poverty is reduced. This study therefore seeks to examine how ICT diffusion can also be used as a tool to reduce poverty in Sub-Saharan Africa. The sections above have shown that benefits that can materialise from the use of ICT. However, since all SSA countries have diverse ICT diffusion, poverty remains a common enemy that requires collective effort.

Mbuyisa and Leonard (2016) carried out a study on SMEs' usage of ICT in poverty alleviation. Their research findings showed that the use of ICT by SMEs helped to improve profitability and job creation while it increased labour productivity and administrative efficiency (Mbuyisa & Leonard, 2016: 5). This depicts that ICT can be used as a tool for fighting poverty. When more jobs are created, more people become employed and earn income that capacitates them to meet their food and other requirements, hence the number of poor people decreases.

However, some key challenges that SMEs face include lack of business opportunities, capital constraints, information asymmetry and lack of trust in using ICT tools (Mbuyisa & Leonard, 2016: 4). It is therefore clear that all stumbling blocks which affect full capacity utilisation of ICT by SMEs should be addressed to ensure that poverty alleviation becomes a reality.

Finally, through digital finance techniques, SMEs can play an important role in providing credit and financial services (Ozili, 2018). This is advantageous because digital mechanisms can help people who live in remote areas. Access to funding plays an integral part in business start-ups and this can translate into growth for SMEs, which in turn leads to job creation and poverty reduction.

2.3.1 Continental Analysis on Overview of Benefits of ICT Investment and Poverty Reduction

This discussion centres on the benefits of ICT investment, with specific focus on selected economies on various continents. For example, Asia, Europe and Africa, among others.

ICT can be channelled into different sectors of an economy for poverty alleviation. Poverty is multidimensional and incorporates low education and possible illiteracy issues. The use of ICT is regarded as a useful tool in transforming primitive pedagogy to a virtual learning environment (Aftab & Ismail, 2015: 24). In Pakistan, increased ICT diffusion has led to increased literacy levels. Thus, as more people acquire education, information asymmetry on available life-changing opportunities is reduced. People are informed about job opportunities, which improve their standard of living while also reducing poverty. ICT is regarded as a useful tool for increasing access to global markets in the Southern African Development Community (Mogotlhwane, Talib & Mokwena, 2011: 61). However, there is no clear research of how ICT can be channelled towards poverty reduction. This research seeks to bridge that gap.

In Europe, it was discovered that high ICT usage is positively correlated to high quality of life (Nevado-Peña, López-Ruiz & Alfaro-Navarro, 2019: 3). It can therefore be deduced that low ICT usage can be correlated with low quality of life. Although it would be a mammoth task to ascertain the degree of lowness in quality of life, it can be said that low quality of life is often caused by poverty ((Nadimi, Tokimatsu and Yoshikawa, 2017). Other economies that benefit from high usage of ICT in central Europe include Germany and Slovakia (Becker, 2018: 9). Their substantial investment in ICT has yielded increased productivity in their enterprise sectors, leading to increased production of goods and reduced poverty levels.

Through ICT application, China carried out a program of capacity building for poverty reduction (Yanfeng & Qingjie, 2019). The program aimed at ensuring that poverty was alleviated through tailored ICT strategies that improved information dissemination, internet coverage, and promotion of e-commerce activities, which helped to reduce poverty levels in China (Yanfeng & Qingjie, 2019: 44).

Access to quality information on ways to do business in the modern way is important for productivity. However, some SME players in South Africa are ignorant of the benefits of using ICT in their businesses (Motlhanke, 2019: 7). This becomes a barrier in ICT investment and thus causes difficulties in the eradication poverty.

Government funding and training assistance would help improve ICT adoption and usage, and has proved successful for SMEs in Botswana (Chube, 2015: 64).

However, in the African context, a number of governments operate on shoestring budgets. Funds allocated for ICT initiatives can be meagre, and this limits ICT investment and realisation of its benefits. Given that status quo, it is essential to examine transmission mechanisms that can be used to channel ICT in poverty alleviation.

In 2019, Indonesia had more than 109 million internet users and high corruption levels (Sabani, Farah & Sari Dewi, 2019: 3). High corruption levels imply the diversion of resources from their intended users. Corruption promotes high poverty levels when resources that are intended for the benefit of the majority are purloined (Nur-tegin & Jakee, 2020: 2).

Research has proven that the introduction of e-governance in Indonesia helped to reduce corruption levels (Sabani, Farah & Sari Dewi, 2019: 7). Investment in ICT, particularly e-governance, helps in the fight to reduce corruption and poverty. Although some African countries such as South Africa are tapping into e-governance, they still face many challenges in the efficient operation of e-governance systems (Meyer, 2019: 6).

Africa is regarded as the world's most corrupt continent (Seko & Chiluba, 2020: 1). In Chapter 1, it was clearly stated that Africa has high poverty levels. Indonesia, as an Asian country, benefits from ICT initiatives such as e-governance in reducing corruption and improving standards of living. The emphasis is on countries in SSA to tap into technology as what was done by Indonesia in reducing corruption through the use of technology. There is a possibility for SSA to tap into those benefits through ICT, and reduce its corruption levels and fight poverty at the same time.

2.4 SUB-SAHARAN AFRICA ANALYSIS

Sub-Saharan African countries have low ICT diffusion rates, the main reason being poor implementation of ICT policies, while some ICT policies may adversely affect the prices of ICT-related products. For example, in South Africa 1 GB of data is twice as expensive compared to other neighbouring countries (Gillwald, Mothobi

& Rademan, 2018: 112). This implies that the proportion of people who cannot afford that data are exempted from enjoying the benefits of using ICT-related facilities. This could be a push factor in exposing such people to poverty. Sound ICT policies can foster economic growth. However, sound ICT policies cannot be regarded as necessary and sufficient conditions for economic growth and poverty alleviation, but it plays an important role in enhancing economic growth and aids in reducing poverty levels (Bohlin, Hanafizadez & Vu, 2017).

Karakara and Osabuohien (2019) examined the demand side of ICT and banking services in West Africa. Their study findings revealed that socio-economic factors such as levels of education, income, age, and gender influenced ICT diffusion in West Africa (Karakara & Osabuohien, 2019: 2). They found that female headed households in Ghana had a lower demand for banking services relative to those in Burkina Faso (Karakara & Osabuohien, 2019: 9).

The above research findings show a need for information dissemination on banking services. Banking services can help those living in poverty as some remittances from family members in the diaspora are done through the banking sector. This means that those without access to banking may suffer. However, it should be noted that remittances cannot be viewed as a remedy for poverty reduction, but research has shown their importance in reducing poverty (Ogunniyi *et al.*, 2020). Remittances may not be sustainable in poverty reduction, but they are helpful.

Government support remains relevant in supporting ICT programmes and policies in Sub-Saharan Africa. This support can be in the form of sound ICT policies, opening up markets, and reduction of monopolies in the ICT sector. For example, due to poor government support it took years for Econet Wireless to be licenced to operate in Zimbabwe (Nsehe, 2013).This implies that government laws were too restrictive and had affected competition and quality, as state-owned telecommunication firms were offering substandard services.

However, once Econet became licenced, more jobs were created and philanthropic scholarships were offered to students by the Higherlife Foundation. In other words, if opportunity costs are taken into account, Zimbabwe lost a great deal over the years during which the country refused registration to ICT and telecommunication firms.

Mushtaq and Bruneau (2019) researched the role of ICT on poverty and inequality reduction in low- and high-income countries. Their study found that ICT is a key enabler in positively influencing economic growth (Mushtaq & Bruneau, 2019: 12), and that ICT has helped reduce poverty and inequality, as more goods and services were produced. This study shows that information communication technology is a useful mechanism that enables poverty reduction.

Key insights drawn from the Mushtaq and Bruneau (2019) study are that digital finance can be achieved through the use of ICT, which in turn can help reach marginalized populations. Thus, access to e-financial services helps in poverty alleviation. However, this can only be achieved if the government offers maximum support and allows for some degree of competition among the ICT players. Although government regulation is key in avoiding monopoly emergence, there must be enough room for healthy competition to exist. This enables economies to fully benefit from ICT investment.

2.5 SUMMARY AND CONCLUSION

This chapter presented the literature on poverty and ICT in Sub-Saharan Africa. The focus was on investment in ICT and how it has reduced poverty. It was found that countries which invested heavily in ICT have relatively lower levels of poverty. The potential benefits of ICT diffusion are increased job opportunities, increased government revenues, a stronger balance of payments position, and creation of entrepreneurial opportunities. This is from a supply-side perspective. When all these opportunities are utilized, poverty reduction is supported. Structural forms of poverty can be addressed when there are abundant employment opportunities and income is earned. ICT diffusion can indirectly result in rural areas development, financial deepening, improved productivity of manufacturing companies, and capital accumulation. For this to be achieved there must be sound and effective ICT and poverty reduction policies in place. Empirically, it has been proven that some economies have benefited from the use of ICT. ICT diffusion in SSA must be prioritised in order to reduce poverty. Although poverty cannot be completely eliminated, SSA has lagged behind in ICT diffusion. This has been shown through an

in-depth analysis of individual country investment in ICT in SSA, and the specific sub-sectors these economies have invested in. As such, there is need for ICT to be diffused in Sub Saharan Africa to alleviate poverty.

CHAPTER THREE: LITERATURE REVIEW

3.1 INTRODUCTION

This chapter presents the literature relating to theories connecting ICT, development, poverty, and growth. The first focus is based on theories of ICT development and growth. Key theories discussed are the Schumpeterian Theory, the Behavioural Decision Based Theory, Classical Growth Theories, Neoclassical Theories, the Harrod-Domar Model, the Solow-Neoclassical Growth Model, and the New Growth Theory (NGT). A discussion follows on theories of poverty, the Classical Theory of Poverty and perceptions of poverty causes. Furthermore, measures of poverty are discussed such as Poverty Lines, Headcount Index, Poverty Gap Index, Watts Poverty Index, the severity or FGT2 Index, and the Human Poverty Index (HPI), followed by a presentation of ICT and poverty perspectives. The focus is on global perspectives such as European, Asian and North-American contexts, Sub-Saharan Africa, and country-specific perspectives. An empirical analysis on ICT and how it impacts poverty is examined, and an overall conclusion is presented.

3.1 THEORIES OF ICT DEVELOPMENT AND GROWTH

Economic growth is essential for poverty alleviation (Nakabashi, 2018: 456). However, economic growth cannot be solely treated as the only necessary and sufficient tool for reducing poverty. Diverse theories of economic growth have been propounded and new theories continue to emerge (Dunga, 2014: 13). Figure 3.1 below maps ICTs and poverty eradication. ICTs can be used as a tool to reduce poverty, bringing both economic and non-economic benefits.

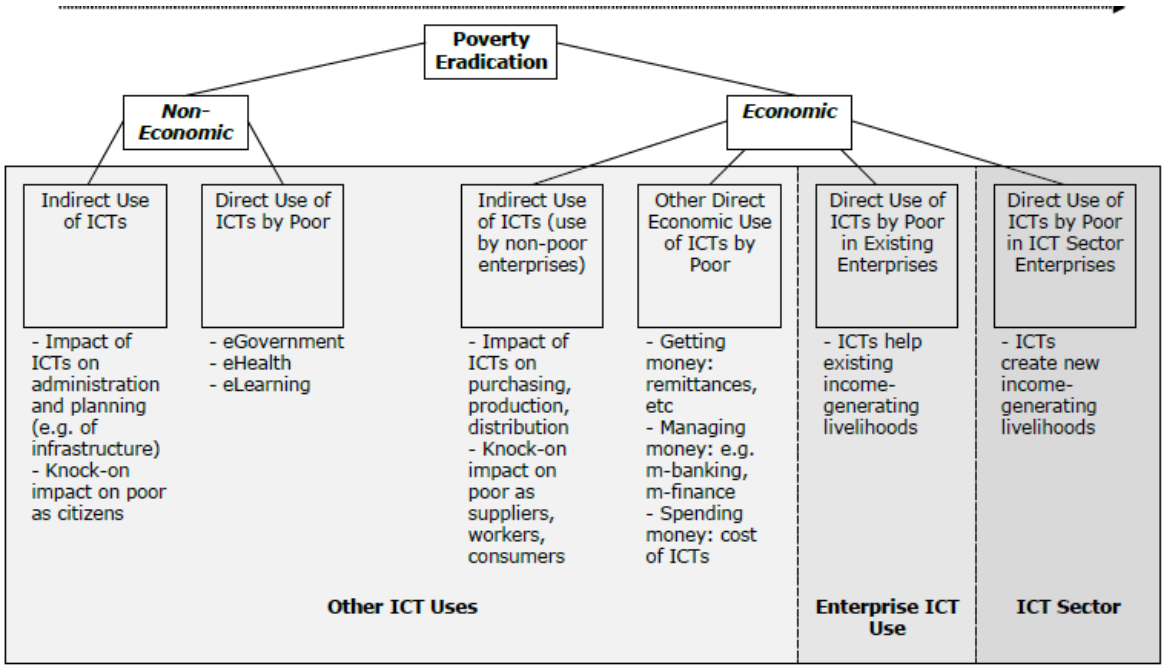

Figure 3.1: Direct and indirect use of ICT in an economy

Source: Heeks, 2014:9

Figure 3.1 shows that the non-economic benefits can accrue as a result of the direct or indirect use of ICT in an economy. Indirectly, ICT can be used to enhance sound administration and planning, especially in the public sector (Heeks, 2014: 13). For example, if a government department introduces modern methods for paying social welfare recipients, the overall effect is on the entity. Of course, the social welfare beneficiaries will benefit indirectly through improved efficiency and the release of their grants. However, introduction of modern technology should be complemented with sound education campaigns (Padli, Ahmat & Nawawi, 2019). These would help the intended recipients and assist in the effective use of technology and poverty reduction.

Direct benefits that could accrue for the poor due to the use of ICT would be in the form of improved service delivery from e-government services, e-health or e-learning platforms. Africa has the potential to tap into e-health to improve access to healthcare, though it would be a mammoth task due to poor health systems and poor ICT infrastructure (Olu *et al.*, 2019). Long-terms use of ICT in the health sector would help poverty eradication particularly if the majority of people had access to healthcare.

Economically, indirect use of ICT by enterprises could lead to increased production and business expansion. Increased output of goods means an increase in economic growth, and an increased supply of goods helps to lower prices, to the benefit of low-income earners. Business expansion implies that enterprises will hire more people, and as unemployment rates fall, poverty reduces (Gómez-Plana & Latorre, 2019).

The direct benefits of ICT usage by the poor can be in the form of bank remittances. Banking institutions now offer online banking, thus reducing travel and its costs. For example, Econet Wireless partnered with Mukuru to allow citizens in foreign economies to send money directly to recipients in Zimbabwe (Gambanga, 2016). The system allows the receiver to access the funds as long as they are Econet subscribers. Thus, technology enables even those in rural areas to receive their remittances. This implies that the use of ICT can also have a saving effect for consumers, which increases their disposable and helps to reduce poverty. From this perspective, it is clear that the use of ICT can help in the improvement of livelihoods and poverty reduction (Ofori, Armah, Taale, & Ofori, 2021).The following discussion is based on the Livelihoods Framework, as seen in Figure 3.2.

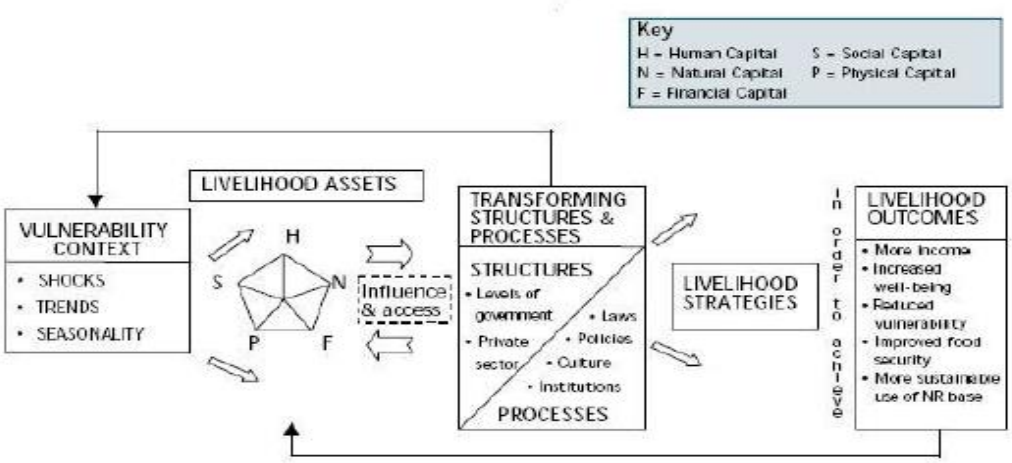

Figure 3.2: Livelihoods Framework

Source: Heeks, 2014:12

The Livelihoods Approach hinges on providing a fundamental view on poor people's financial aspects and their poverty (Heeks, 2014: 15). ICT can be used for networking health experts, thus improving human capital. Furthermore, ICT training can aid in improving people's empowerment levels, which implies improvement in

their political capital. It can be assumed that less privileged entrepreneurs can use ICT to network and search for new contacts and business opportunities. This in turn improves their livelihoods and helps in reducing poverty levels, provided the entrepreneurs are successful (Heeks, 2014).

Family members and friends (social capital) are the most common source of labour for poor households (Mahfud *et al.*, 2020). The success of a poor entrepreneur may improve the family's standard of living due to his/her asset accumulation (Hernández-Carrión, Camarero-Izquierdo & Gutiérrez-Cillán, 2019). Overall, government and private sector policy influences livelihoods in different ways. Sound ICT policies often yield improved livelihoods through income-generating projects, asset accumulation and reduced vulnerability to dire poverty (Heeks, 2014: 16). Figure 3.3 shows a capabilities framework.

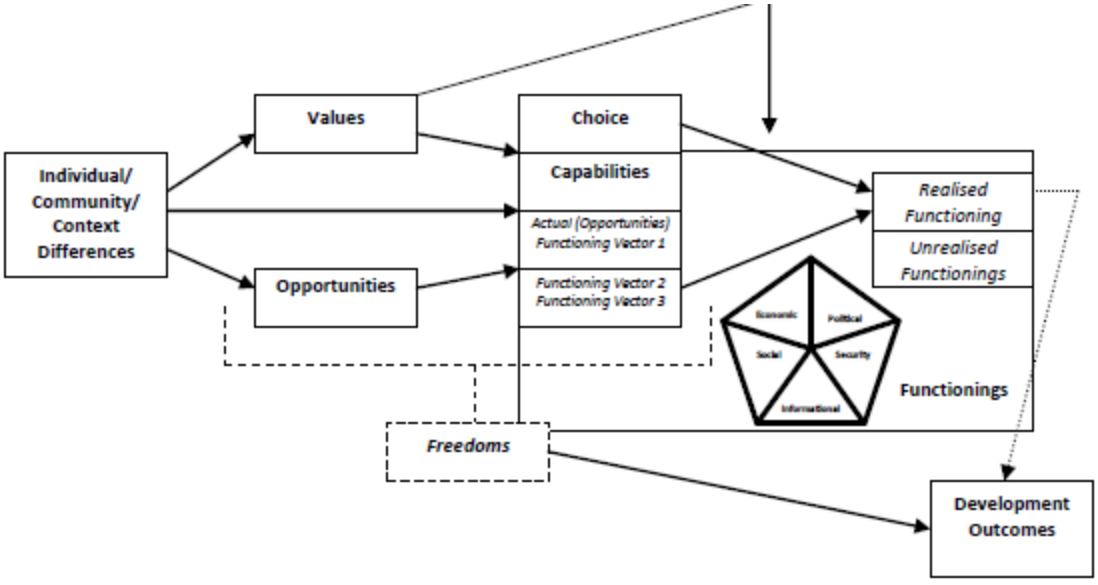

Figure 3.3: Capabilities Framework

Source: Heeks, 2014:14

The capabilities approach of Amartya Sen is based on two assumptions. Firstly, the theory assumes that the freedom to achieve wellbeing is of great importance (Heeks, 2014: 19). This approach is based on the notion that the freedom to achieve well-being is to be understood in terms of people's specific capabilities (Heeks, 2014: 19). This implies that focus should be on their real chances or opportunities to execute

that which is of high value in their lives. This is shown in the above Figure, and if simplified, it can be deduced that the approach can cover what ICT used for. In this context, poverty can be eradicated if, and only if, people value ICT and fully utilise ICT opportunities.

3.1.1 Schumpeterian Theory

Joseph Schumpeter developed his theory in 1911. The theory is based on four key features: circular flow, role of entrepreneur, end of capitalism, and cyclical processes for business cycles (Englmann, 1994) It is based on the premise that change in investment accompanied by monetary expansion are the key variables of business fluctuations (Bodrožić & Adler, 2018). The theory posits that innovation in the corporate world is the main reason for increased investment and business fluctuations in an economy (Mehmood, et al 2021) and states that innovation, technology, and research and development play key roles in developing economies.

Entrepreneurs can harness technology to increase their scale of operations and hire more labour. When more people are employed, unemployment levels drop and poverty drops as well (Kiaušienė, 2015). As people start earning income, they are able to improve their standard of living by getting proper accommodation, safe water and sanitation, and easier access to health facilities. They use their wages and salaries to cater for expenses related to the aforementioned necessities. From this perspective, entrepreneurial technological innovation addresses poverty. Empirically, there is need for technology diffusion by diverse corporate players such as SMEs and entrepreneurs in SSA to reduce poverty levels (Igwe, Onjewu & Uguru, 2018), since an increase in technology usage enables increased production and business expansion, which requires extra labour. When more people are employed, poverty is reduced as those people can access shelter, nutritious food, and water and sanitation among other essentials.

However, the Schumpeter theory is not watertight since it is based more on social factors such as individual wealth rather than economic factors, hence it is difficult to perform an objective evaluation of the theory on business cycles. The theory also excludes other key variables that explain fluctuations in an economy, as it is based solely on investment in research and development to drive innovation/technology.

The Schumpeterian Theory was of great value in this study as it helped explain the technological innovation aspects that can be useful in addressing poverty issues in Sub-Saharan Africa. The theory explains that innovation can be achieved through creation of new products, use of new technology in production, and the opening up of new markets and sources of raw materials (Mehmood, Alzoubi, Alshurideh, Al-Gasaymeh, & Ahmed, 2019). The theory was germane to this study as ICT can be used as a key driver in boosting economic development and reducing poverty levels through entrepreneurship. The study thus examined ICT diffusion and poverty eradication in the Sub-Saharan Africa context.

3.1.2 The Behavioural / Decision Based Theory

This theory is based on the notion that people experience poverty due to their individual deficiencies in education and essential skills needed in the labour market (Davis & Sanchez-Martinez, 2014: 17). Individuals are affected or exposed to high poverty levels due to lack of education, useful skills in the labour market, and an industrious work ethic. Davis and Sanchez-Martinez (2014: 18) posit that the individual may continue to suffer from poverty due to poor choices and reliance on charity or aid. In the SSA context, in several instances aid has been proved to cause dependency syndrome (Wang, Yu, Zhang, Zheng, Song & Deng, 2021). This implies that donors seeking to ease poverty only provide a short- term solution.

In the absence of aid, poverty remains unsolved in Sub-Saharan Africa. This theory is not watertight since one can be jobless due to economic downturns in the labour market. For example, Zimbabwe has high unemployment rates and many companies have closed (Mpofu and Chimhenga, 2016). From this perspective individual cannot be blamed for being jobless as the economic problems are at play.

Theories of economic growth are premised on the fundamental aim of ensuring an improvement in the living standards of people in a community or in any economy (Dunga, 2014: 5). Increased economic growth can lead to increased taxation. The state uses taxes for the provision of education, low-income assistance and healthcare among other things, which in turn bolster living standards.

3.2.3 The Classical Growth Theories

Classical Growth theories (CGTs) resulted from the work of Robert Solow and J. E. Meade, and were developed during the 1950s and1960s. The key assumption of Classical Growth theories is that output is a function of growth in variable or factor inputs such as labour and capital as well as technological inventions and progress (Masoud Asst, 2013).

Classical Growth theories postulate that economic growth decreases with an increase in population, and scarce resources (Waldén, Meade and Walden, 1961). In reality however, the opposite pertains. It is believed that an increase in population means more labour and that more labour means increased output more than economic growth (Rahman, Saidi & Mbarek, 2020) This shows that the theories' assertions on the inverse relationship between economic growth and population is merely hypothetical. CGTs are based on the notion that a temporary increase in real GDP per person result in a sharp increase in population. This limits an economy's resources, which lowers real GDP.

Classical Growth theory suffers from a number of weaknesses. Classical Growth models disregard the role of technology in an economy, and do not accurately determine total wages as they assume that total wages fall below or do not exceed the subsistence level (Masoud Asst, 2013). This is economically incorrect.

Changes in industrial structure and economic development can cause fluctuations below and above the subsistence level. To make matters worse, the Classical Model of Growth ignores the role of labour movements and trade unions in wage determination. It can therefore be surmised that the prognosis for economic growth by classical economists stems from a pessimistic ideology. In reality, trade unions, labour groups and pressure groups can positively influence wage increases, *ceteris paribus*.

Classical growth models ignore the importance of technological progress in the operation of economies and the fact that technological advancements can aid in the reduction of diminishing returns (Masoud Asst, 2013).

The relevance of CGT in this study is that Sub-Saharan Africa has been making efforts to use technological innovation and ICT to foster economic growth. This empirical study is premised on ascertaining how ICT can be used to reduce poverty in Sub-Saharan Africa. ICT inventions have proved beneficial in increasing economic growth and reducing poverty in other economies (Sepehrdoust & Ghorbanseresht, 2019). This research therefore aimed to examine the nexus between ICT diffusion and poverty levels in Sub-Saharan African (SSA) Countries. Since the CGT uses labour as a variable, the theory was germane to this empirical study because of the relationship between poverty and labour.

CGT models acknowledge the existence of wages in the labour market. In the Sub-Saharan region, labour is employed and wages are paid (McCullough, 2017). Despite this, poverty levels remain high in the region and a number of labourers still live below the poverty datum line (Cirera, Fattal-Jaef & Maemir, 2019). As the CGT does not explain the role of technological invention in influencing economic growth, it is imperative to ascertain how ICT aids in improving economic growth in the SSA context. This implies that the Classical Models of Growth are relevant to this study.

3.2.4 Neoclassical Theories

Neoclassical theories such as the Harrod-Domar model and Solow's Growth Accounting theory are discussed below to explain the key issues of poverty. These theories add value to the study as they are important in explaining the link between economic growth and poverty. A focus on ICT aspects is incorporated to meet the research demands of this study.

3.2.5 The Harrod-Domar Model

This model is built on the assumption that a full-employment level of income exists, and that there is equality in the average propensity to save (APS) and marginal propensity to save (MPS) (Ayesha, 2018). The theory assumes that there is no government interference in an economy's operation (Thong and Hao, 2019). The Harrod-Domar model believes in autarky, which implies that the model assumes a closed economy and believes that all nations are autarkic and self-sustaining. Furthermore, the model assumes that there are no lags in the adjustment of

economic factors such as investments, savings, and income (Thong and Hao, 2019). Another assumption of the model is also that income, savings, and investments are treated from a net value perspective, or after depreciation (Ayesha, 2018). Lastly, the Harrod-Domar Model assumes that functionality and accounting equality exist between savings and investments.

The Harrod-Domar Model aims to ascertain three types of growth: the actual growth rate, the natural growth rate, and the warranted growth rate (Ayesha, 2018). The model further believes that savings and investment levels in an economy determine the actual growth rate, and that the savings income ratio and the capital output ratio determine the warranted growth in an economy (Thong & Hao, 2019). The natural growth rate is ascertained by key variables such as natural resources, the labour force, technical expertise and capital equipment. The problem with this theory is that it does not incorporate labour (Dunga, 2014: 46).

This theory is relevant to the current study as Sub-Saharan Africa is rich in natural resources but has no transmission mechanism of ensuring that they yield significant economic growth and ultimately reduce poverty (Demissie, 2014). Since the Harold-Domar Model emphasises the importance of technical expertise in the determination of natural growth, SSA still lacks the relevant ICT expertise that could be used to reduce poverty.

It remains a mammoth task for some of the economies in the SSA to attract meaningful local and foreign direct investment (FDI) to improve actual economic growth (Dunne *et al.*, 2015). Some of the key challenges that hamper investment are poor economic policies, a harsh economic environment, civil wars, and drought, to mention but a few (Nyiri, 2014). To exemplify the poor economic policies, Zimbabwe initiated the Indigenisation and Economic Empowerment Act No.14 of 2007 (Shumba, 2014). The Act promoted 51% corporate stakeholder ownership by locals and 49% by foreigners. This chased away foreign investors and the Act was revised several times in a bid to attract investors back (Marazanye, 2016).

3.2.6 The Solow Neoclassical Growth Model

The Solow Neoclassical growth model is regarded as an exogenous growth theory. It is built on the assumption that changes in the output levels of an economy are due to changes in savings levels, the pace of technological progress and the population growth rate. The theory assumes a constant increase in the population of an economy, and that all manufacturing firms employ homogeneous production technology. Lastly, The Solow Neoclassical growth model assumes that all people in an economy save a certain proportion of their income. The immediate implication of the theory is that economies with non-heterogeneous savings levels, increased population growth rates and capital levels, will ultimately converge.

In reality however, economies will never have homogeneous populations and static capital and savings levels.

This theory is relevant to the study because Sub-Saharan Africa desires more technology that can be used to boost economic growth and development, and ultimately aid in poverty alleviation (Adzawla, Sawaneh & Yusuf, 2019).

Sub-Saharan Africa has been facing increasing in population levels (Zerbo, Delgado & González, 2020), mainly due to a lack of family planning methods (Tsui, Brown & Li, 2017). If such increase in population is not offset by high economic growth levels, poverty levels may increase further and reach alarming levels.

3.2.7 New Growth Theory

The New Growth Theory affirms the notion that knowledge is a key enabler of economic growth. Knowledge is regarded as the source of technology in the New Growth Theory (Dunga, 2014: 51). Advancement and increase in the knowledge base of an economy can positively influence economic activities, which in turn can lead to increased GDP.

The theory emphases that advancement in technology is the end result of diverse economic activities in an economy for a given time frame. A key point to note in this theory is that it acknowledges that knowledge and technology provide increasing

returns (Dunga, 2014). The NGT is useful in explaining why and how diverse economies face unique growth trajectories. It all lies within the knowledge and technological base. As a result, economic growth can be achieved only if there is a sufficient accumulation of knowledge (Dunga, 2014).

Sub-Saharan Africa still craves ICT knowledge and the methods of how it can be used as a transmission mechanism for poverty reduction. This is justified by the fact that a number of Sub-Saharan economies export raw minerals to other economies because they lack the necessary technology needed for value addition to these minerals as well as improving the skills of the masses in the small to medium enterprises sector (Kurečić & Seba, 2016) (Cano *et al.*, 2019).

This research therefore sought to examine how ICT can be used a tool for poverty alleviation in Sub-Saharan Africa. More needs to be done regarding knowledge accumulation, especially in the ICT sector and many other sectors.

3.2.8 Theories of Poverty

Different theories are used to explain poverty. These theories provided value to this study by explaining the implications of poverty, poverty's potential impacts, and how poverty can be measured.

3.2.8.1 The Classical Theory of Poverty

The Classical Theory of Poverty is built on the assumption that markets operate efficiently and individual productivity is directly correlated to wages earned (Davis and Sanchez-Martinez, 2014). Poverty in therefore regarded as a sign of poor individual choices that result from poor productivity.

However, the Classical Theory acknowledges that poverty can be caused by the pure heterogeneity that exists in people's genetic abilities (Davis & Sanchez-Martinez, 2014:15). The theory also assumes that government intervention is necessary when poverty levels increase. In reality, Sub-Saharan Africa governments have shown some effort in solving poverty, though far from enough (World Bank, 2015).

For example, the Zimbabwean government introduced Value Added Tax (VAT) on basic goods that were previously tax free (Manungo, 2017). This affected the poor as the VAT increased cost of basic goods. The policy was reversed few days later. From this example, it is clear that poor policy implementation affects the poor (Kundishora, 2015) carried out research on the role of ICT and poverty reduction for the Zimbabwean economy. It was found that use of ICT technology such as e-hurudza was effective in supporting Zimbabwean agrarian reform. Bumper harvests were then produced, which lessened poverty levels to some extent (Kundishora, 2015: 15).

3.2.8.2 Perceptions of Poverty Causes

Poverty can be viewed from fatalistic, individualistic, structural or psychological perspectives (Dunga, 2014: 38). Discussion on these aspects is crucial in helping to ascertain how ICT can be used as a mechanism to reduce poverty in Sub-Saharan Africa that could emanate from any of the above perspectives.

3.2.2.8.1 Fatalistic View of Poverty

A fatalistic view of poverty is based on the notion that anyone can be poor, and poverty is fate. Individuals or a communities can find themselves trapped in poverty due to circumstances beyond their control (Dunga, 2014). For example, children who lose parents or breadwinners due to civil war. In some cases, such children may be exposed to poverty through no fault of their own,

Views on Poverty

The individualistic approach places key emphasis on poor peoples' capability and effort to attain better living standards. The approach therefore points out that poverty may not be completely eradicated, as some people may choose to be lazy (Dunga, 2014: 39) As such, although this poverty may exist because there will always be lazy

people in the world, a solution must be found for it, because some lazy poor people may end up committing crimes which affect the lives of the non-poor. It can therefore

be concluded that lazy people will always exist, and there is a possibility that any of their antisocial activities will also affect the rich. Poverty alleviation remains a global phenomenon to be addressed at all levels on a collective effort basis. The individualistic view of poverty outlines that the poor are uneducated, unskilled and lazy and that they must be made accountable and responsible for their own economic situation (Majid, Esfahani & Haghighi, 2012: 46).

3.2.8.3 Structural View of Poverty

This approach assumes that lack of economic opportunity exposes people to poverty, and that capitalism creates conditions that promote poverty (Sameti Majid;Rahim Dallali Esfahani;Hassan Karnameh Haghighi, 2012). For example, Zimbabwe is plagued by myriad economic problems, and there are few if any opportunities for people to earn a better life. This perfectly suits the structural view of poverty, which believes that societies have a duty to ensure that their economies thrive and that their people are exposed to abundant opportunities that enable them to improve their living standards. Access to quality education, health, water and sanitation, and political freedom among others must be available to all citizens at affordable fees.

3.2.8.4 Psychological Perspectives of Poverty

The psychological challenges people face in life can expose them to poverty. Emotional problems as well as poor interpersonal relations can be impeding factors that limit a person's chances of succeeding in life (Dunga, 2014). For example, Somalian communities have been affected by civil war since the 1980s, and this has affected the psychological state of many citizens. Coping mechanisms and social welfare counselling services may be deemed essential to assist war victims to rid themselves of psychological disorders. However, in developing economies, social welfare programmes and counselling services are scarce, thus people remain psychologically exposed to poverty (Ssewamala *et al.*, 2018).

3.3 MEASURES OF POVERTY

Poverty measurement is normally associated with household's or people's incomes (Dunga, 2014). There are diverse measures of poverty that assist in policy formulation. For example, if poverty is measured using a monetary approach, say the dollar value spend of a person per day, this helps in ensuring that proper poverty alleviation strategies are put in place so that those who earn below a given threshold are uplifted.

However, in some cases poverty measurement can be difficult where people earn a living through subsistence farming or from agricultural activities, because some of their transactions are done at peasantry farming level and are not officially recorded. The consumption measure is more applicable compared to the income measure in such instances. For example, in Malawi, 80% of the people earn their living through agriculture (Dunga, 2014: 69). The main drawback of the income measure is that it does not accurately measure poverty in developing economies because it does not capture non-market activities (Dunga, 2014).

3.3.1. Poverty Lines

The poverty line depicts the total amount of goods and service deemed necessities to meet the basic needs of an individual (Dunga, 2014). Diverse ways are used to get a poverty line. Poverty lines can be absolute, relative, or subjective. Relative poverty lines measure poverty in relation to societal wellbeing. For example, a threshold of 60% of median income is used as a relative poverty line in Europe (Marrone, 2013). On the other hand, absolute poverty lines are frequently used and applicable to developing economies.

The main aim of calculating a poverty line is to reach a desired minimum living standard for bigger populations (Marrone, 2013). Poverty lines can be used on an international scale of at national level. Internationally, the World Bank uses the absolute poverty line of $1.90 per person per day (World Bank, 2020).

In South Africa, poverty lines are used for providing a statistical measurement of money metric poverty. The subjective poverty line emanates from the premise that people's views on what they ideally view as the minimum income amount for their households must be captured. Hence, the line varies per person and is subjective (Dunga, 2014). Poverty lines can be constructed using the cost-of-basic-needs approach that connects welfare to the consumption of goods and services (STATS-SA, 2018).The lines include both food and non-food components of household consumption spending.

Economically, poverty lines are derived from the view that consumption bundles and the corresponding opportunity cost to the person or household for acquiring that bundle. Ravallion (1998) states that to determine the absolute poverty line, two key conditions must be met. The first is that one must specify a reference level of satisfaction representing the minimum living standard; secondly, one must identify a money metric threshold between the non-poor and poor that is associated with the reference satisfaction level (Ravallion, 1998).

3.3.2 Headcount Index

The headcount Index is a percentage measurement of people regarded as poor in a society or an economy. This is represented in algebraic form below.

$$H = \frac{q}{n} \qquad \text{.....3.1}$$

H represents the Headcount Index, q represents the number of people in an economy with incomes below the poverty line, n represents the population size. This method is easy to construct and interpret. However, the demerits of the Headcount Index are that it does not show the degree of poverty in people and does not reveal poverty intensity (Dunga, 2014: 72). This means that the severity of poverty cannot be determined when using the Headcount Index. Thus, the Index can be misleading when developing poverty alleviation policies. This is because policies to curb poverty should be diverse, especially for people suffering from absolute and relative poverty.

The Headcount Index does not show poverty level changes. For example, it cannot show if a poor person is now more poor (Krishnan, 2014), nor does it show the

transfer axiom. This means that little attention is given to the exact ways that policymakers can use to uplift everyone living below the poverty line (Krishnan, 2014). However, this does not render the index useless; any poverty measurement technique can have shortcomings.

3.3 Poverty Gap Index

The Poverty Gap Index measures poverty intensity. It shows how the incomes of poor people fall below the poverty line. The Poverty Gap Index is normally used in conjunction with the Headcount Index (Dunga, 2014) as the Poverty Gap Index helps to offset the drawbacks of the Headcount Index. The Poverty Gap Index focuses on how the welfare of the poor can be improved. Hypothetically the index puts more value on US$100 given to a poor person compared to the same amount given to a rich person. The biggest flaw of this index is that it does not clearly show variations in the severity of poverty among the poor (Krishnan, 2014). For policymakers to design anti-poverty policies, it is essential for them to dig deep and unearth the extent of poverty that exists for poor people. A universal poverty policy designed on the basis of this Index would be misleading and may cause significant disparities between those who are absolutely affected by poverty and those relatively affected by poverty (Karpinska & Śmiech, 2021).

3.4 Watts Poverty Index

The Watts Poverty Index was developed by Harold W. Watts in 1964. The Watts Poverty Index calculates by division of the poverty line by income (Foster, 2003). The main benefit of the Watts Poverty Index is that it considers the social welfare function. This index is considered far better than the Headcount Index and the Poverty Gap Index (Muller, 2001). This is because the Watts Poverty Index shows the exact amount of social welfare loss due to poverty levels faced by an individual or an economy (Palomino, Rodríguez, & Sebastian, 2020) .The use of this index can be advantageous to policymakers as they can clearly ascertain the best way to compensate the social welfare loss incurred by people in an economy as a result of poverty.

3.5 The Severity or FGT2 Index

The Severity Index was developed by Foster, Greer and Thorbecke (1984). The index puts emphasis on the poverty of the poorest of the poor, and thus combines poverty measurement and income inequality (Fernandez-Morales, 2016).

When $\alpha = 0$, the FGT measure is equal to the Headcount Index; when $\alpha = 1$ it is equal to the Poverty Gap Index (Dunga, 2014). This measure is useful for poverty analysis as it focuses on the poverty levels of the poorest people in a society. For policy- makers, it is useful as it gives direction on where poverty is high.

3.6 THE HUMAN POVERTY INDEX (HPI)

The Human Poverty Index (HPI) is based on the notion that poverty can go beyond issues relating to income or money. The HPI puts emphasis on the fact that poverty measurement should be based on three key points: longevity, knowledge and a decent standard of living (UNDP, 2011). This implies that non-monetary aspects such as education, health, water and sanitation are of great importance in uplifting the living standards of all individuals. The HPI is a human poverty index for developing economies and is based on three aspects: life expectancy, adult literacy and access to basic amenities (Weziak-Bialowolska & Dijkstra, 2014). The HPI-2 is a human poverty index for high-income OECD economies. It emphasises aspects such as long-term unemployment, adult functional illiteracy, number of people below the poverty line and life expectancy, which is pegged at 60 years.

3.7 REAL GDP PER CAPITA

Real GDP per capita can be used for poverty measurement. Real GDP per capita is a calculation of an economy's gross economic production separated by the number of inhabitants and adjusted for inflation (World Bank, 2020). It is used to compare living conditions between countries over time.

3.8 ICT AND POVERTY PERSPECTIVES

This section is based on a discussion of ICT and poverty perspectives.

3.8.1 Global Perspective

Globally, developed economies tend to benefit more from the use ICT in achieving higher economic growth and fighting poverty, compared to developing economies (Niebel, 2018). This is due to sound ICT policies, considerable financial resources that allow investment in ICT infrastructure, and market efficiency between public and private ICT players.

Ivanic and Martin (2018) investigated poverty reduction and sectoral productivity growth for global economies. The study found that an increase in agricultural output helped socially in poverty reduction in poor economies (Ivanic & Martin, 2018: 429). However, this is not the case in Sub-Saharan Africa, as there are several agrarian-based countries in the region and most of them have a high number of poor people (Kabuya, 2015).

In their qualitative research, Raja and Nagasubramani (2018) examined the effects of modern technology on education. The study's primary goal was to investigate the role of technology in the education sector. They found that technology helps to reduce usage of paper (photocopying) and that the quality of education improved through access to electronic resources (Raja & Nagasubramani, 2018: 3).

It was also established that modern technology is costly to acquire, and can lead to job loss as more work becomes automated (Raja & Nagasubramani, 2018: 3). However, the research does not show how a nation can strike a balance given the costs and benefits of ICT, nor does the study explain how modern technology used in the education sector can be used for poverty alleviation. All these gaps will be addressed in this study.

Song *et al.* (2019) researched the attributes and determinants of the digital divide in China. The aim of the study was to examine the variables behind China’s digital divide. From the results, it was found that “there was a significant prefectural digital

divide in China that was attributed to a fall of the ICT development index (IDI)" (Song *et al.*, 2019: 1).

It was also found that poverty-stricken regions in China had a low IDI, while cities had a bigger IDI value (Song *et al.*, 2019: 1). This shows that more needs to be done to improve the ICT development index for the poor regions of China. The study concluded that education and economic factors played a key role in determining the prefectural digital divide in China. However, the study was silent on how ICT can be improved in rural areas and mentioned nothing on poverty alleviation. In terms of digital divide, SSA is no exception and as such, ICT must be diffused for poverty alleviation purposes.

Ali *et al*. (2020) carried out quantitative research on how ICT maturity catalyses economic development. Focus was on the OECD countries. Research findings showed that high ICT maturity is positively associated with high economic development levels (Ali *et al.*, 2020: 1). The research concluded that ICT development can augment economic development. The study gives no explanation on how ICT can be developed to ensure economic development so that poverty is alleviated.

Health is an important component included in the subject of poverty (Espanha & Ávila, 2016) examined health literacy in Portugal. The objective of the study was to determine how an individual's literacy level affect his or her health life. The study was based on quantitative research methods and found that levels of education, access to the internet and computers were key determinants of high health literacy levels (Espanha & Ávila, 2016: 8).

However, the study does not explain how the low-level educated can be helped to have higher health literacy levels. This implies that the subject must be explored further to establish ways of using ICT (internet and computers), especially in the Portugal context, to ensure that the less advantaged Portuguese become health literate.

3.8.2 European Context

Toader *et al*. (2018) and Oshota (2019), share antagonistic research views on the effect of ICT on economic growth. This can be attributed to differences in countries usage of ICT and its penetration levels. The Toader *et al*. (2018) research focused on European economies. Such countries will generally have better ICT penetration rates relative to Nigeria, hence the discrepancies in the two research outcomes. This study showed that ICT can be used as a tool for poverty alleviation and that ICT has a role to play in different sectors of an economy. ICT can be used by entrepreneurs in the manufacturing sector, in the service sector and the banking sector.

Toader *et al*. (2018) examined the effect of ICT infrastructure on economic growth for European economies. The research methodology was based on quantitative methods and found that ICT infrastructure has a positive and strong effect on economic growth (Toader *et al.* 2018: 16). It can therefore be concluded that an increase in ICT infrastructure helps to drive economic growth higher, and this improves living standards. Since ICT allows mass production of goods in the manufacturing sector this in some instances can lower the price of some goods due to the laws of demand and supply. However, the research lacks a succinct explanation of how ICT can be used as a driver for economic growth and help in reducing poverty. This shows that those gaps need to be covered, and consequently the current research will close the gaps with specific focus on SSA.

. Goedhart *et al*. (2019) examined the use of ICT among mothers in the Netherlands. The overall objective of the research was to examine the ICT usage of mothers only. The study found that mothers with low socio-economic positions had no exposure to ICT tools or information (Goedhart *et al.*, 2019: 2348). It can thus be concluded that ICT education should be prioritised in the Netherlands to ensure that poverty alleviation is achieved. The main challenge of this study is that it excludes males. The present study therefore examines how ICT can be used by people of all genders in SSA for poverty alleviation.

Becker *et al*. (2018) investigated ICT usage in European enterprises in a quantitative study. The objective of the research was to evaluate the usage of ICT in enterprise sectors. Research findings showed that Germany, the Czech Republic and Slovakia, Hungary and Poland, had low levels of ICT usage while Austria and Slovenia had high levels of ICT usage (Becker *et al*. 2018: 9). However, the research does not explain the benefits derived by Austria and Slovenia from high ICT usage.

Strzelecka *et al*. (2017) examined the integration of water, waste, transport, energy and ICT into smart cities. The study aimed at assessing how the aforementioned factors and responsible departments can be synergized to ensure that efficiency is achieved. Research findings showed that cities can be better developed through the use of ICT in various departments. In the long term this improves the quality of life for citizens. However, desirable and ideal a smart city can be, poverty must be addressed on all national and individual levels.

Savulescu (2015) investigated ICT development in the European Union. The objective of the study was to examine the correlation between the share of ICT sector and network readiness among the economies that fall under European Union. Comparative analysis was used in the study. Research findings showed that ICT is a useful tool for enhancing economic growth (Savulescu, 2015: 7). Missing from the research is an explanation of how ICT can be used as a tool to link with economic growth, and there is no clear presentation of possible sectors of the EU economies where ICT could be channelled so that high economic growth is achieved.

3.8.3 Asian Context

Dewi and Kassim (2018: 27) investigated Indonesian economic growth and poverty reduction and discovered a positive long-running relationship between economic growth and poverty alleviation. The aim of the study was to ascertain how economic growth affects poverty. An increase in economic growth was seen as an integral part of job creation and poverty reduction. This implies that economies can achieve reduced poverty reduction when they implement pro-economic growth policies, *ceteris paribus.* However, the research does not have a full elucidation of the possible ways of attaining sufficient economic growth needed for poverty alleviation.

Ali and Singh (2017), examined the role of ICT on economic growth for India, and found a positive correlation between ICT and economic growth (Ali & Singh, 2017: 5) This implies that ICT has positively influenced economic growth in the Indian economy. ICT is seen as a key mechanism that even helps to sell goods online, thus creating new clients and increasing sales and ultimately, economic growth (Ali & Singh, 2017). The use of e-commerce is essential to businesses in India, but if consumers lack access to the internet or lack e-buying skills, the economic growth gains from ICT will be meagre. This implies that consumers must be well-educated on how to use ICT in order to improve economic growth.

Halili & Sulaiman (2019) carried out research on factors that affect ICT acceptance by rural students for educational use in Indonesia. Data collection took place through questionnaires. It was found that students in rural areas were demanding more ICT for improving their academic performance and for developing their ICT skills (Halili & Sulaiman, 2019: 5).

The main drawbacks faced by many rural students are lack of internet and ICT experts as well as poor ICT infrastructure (Halili & Sulaiman, 2019). Poverty encompasses several aspects, and access to quality education is one of them.

3.8.4 North American Context

Garcia (2019) studied ICT and economic growth in Mexico. The main aim of the research was to examine how ICT in Mexico affects the country. The study was based on quantitative research methods and found a positive correlation between mobile phone usage and economic growth (Garcia, 2019: 19). The findings showed that the higher the number of mobile phone users, the more the increase in GDP. This is economically justifiable, as when many people have access to mobile phones, commercial and production activities are enhanced through this effective form of communication (Garcia, 2019). This also implies that digital poverty must be dealt with to ensure that poverty in all its forms is alleviated. Digital poverty refers to a state whereby people lack the ICT skills that are essential for access to all forms of information (Cáceres, 2007).

When people lack the basic skills on how to use mobile phones, it may mean that no significant volume of calls in commercial and production activities will be registered. The Garcia (2019) research is silent on how the economic growth achieved translates to poverty reduction. The study identifies governments as the only partner that can improve the usage of ICT. This shows that the private sector is ignored, yet the private sector may have a big impact on ICT diffusion. This will be addressed later in this study.

Montiel (2016) examined the digital divide in Mexico. A qualitative research approach was used, and the objective of the study was to examine the differences in ICT usage a Mexico's diverse regions. The study found that poor people in Mexico have lower internet penetration rates relative to wealthy Mexicans (Montiel, 2016: 2).

Montiel (2016) regarded the absence of a digital skills policy, the lack of infrastructure and the lack of access to online payment as the cause of the digital divide in Mexico (Montiel, 2016: 9). The research findings show that improving ICT usage in Mexico would need a multidimensional approach. Several factors must be considered, for example, sound ICT policies, expertise, government support and sufficient ICT infrastructure. Saba and David (2020) emphasise the importance of telecommunication polices in terms of ICT development of ICT. The digital divide in Mexico emanates from three sources: access to ICT, benefits of ICT and ICT usage (Martínez-Domínguez & Mora-Rivera, 2020). Young people who are economically better off than the poor in Mexico, have better access to ICT (Martínez-Domínguez & Mora-Rivera, 2020: 8). Poverty has no borders and it affects everyone. ICT must be channelled towards the poor and to poverty reduction.

People in any economy can be exposed to poverty due to natural disasters. For example, in recent years, Haiti has suffered earthquakes, floods and hurricanes. These disasters left thousands homeless and without safe water and sanitation. This implies exposure to poverty. Firdhous & Karuratane (2018) examined the role of ICT in improving community resilience to natural disasters. Results from their research show that ICT can be used for communication purposes and for warning people (Firdhous & Karuratane, 2018: 7).

Rural population may lack access to radios or other media and hence may be exposed to more harm from natural disasters. This implies that technology should be tailor- made to reach intended beneficiaries, and for them to avoid adverse effects from natural disasters. Some of these adverse effects are loss of property, livestock, among other things. Sub-Saharan Africa is not exempt from natural disasters. For example, some countries such Zimbabwe and Mozambique were recently affected by Cyclone Idai (Emerton *et al.*, 2020). Countries in the SSA region need to harness ICT for minimising the effects of natural disasters.

3.8.5 Sub-Saharan Africa

The rate of ICT diffusion varies among economies in SSA. However, there are some benefits that other economies enjoy in Sub-Saharan Africa as a result of usage of ICT). As presented in previous chapters, ICT diffusion is still very low in SSA, such that the opportunity for rural students to have access to ICT for education purposes is practically nil.

Bahrini and Qaffas (2019) examined the effects of ICT on economic growth in developing countries. Research findings showed that ICT is an impetus for improvement in economic growth in Sub-Saharan Africa, the Middle East and North Africa (Bahrini & Qaffas, 2019: 1). Countries in these regions need to increase their investment in ICT as this will help poverty reduction in the long run.

The Bahrini and Qaffas (2019) study focuses on the development of ICT infrastructure, but examines only a few economies in SSA, hence the research findings cannot be generalised and applied to SSA at large, since each economy in the region faces diverse challenges. The Ali and Singh (2017) and Bahrini and Qaffas (2019) studies both show similar outcomes on the effects of ICT on economic growth. Both agree that ICT has positive effects on economic growth.

David and Grobler (2020) examined the ICT penetration level as a driving force for economic growth in Africa. Descriptive statistical techniques were used in the study, and analyses 16 years of panel data. The research findings show a fast growth in mobile telecommunications and that the ICT penetration has had a positive effect on

economic growth. The current study is based on analysis of 30 years of panel data to enable more findings on the subject matter.

In Ghana, ICT is used in the agricultural sector. Ghana uses e-platforms to enhance information dissemination within the agricultural sector, which has improved the sector's output and increased the country's GDP (Munthali *et al.*, 2018b).

Haftu (2019) examined the relationship between mobile phones, the internet and economic growth in the Sub-Saharan Africa. The research objective is to examine the linkages between the internet, mobile phones and economic growth. The research found that a 10% increase in mobile phone usage resulted in a 1.2% change in real GDP, but that internet use had an insignificant impact on economic growth (Haftu, 2019: 4). This could be attributed to low penetration rates of technology in Sub-Saharan Africa. These research findings show that more should be done to improve the state and rate of ICT diffusion in SSA, but is silent on how ICT can be used to benefit poverty alleviation. Other research, for example by Bohlin, Lindmark and Zaber (2017), proved that internet usage helps to improve quality of life. More needs to be done to show that quality of life in SSA would improve with increased ICT usage. The current study therefore examines the nexus between ICT diffusion and poverty levels in Sub-Saharan Africa.

Bakari (2019) carried out research on the impact of financial inclusion on poverty reduction in SSA. The objective of the study was to examine how financial inclusion can be used as a tool for poverty reduction. Panel data was used in the study. the findings show that the availability of credit and ICT infrastructure can help in poverty alleviation (Bakari, 2019: 12).

Aldosari *et al*. (2019) studied the views of Pakistani farmers on ICT. The aim of the study was to examine the relevance of ICT in Pakistan's farming sector. Research findings show that farmers benefited from information dissemination via electronic media (Aldosari *et al.*, 2019: 3). The study also established that the country's farmers were in need of agricultural experts to train them on the ICT usage (Aldosari *et al.*, 2019: 3). It can therefore be concluded that ICT can help in improving agricultural production, which helps reduce poverty in the long run. When output increases, prices decrease, improving food accessibility for the poor.

Amarnath *et al.* (2018b) investigated the use of ICT by smallholder farmers in the Sudan. The research found that smart technology (weather and water information) was useful in improving the farmers' knowledge base (Amarnath *et al.*, 2018: 14). This shows that ICT is useful in improving productivity and aids poverty reduction in the long run.

3.9 Country-specific perspectives

The Zimbabwean economy lags behind as far as ICT diffusion is concerned, with little progress being made in the implementation of ICT in educational institutions (Chisita & Chiparausha, 2019). However, universities are starting to use technology to enhance learning through open access initiatives introduced in their libraries. On a positive note, this has improved education quality in the country (Chisita & Chiparausha, 2019:7). However, the main drawback is that many Zimbabwean university students come from poor backgrounds and have limited or no access to ICT services.

Agriculture in Zimbabwe has been badly affected by poor rainfall, pests and diseases, and a lack of farming implements (Zimbabwe Ministry of Economic Affairs, 2014). This has affected the nation's coffers to the extent that food is now imported from other countries. To ensure that technical skills are imparted to the youth, Zimbabwe's Ministry of Education has introduced technical subjects into school curriculums, which is meant to impact on the country's poverty in the long term (Majoni, 2016). In terms of Zimbabwe's manufacturing sector, output is extremely low due to its dilapidated ICT infrastructure (Tsokota & Solms, 2013).

In Zambia, mechanization programmes have helped farmers to improve productivity (Rosenberg *et al.*, 2018: 9) This increases their income through the sale of agricultural produce and has helped in reducing poverty as the farmers produce enough to feed the country. From this research it can be concluded that ICT assists in improving agricultural output and this helps poverty alleviation. The Zambian economy benefits from having good ICT infrastructure in its urban areas (Isaacs, 2007).

Rwanda shows significant progress in its ICT usage (Korpela, 2018). In its education sector, Rwanda is making a significant effort to improve the quality of ICT skills (Korpela , 2018:34). In 2015, Rwanda gained a 3% contribution in ICT towards economic growth (Korpela, 2018: 37).

Due to Rwanda using ICT in its services sectors, the country enjoys diverse benefits such as low-income earners being able to access basic commodities at affordable prices. Rwanda aims to be a regional technological hub and has started manufacturing smart phones Uwiringiyimana (2020). This has created employment and improved standards of living countrywide.

Ziemba (2020) explored ICT adoption levels and sustainability in Poland local governments. It was found that there were low levels of ICT adoption in some departments. For example, the use of electronic document management systems was very low, but the use of electronic delivery box systems and electronic security systems was high (Ziemba, 2020: 1). The research was limited to local government in Poland and as such, ICT adoption at national government level was not examined. These research findings show that efficiency in local governments can be achieved through ICT usage. The current research seeks to examine ICT diffusion at national level for each country in SSA, and how it can be used in poverty alleviation.

Yazdan and Hossein (2013) carried out research on the effects of FDI and ICT on productivity in Middle East countries. It was found that the contribution of FDI and ICT on economic growth was positive in all countries studied (Yazdan & Hossein, 2013). From these research findings it can be concluded that FDI and ICT are necessary tools that can be used for improving economic growth. These research findings are on a par with the views of Sokang (2018), who found that FDI had a positive effect on economic growth in Cambodia. Increased economic growth can help poverty alleviation in the long run through prices becoming lower when goods and services are available in abundance.

3.10 LITERATURE REVIEW

Sub-Saharan Africa suffers from high poverty levels, one of the causes being poor resource allocation in industry (Cirera, Fattal-Jaef & Maemir, 2019: 2), which in the end exposes the masses to poverty. Some economies in Sub-Saharan Africa tend to benefit from good agricultural output that is produced with modern technology (Dorosh & Thurlow, 2018). However, the adoption of ICT is low, hence meaningful yields are not obtained by the agricultural sector overall. If resources were allocated to productive sectors and ICT was applied towards production of high output, poverty would decrease.

Apart from poor resource allocation, Sub-Saharan Africa suffers from high corruption levels (Kanyam, Kostandini & Ferreira, 2017). Top officials in the public and private sector have diverted significant amounts of resources for their own use, leaving poor people exposed to extreme levels of poverty. However, mobile phone penetration has been a powerful tool in reducing corruption and improving transparency and governance in the region (Kanyam, Kostandini & Ferreira, 2017: 9). This shows that ICT can be used as a mechanism for poverty reduction.

Smallholder farmers are regarded as an important group that can help in reducing poverty. However, in Sub-Saharan Africa many small-scale farmers lack efficient farming machinery as well as knowledge (Misaki *et al.*, 2018: 12). This is a limiting factor in the production of bumper harvests that would help reduce food shortages. Ivanic & Martin (2018: 2) posit that increasing agricultural productivity tends to be more beneficial to poor economies than increasing productivity in service sectors.

This implies that poor economies must ensure that agricultural activities are done efficiently. One way to achieve this is the introduction of ICT into the agricultural sector. For example, in Zimbabwe, Econet Wireless launched Ecofarmer, a platform that helps farmers with relevant information on best farming practices. The Ecofarmer platform is a modern mobile technology solution that delivers weather-based information, as well as agricultural information via cell phone (Mutingwende, 2019). Ogunniyi *et al.* (2020: 9) state that Sub-Saharan Africa suffers from food insecurity, and remittances help to stabilize this in a small way.

Remittances from relatives can stave off hunger in the short term but cannot be viewed as a sustainable solution as they depend on the amount that people earn and what they can afford to send to their relatives. For example, many people lost jobs due to the corona virus pandemic, and the possibility of such people being able to remit funds could have been affected. If remittance beneficiaries could invest in some entrepreneurial projects that generate income, this will help in poverty alleviation provided they were successful (Morris, Santos & Neumeyer, 2020).

Dunne *et al.* (2015) researched conflicts and economic growth in Africa and examined the effects of conflict on economic growth. Using ICT as a tool for reducing conflict was not examined. The study results found that conflict adversely affects economic development and the functionality of neighboring economies (Dunne *et al.*, 2015: 22). The study findings mirror the current conflict in Nigeria and Somalia where many people have been displaced and have their lost crops, livestock and property (Adelaja & George, 2019). This implies that conflicts expose people to high poverty levels.

Sub-Saharan Africa also suffers from high rates of HIV and AIDS (Kharsany & Karim, 2016). In addition, the region is affected by many communicable and non-communicable diseases that are caused by diverse factors (Zerbo, Delgado & González, 2020). Some are caused by lack of water and sanitation, and poor living conditions. Limited access to healthcare has poverty connotations, thus poverty remains a multidimensional problem. ICT could be used in many different ways to reduce this problem.

The high prevalence of deadly diseases in SSA has affected many families and resulted in increased poverty and child headed families. Garza-Rodriguez (2018) carried out research on economic growth and poverty with specific focus on Mexico. The research found that increasing economic growth is key to poverty reduction. However, increased economic growth is often associated with increased inflation, which affects the poor (Ghan *et al.*, 2019: 66). This implies a need for a trade-off between economic growth and macro-economic objectives, as high economic growth is desirable, but poverty must be reduced.

Dewi & Kassim (2018) examined economic growth, financial development and poverty alleviation in Indonesia. The main objective of the study was to ascertain if linkages exist between financial development, economic growth and poverty alleviation. The results found a long-term relationship between financial relationships, economic growth and poverty reduction (Dewi & Kassim, 2018: 27). This research finding shows that higher economic growth is useful for poverty reduction.

Dewi and Kassim (2018) note the need for more credit funding to be made available from both the Indonesian private and public sector. This will enable more businesses to open, which will result in employment creation. When more jobs are created, standards of living tend to improve through the multiplier effect. It is therefore imperative for economies to implement policies that foster economic growth while taking into account other key macro-economic objectives such as inflation and balance of payments, etc.

3.11 CONCLUSION

This chapter presented the literature relating to ICT and poverty. A discussion on the different theories that explain ICT was presented and a number of economies referenced and this was done using the researcher's discretion. From the discussion, it was found that ICT can be used to impact entrepreneurship, which in turn creates employment and alleviates poverty. Global ICT and poverty perspectives were discussed, and it was found that poverty affects all economies. Some economies have successfully used ICT as a mechanism for poverty reduction, and it has proved successful. From a regional perspective, gains from using ICT in poverty alleviation strategies have been small due to factors such as slow rates in ICT diffusion. ICT can be used in many different sectors of an economy such as manufacturing and the service industry, among others. The following chapter is based on the research methodology of the study.

CHAPTER FOUR: METHODOLOGY AND RESEARCH DESIGN

4.0 INTRODUCTION

Guided by the literature discussed in Chapter 3, this chapter describes the methods used to achieve the objectives of this study as mentioned in Chapter 1. The chapter presents the methodology and research design employed in the study. Key aspects include methodologies for poverty and ICT measurement. The research philosophy used and panel data that was used forms part of this chapter as well. The use of panel data, econometric methods of analysis, model specification and the modelling of all research objectives are explained in this chapter. Fixed effects models, random effects models and error component models are explained, in line with the research demands. Diagnostic checks are made and the following tests are conducted: Pooled OLS, the Chow test, Hausman test and the Breusch-Pagan test. Furthermore, an in-depth analysis on the data and a description of the Head Count Poverty Measure and poverty data are presented.

4.1 RESEARCH PHILOSOPHY

A researcher can employ numerous philosophies when conducting research. Andriukaitiene, Vveinhardt and Zukauskas (2013) state that research philosophy is a belief regarding the approach in which information or data on a phenomenon ought to be assembled, analysed and used. Pozzebon (2018) posited that when undertaking scientific inquiry, it can be based on interpretivism, realism, positivism or pragmatism. The current research is based on positivism. This technique was selected for the study because it allowed the researcher to use a large sample of all the economies in Sub-Saharan Africa (Ayoob, 2020), and perform a robust data analysis on the subject matter. The choice of positivism enabled meaningful research results to be obtained for use in the real world (Pham, 2018). In this context, the research output will be useful for all Sub-Saharan economies. Figure 4.1 shows data collection method(s) suitable for each philosophy.

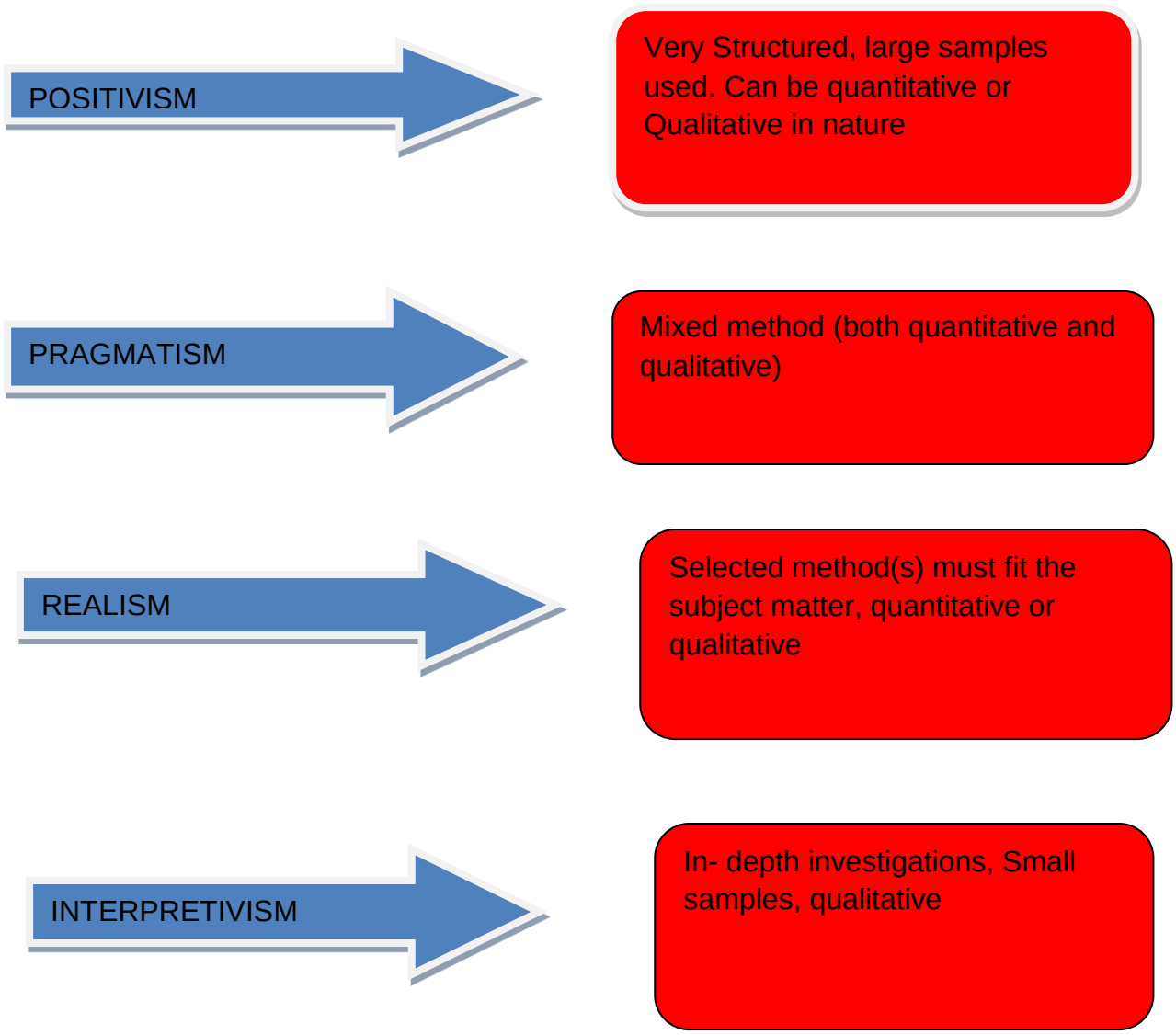

Figure 4.1: Research Philosophies

Source: Researcher's construct.

In summary, Figure 4.1 shows that the philosophy of positivism is highly structured, sizeable samples are used, and it can be quantitative or qualitative in nature. On the other hand, pragmatism is based on mixed-methods (Hashemi & Daneshfar, 2020). Realism is a philosophy based on the notion that the selected method(s) must fit the subject matter (Pham, 2018). It can be quantitative or qualitative in nature. Interpretivism enables the researcher to carry out in-depth investigations (Ryan, 2018) using small samples.

4.2 RESEARCH DESIGN

Research design is defined as a plan and structure of an investigation, put together to obtain answers to the research questions (Kubisch, 2020). Devisch (2019) posited that research design is an explanation of how to conduct scientific research to ensure reliability and validity of results. There are three broad types of research design: qualitative, quantitative and mixed methods (Leppink, 2017). Qualitative design is based on interpretative philosophy (reality does not exist), while quantitative design is based on positivism (reality exists) (Mitchell, 2020).

In qualitative research, the researcher asks broad, general questions; collects data consisting mostly of responses from the respondents; describes and analyses these words to extract themes; and conducts the inquiry in an unbiased and subjective manner (Wagner, 2020). Hou (2020) describes the qualitative research method as the study of people's everyday lives, looked at through their natural settings.

The quantitative approach asks specific and narrow questions; collects quantifiable data from respondents and analyses them using statistics; and conducts the inquiry in an objective manner (Meng, 2020). The mixed-methods approach is a combination of the two designs. Simply put, this study used the quantitative research design (Younis, Sundarakani & O'Mahony, 2019) because it allowed for analysis of the data on how ICT diffusion helps in poverty reduction in SSA. A key reason of using this research method was that it enabled verification of the research results (Suárez, 2017), rendering the study authentic, valid and reliable.

4.3 MODEL SPECIFICATION

4.3.1 Model

To determine the causality between ICT diffusion and poverty levels in SSA, the researcher deployed the Dumitrescu and Hurlin test (2012) to test for Granger non-causality in heterogeneous panels. This helped in achieving the first research

objective. The main advantage of using the Dumitrescu and Hurlin (2012) test is that it aids in depicting the direction of causality between variables (Dumitrescu & Hurlin, 2012).

To investigate the influence of ICT diffusion on poverty levels in SSA countries, the researcher deployed FE, RE, PVAR and GMM models to determine the impact of ICT on poverty in SSA countries. The researcher then interpreted the post-estimation diagnostic tests – autocorrelation, heteroscedasticity, AR serial correlation and the Sargan. The GMM model aided in the estimation of the model parameters, and was thus useful in achieving the second empirical research objective of this study (Tripathi, 2011; Bennet, Kallus & Schnabel, 2019).

To ascertain the long-run and short-run equilibrium of ICT diffusion on poverty levels in SSA countries, the researcher used panel cointegration and VAR/VECM to determine if long-run equilibrium exists between ICT and poverty in SSA countries. The post-estimation diagnostic tests were then estimated. The models were useful in achieving the third research objective of this study, as they helped to ascertain both the short-run and long-run positions of the variables (Menegaki, 2021).

To determine the reactions of ICT diffusion and poverty levels to possible shocks from each other, the researcher used variance decomposition/impulse-response techniques. Variance decomposition was useful in the determination of changes between the key variables in question in this research (Giner, 2019).

The model used to investigate the nexus between ICT diffusion and poverty levels in SSA is specified below:

$$\boldsymbol{Y_{it} = X_{it}1 + X_{it}\beta 2 + X_{it}\beta 3 + X_{it}\beta p + u_{it} + \epsilon_{it} \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots 1}$$

To examine the nexus between ICT diffusion and poverty levels in Saharan African (SSA) countries, the study deployed the Panel Vector Autoregressive (PVAR) model. Holtz-Eakin, Newey and Rosen (1988) proposed the first vector autoregressive panel model (PVAR), and it is widely used in applied research as well as in macro-economic policy analysis (Abrigo & Love, 2015).

Where

$\boldsymbol{Y_{it}}$ represents the dependant variable, poverty. Independent variables in the model were: ICT, private domestic credit, foreign direct investment, remittances, and development aid. These variables are important as far as poverty is concerned and are justified by the fact that all these factors have a bearing on human welfare. For example, development aid can be useful in the provision of public and merit goods, which in turn help in improving living standards and reduce poverty levels.

Xit represents vector of exogenous covariates

uit **and** εit denotes vectors of dependant variables, specific fixed effects and idiosyncratic errors. $\boldsymbol{\beta 2, \beta 3, \beta p}$ denote parameters that were estimated in the study. Since the research used the GMM, it is essential to present the model.

$$\Delta \boldsymbol{RGDP_{it}} = \boldsymbol{\gamma 0} + \boldsymbol{\gamma 1 i \Delta RGDP_{it-1}} + \boldsymbol{ICT} + \boldsymbol{FDI} + \boldsymbol{REM} + \boldsymbol{PDC} + \boldsymbol{PSE} + \boldsymbol{DA} + \Delta \boldsymbol{\pi_{it}} \ldots\ldots\ldots\

$H_0 =$ **(Null Hypothesis)**: There is no mutual reaction between ICT diffusion and poverty levels to possible shocks from each other.

$H_1 =$ **(Alternative Hypothesis**): There is a mutual reaction between ICT diffusion and poverty levels to possible shocks from each other.

The focus of the analysis was on the resulting impulse-response functions, which estimated the response of particular variables in the system to innovations in another variable in the system, while holding all other shocks at zero. However, the variance-covariance matrix of the errors was unlikely to be diagonal; therefore, in order to isolate the shocks to one of the VAR errors it was necessary to decompose the residuals in such a way that they become orthogonal.

In order to do this, the current PVAR model used a Cholesky decomposition of the variance-covariance matrix of residuals (Seleteng, 2016). The convention is to adopt a particular ordering and allocate any correlation between the residuals of any two elements to the variable that comes first in the ordering. Therefore, the assumption is that the variables at the beginning of the ordering contemporaneously affect variables that follow them, as well as with a lag, while the latter variables affect the former only with a lag.

The following processes were carried out in running the PVAR model. Panel unit root, panel co-integration, panel causality, PVAR estimation, variance decomposition, impulse response, and other post-estimation tests. Chi-square tests were conducted to ascertain statistical differences. To test for autocorrelation, the Portmanteau Autocorrelation Test and Autocorrelation LM Test were employed in the study. All these tests were done to check the direction of causality, assess if a long-run relationship existed between the variables, and for testing whether the time series variables or factors were non-stationary.

According to Gujarati (2003), an econometric model is a representation of the basic features of an economic phenomenon. For this study, after diagnostic tests, a suitable model was chosen from Fixed Effects and Random Effects. There two popular assumptions that should be made clear about these specific effects. The first is the random effects assumption which states that individual-specific effects are

uncorrelated with independent variables. The second is the fixed effects assumption which is based on the idea that individual-specific effects correlate with independent variables

This research was based on secondary data and all economies in SSA were focused on. The research adapted the PVAR approach to control for heterogeneity and endogeneity in a panel framework. PVAR combines the VAR approach, which treats all variables in the system as endogenous, which allows for unobserved heterogeneity (Love & Zicchino, 2006).

The Panel Vector Autoregressive Model was appropriate for this study since it enables capturing of the linear interdependencies among multiple countries' time series (David, 2019). Due to the limited time span of data for countries in the SADC region, using a single VAR model was not appropriate since this compromises the degree of freedom. A PVAR overcomes this problem as well as gaining degrees of freedom through analysis of a panel of economies in Sub-Saharan Africa (Bouvet, Brady & King, 2013). Spillovers from one economy to another were captured in the study since panel techniques enabled the capturing of economy-level heterogeneity (Bouvet, Brady & King, 2013).

The following exogenous variables were used in the study: primary school enrolment, private domestic credit, ICT, foreign direct investment (FDI), development aid, and remittances. These variables were selected for the study as they have an effect on the welfare of individuals in Sub-Saharan Africa. Three ICT indicators were used in this research to allow for robust policy suggestions (Asongu & Le Roux, 2017). These indicators are mobile phone penetration (per 100 people), internet penetration (per 100 people), and telephones (per 100 people). Asongu & Le Roux (2017) used these proxies in their studies.

From this perspective, a Composite Index: Telecommunications (CIT) was used in the study. The Index consisted of mobile lines, fixed telephone lines, and the internet (David, 2019). The following equation represents the Composite Index: Telecommunications:

$$CIT = \alpha Mobilelines + \alpha FixedTelephone + \alpha Internetaccess \quad \text{.....3}$$

4.3.2 Modelling for first research objective:

The first empirical objective was achieved methodologically through a Granger Causality test.

4.3.3 Modelling for second to fourth objectives

The second and third objectives were empirically tested through fixed effects and random effects. The fourth objective was tested through PVAR.

4.3.4 Fixed Effects Models (FEM)

Estimation using this model depends on assumptions about the intercept, the slope coefficients, and the error term. There are several possibilities for using this model for estimation. The model assumes that the intercept and slope coefficients are constant across time and space, the error term captures differences over time and individuals, and the slope coefficients are constant, but the intercept varies across individuals.

Practically, the model allows for heterogeneity or individuality among cross-section units (countries) by allowing each country to have its own intercept. The term fixed effects is due to the fact that the intercept does not change over time, although it may differ across firms. This means that the Fixed Effects Model (FEM) allows the individual-specific effects α_i to be correlated with the regressor X_i over time.

Panel units have a different intercept term but the same slope parameters. The fixed-effects model is therefore theoretically given as:

$$\boldsymbol{Y_{it} = \alpha i + X_{it} + \mu it} \text{.....4}$$

Gujarati (2003) stated that FEM deals with the omitted variables problem like bias and variance inefficiency that affect either the REM or OLS estimators. Poverty rate was treated as the dependent variable and the other variables mentioned in were treated as independent variables. Individual regressions were run to ensure that the

exact effects were well captured for the identified variables. The following standard regression was run in this study:

$$PRit = \beta 1 + \sum_{j=2}^{k} \beta jXjit + Uit \quad \text{.....}$$

i – 1, 2, 3 …… N (economies in SSA).

t 1, 2, 3……. T (number of years)

Where i represents the i-th cross-sectional unit and t stands for the time period. $\beta 1$n stands for an intercept in this study and $\beta 2$ represents the slope coefficient, and Pr is the poverty rate for each economy in the Sub-Saharan Africa.

4.4 Econometric Methods of Analysis

Chernyshov and Jharko (2016) posit that an econometric model is a representation of the basic features of an economic phenomenon. The captured data was analysed using E-views econometric software. The following statistical methods were used on the empirical data sets:

- Descriptive analysis
- Panel Regression analysis
- Significance tests

For the first empirical objective the following model was used.

$$\boldsymbol{RGDP_{it} = \beta 1_{it} + \beta 2PDC_{it} + \beta 3DA_{it} + \beta 4REM_{it} + \beta 5ICT_{it} + \beta 6FDI_{it} + \beta 7PSE_{it} + \varepsilon_t} \quad \text{.....} \quad \textbf{5}$$

Where RGDP is the proxy for poverty measurement. The i on the intercept $\boldsymbol{\beta 1_{it}}$ represents the intercept across economies in SSA. $\boldsymbol{\beta 2PDC_{it}}$…. $\boldsymbol{\beta 7PSE_{it}}$ are coefficients of the independent variables. $\boldsymbol{\varepsilon_t}$ is the error term of the model. These variables are: DA- development aid, PDC - private domestic credit, RE - remittances, ICT- information and communication technology, FDI - foreign direct investment, PSE - primary school enrolment.

The subscript i is the cross-sectional component and the t is for the time series component; this is because the empirical analysis used panel data across economies in Sub-Saharan Africa from 1989-2019.

Poverty refers to a state in which basic human needs such as food, safe drinking water, sanitation, health, shelter, education, and information are severely deprived (United Nations Global Impact, 2021). Bruneau and Mushtaq (2018) used this variable in their research which focused on micro-finance, financial inclusion and ICT. This source was also used the literature review. In this research poverty was measured using the real GDP per capita.

Private domestic credit (PDC) refers to all financial resources provided to the private sector such as loans, purchases of non-equity securities, trade credits and accounts receivable (World Bank, 2020). This variable was used by Asongu and Le Roux (2016) in research that focused on the enhancement of ICT for human development in Sub-Saharan Africa. The research findings of Asongu and Le Roux (2016) were discussed in the literature review section of this study.

Development aid was another variable used in this study. This refers to an aggregated value comprising disbursements of loans made on concessional terms and grants by official agencies of the members of the Development Assistance Committee (DAC), by multilateral institutions (World Bank, 2020). Previous research by the World Bank (2020) titled *Accelerating poverty reduction in Africa*, showed that development aid can be used to explain poverty dynamics (Word Bank, 2020).

Remittances refer to employee compensation and personal transfers and include personal remittances. All current cash or in-kind transfers made or received by resident households to or from non-resident households are referred to as personal transfers (World Bank, 2020). Research by Amega (2018) used remittances as a variable. The research focused on examining the role of remittance, education and health in Sub-Saharan Africa.

Foreign direct investment refers to the total of equity capital, earnings reinvestment, and other capital. Foreign direct investment is a type of cross-border investment in which a person from one country has control over or a significant amount of influence over the management of a company in another country (World Bank,

2020). Wako (2021) used this variable in a research that focused on Sub-Saharan Africa.

Information and communication technology (ICT) was used as a variable in this research, and in this context it referred to the principal component value of connected mobile phones, the percentage of people with access to the internet, and fixed line penetration. David (2019) used ICT as a variable in research that focused on telecommunication operations and economic growth and development in selected African economies.

4.5 Random Effects Model (REM)

The Random Effects Model (REM) assumes that individual-specific effects (αi) are distributed independently of the regressor. αi is included in the error term. Each individual has the same slope parameters and a composite error term of the form:

$$\boldsymbol{\varepsilon_{it} = \alpha i + eit} \quad \textbf{.....6}$$

Thus, REM is specified as follows:

$$\boldsymbol{Y_{it} = X_{it}\beta + (\alpha i + eit)} \quad \textbf{.....7}$$

There are assumptions about individual-specific effects, one of which is the random effects assumption that states that individual-specific effects are uncorrelated with the independent variables. and that the fixed effects assumption, which is based on the idea that individual-specific effects, correlate with independent variables. Given that the random effects assumption holds, then the random effects model is preferred over the fixed effects model.

For random effects to work in the SADC countries, the nation-specific effects must be uncorrelated to the other covariates of the model. Fixed effects suffer from the drawback of a loss in the degrees of freedom if one uses more dummy factors. Random effects were used to ensure that the differences in the intercepts were accounted of through the use of an error term. The following random effects general form was used:

$$\boldsymbol{Pr_{it} = \beta 1_t + \beta 2X1_t + \beta 3X_{it} + u_{it}} \quad \textbf{.....8}$$

In functional form, the following equation was employed in this study:

$$\boldsymbol{Pr_{it} = \beta 2 X 2_t + \cdots \beta n X_{it} + u_{it}} \text{.....9}$$

Where

$\boldsymbol{Pr}$ is the poverty level per nation in SSA, β1 represents a model intercept and β 2….n are coefficients of the exogenous factors X 2…n. These exogenous factors are primary school enrolment, private domestic credit, ICT, foreign direct investment (FDI), development aid, and remittances. $\boldsymbol{u_{it}}$ is the error term of the model. The subscript i is the cross-sectional component and the t represents a time series component.

4.6 Hausman specification tests

This is a formal test used in choosing between FEM and REM (Gujarati, 2003). The test is conducted on the null hypothesis that the FEM and REM estimators do not differ substantially. To identify the most suitable panel model to apply to the data, the Hausman test must be conducted on the data. The test follows a Chi-square (χ2) distribution.

The formal test is as follows: H=($F\ \ E$− $R\ E$)′[var(FE)−var($R\ \ E$) −1(FE− $R\ E$) ~ χK2. Where *K* denotes the dimension of the slope vector, thus H_0: Cov (X_{it},) =0 . Fa=0.e to accept the null hypothesis leads to the conclusion that the REM is not appropriate; hence, we are better off using the FEM. Accordingly, the Hausman test needs to be conducted on the data to identify the most suitable panel model to apply to the data. The Hausman test is used to ascertain the suitability of a fixed-effects model.

4.7 Diagnostic tests of the model

Diagnostic tests of the model are presented on this section.

4.7.1 The Breusch-Pagan Test

The Breusch-Pagan Test was developed in 1980. This test is used to ascertain heteroskedasticity (Dunga, 2014). The Breusch-Pagan Test assumes that heteroskedasticity may be a linear function of all the independent variables in a

model (Halunga, Orme & Yamagata, 2017). The Breusch-Pagan test was used in this study for the purpose of determining the choice between random effects and fixed effects.

4.7.2 Chi-Square Tests

The Chi-Square test is used to examine the relationships between categorical factors or variables (Whitby, 2013). The Chi-Square test was used to test for any relationship between ICT diffusion and poverty in Sub-Saharan Africa.

4.7.3 Autocorrelation Test

Autocorrelation can be defined as the degree to which the values of the same variables correspond through different measurements in results (Hajria, Khardani & Raïssi, 2018). To test for serial correlation, the Generalised least squares method was used. This method was used in the research because the technique is deemed perfect for estimating regression models (Chetty, 2017).

4.8 DEFINITIONS OF VARIABLES AND EXPECTED SIGNS

4.4.1 Definitions of variables and expected signs

The discussion in this segment centres on defining the variables used in the study, and the expected signs. ICT is treated as an independent variable and poverty is regarded as the dependant variable based on previous study postulations.

4.8.1 Real GDP Per Capita (RGDP)

Real GDP per capita is a calculation of an economy's gross economic production separated by the number of inhabitants and adjusted for inflation (World Bank, 2020). It is used to compare living conditions between countries over time. In this study, the real GDP per capita used was based on constant 2010 US$. The variable

was assigned a positive sign because an increase in real GDP per capita is likely to reduce poverty, *ceteris paribus*. This method was selected for poverty measurement because it shows the living standards of people. It is simplistic to draw comparisons because the total population of a country is considered when calculating the real GDP per capita (Ifa & Guetat, 2018).

4.8.2 Foreign Direct Investment (FDI)

Foreign direct investment refers to international flows of equity investments in the reporting economy (Paul & Feliciano-Cestero, 2020). This is the amount of equity income, earnings reinvestment, and other income. Direct investment is a form of cross-border investment associated with a resident in one economy having power or a substantial degree of influence on the management of a business that resides in another (World Bank, 2020). In the current research, this variable was assigned a positive sign. This is justified by the fact that an increase in foreign direct investment can lead to more job creation and increased output as well as a reduction in poverty, all other things remaining constant.

4.8.3 Remittances (REM)

External remittances cover staff transfers and employee benefits (World Bank, 2020). Personal transfers consist of all existing cash or in-kind transfers to or from non-resident households made or obtained by the residents (Kadozi, 2019). Therefore personal transfers include all existing transfers between residents and non-residents. Remittances can have a positive impact in reducing poverty, as discussed in previous chapters, thus the factor carried a positive sign.

4.8.4 Primary School Enrolment (PSE)

Primary education offers basic reading, writing, and math skills to children, along with a basic understanding of a variety of subjects (van Hooijdonk , 2020). Net enrolment rate is the ratio of children of official school age who are enrolled in school from the respective official school age population (World Bank, 2020). Education can

be regarded as a tool for fighting poverty. In Chapter 2 of this study, it was found that poverty can result from a of lack of knowledge on available opportunities. Thus, primary school enrolment can positively influence poverty alleviation. The factor carried a positive sign.

4.8.5 Private Domestic Credit (PDC)

Private-sector domestic credit refers to financial services offered by financial companies to the private sector, such as loans, purchases of non-equity securities, and trade credits and other receivable accounts, which provide a claim for repayment (World Bank, 2020). In certain economies such statements require loans to public undertakings, and in certain nations such statements provide compensation to public undertakings (Levin, 2019) Financial companies include monetary authorities and money deposit institutions, as well as other financial entities where data is available (including businesses that do not allow transferable deposits but do incur liabilities such as time deposits and savings (Gusev, 2020). Credit can be useful to upcoming and existing businesses. This in turn improves productivity and creation of job opportunities, thereby reducing poverty. This variable carried a positive sign.

4.8.6 Development Aid (DA)

Net Official Development Assistance (ODA) consists of disbursement of loans made on concessional terms (net of principal repayments) and grants by official agencies of members of the Development Assistance Committee (DAC), by multilateral institutions and by non-DAC economies to promote economic development and welfare in nations and territories on the ODA recipient list of DACs (World Bank, 2020). This includes loans with a minimum 25 per cent grant feature (calculated at a 10 per cent discount rate). The effect of private domestic credit on poverty can be likened to that of development aid. This variable was assigned a positive sign.

4.8.7 Summary of Variables and Expected Signs

Table 4.1 below shows a summary of expected variables and their respective signs.

Table 4.1: Summary of Variables

Variable	Expected Sign	Symbol	Description	Source Of Data
ICT	Independent variable	ICT	Principal component value of connected mobile phones, percentage of people with access to internet as well as penetration of fixed lines.	ITU (2020)
Poverty	Dependant variable	RGDP	A state in which basic human needs, such as food, safe drinking water, sanitation, health, shelter, education, and information are severely deprived. This is measured through RGDP per capita.	World Bank (2020)
Foreign Direct Investment	+	FDI	Is made up of three components: equity capital, earnings reinvestment, and other capital.	World Bank (2020)

Remittances	+	REM	Employee compensation and personal transfers are included in personal remittances. All current cash or in-kind transfers made or received by resident households to or from non-resident households are referred to as personal transfers.	World Bank (2020)
Primary School Enrolment	+	PSE	Gross enrolment ratio is the proportion of total enrolment, regardless of age, to the population of the age group that officially corresponds to the education level displayed.	World Bank (2020)
Private Domestic Credit	+	PDC	This incorporates all financial resources provided to the private sector such as loans, purchases of non-equity securities, trade credits and accounts receivable.	World Bank (2020)

Development Aid	+	DA	An aggregated value comprising disbursements of loans made on concessional terms, and grants by official agencies of the members of the Development Assistance Committee (DAC), by multilateral institutions.	World Bank (2020)

Source: Researchers construct

4.9 Nature of data and sources/panel data explanation

Data was collected from the International Telecommunications Organisation (ITO) and the World Bank. The time series component of the data was from 1989 to 2019. The cross-sectional dimension comprises selected countries in Sub-Saharan Africa. The time frame was justified because it allowed for meaningful and balanced data analysis and drawing of conclusions on the subject matter. ICT usage in this study was based on internet usage, mobile phones, and fixed landline phone usage. Real GDP per capita was used to measure poverty in this study.

Panel data was chosen in this study because there was need to ascertain the change in movement on the key variables in question i.e. ICT and poverty. Other factors included in the study were dealt with when running the panel data. This implies that the main interest was in assessing how ICT diffusion can be used for poverty alleviation in Sub-Saharan Africa. Another key merit to using panel data was that pooled data enabled the researcher to carry out studies on complex behavioural models.

4.10 CONCLUSION

This chapter presented the methodology and research design employed in the study. Key aspects included the methodology used in poverty measurement and ICT measurement. Econometric methods of analysis, model specification, and modelling of all research objectives were explained in this chapter. The fixed effects model, random effects model and error component model were explained, in line with research demands. Further, diagnostic checks were presented and the following tests were conducted: Pooled effects, Chow test, Hausman test and the Breusch-Pagan test. Finally, in-depth analyses of the data and a descriptive of the Head Count Poverty Measure, Poverty Data, and ICT data were done. The following chapter is based on a presentation of the results.

CHAPTER 5: STYLISED FACT ANALYSIS

5.1 INTRODUCTION

Guided by the research methodology, this chapter seeks to present the stylized facts on the subject matter. Key focus is on variables used in the study such as ICT, poverty, real GDP per capita, and other variables. The first discussion is based on the performance of information communication technology in SSA. A composite index was used to examine the performance. The three indicators presented are mobile phone subscriptions, fixed telephone subscriptions and internet usage in Sub-Saharan Africa. A ranking of the information communication technology index in Sub-Saharan Africa is made, and an analysis of information communication technology growth in SSA. Poverty trends in Sub-Saharan Africa are presented, and the impact of ICT on poverty in SSA is discussed. The main thrust of the chapter is to ascertain how ICT affected poverty from 1989-2019. Trends of other macro-economic indicators and a partial correlation analysis are presented.

5.2 PERFOMANCE OF INFORMATION COMMUNICATION TECHNOLOGY IN SUB-SAHARAN AFRICA

In this section, the key focus is based on a description of information communication technology in Sub-Saharan Africa. First, fixed telephone subscriptions in SSA are examined. The second analysis is based on mobile phone usage in SSA, followed by a presentation on internet usage. In this chapter the period 1989-1999 is referred to as the first quarter. The second quarter is from 2000-2010, and the third quarter is from 2010-2019.

5.2.1 Fixed Telephone Subscriptions in SSA

Fixed telephone subscriptions in Sub-Saharan Africa fluctuated for the period 1989-2019, as is shown in Figure 5.1 and Figure 5.2.

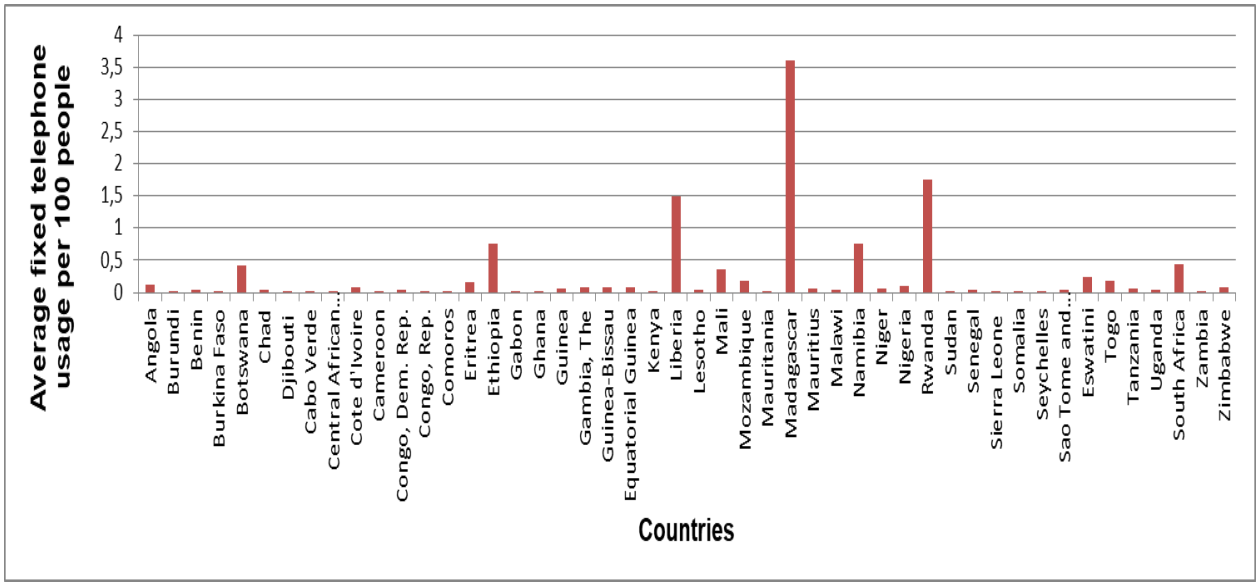

Figure 5.1: Average Fixed Telephone Subscriptions in SSA 1989-2019 (Panel A)

Source: Researcher's calculations (2020)

Figure 5.1 shows that seven countries in Sub-Saharan Africa had higher values. These high values in fixed telephone subscriptions can be attributed to high rates of investment in ICT by the respective countries. This implies that most countries in SSA had low rates or values for the period 1989-2019. A detailed explanation is provided in Figure 5.2 (Panel B).

In the above figure (Panel A), the top performing economies were Seychelles with 12% fixed telephone usage value; South Africa with over 8%; Mauritius with 5%; and Namibia with 5% fixed telephone usage value. Gabon, Cabo Verde and Botswana were practically on par, with values of 2%, 2% and 1,8%, respectively. This means that for the period, forty-one economies in SSA had lower values of fixed telephone subscriptions per hundred people.

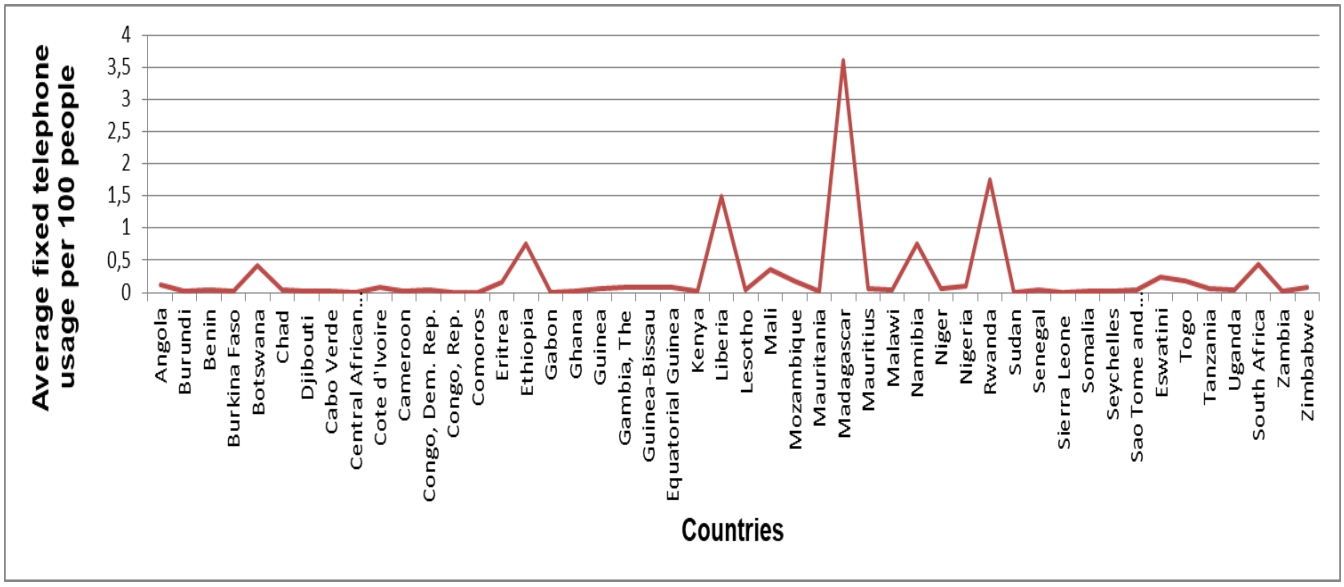

Figure 5.2: Average Fixed Telephone Subscriptions in SSA 1989-2019 (Panel B)

Source: Researcher's calculations (2020)

Figure 5.2 shows that Angola had a low value for fixed telephone subscriptions per hundred, but experienced a steady decrease from 1989-2019. Burundi also had low fixed telephone subscriptions per hundred. However, from 1989-1999 the country registered a sharp increase in fixed telephone subscriptions per hundred i.e. from 0,144 to 0,303 (World Bank, 2020).From 2009-2019, the economy recorded a steady decline in fixed telephone subscriptions per hundred, meaning that the total number of people who had access to fixed telephone lines decreased. Botswana, the overall fixed telephone subscriptions per hundred value was low, but a sharp increase was recorded from 1989-1999. However, there was a slight decrease per hundred in the last quarter. Burkina Faso registered slow growth in fixed telephone subscriptions per hundred for the period 1989-2019. The same applied to Chad, which had extremely slow growth rates for the 30-year period under observation.

Cabo Verde registered a sharp increase in fixed telephone subscriptions per hundred between 1989-1999. However, the country recorded a slight drop in the last quarter, which could have been caused by increased use of mobile cell phones, but overall the country performed fairly well. The Central African Republic showed extremely low rates of fixed telephone subscriptions per hundred from 1989-2019, while Côte d'Ivoire recorded a small increase between1989 -2019.

Cameroon had a slow rate of increase in fixed telephone subscriptions per hundred between 1989-199. However, from 2000-2010 and from 2011-2019, a positive increase was recorded. The Democratic Republic Congo registered a slow increase in the first quarter. However, in the second and last quarters, a steady rise was recorded. The Congo Republic registered an almost uniform increase in fixed telephone subscriptions per hundred for the period 1989-2019.

Comoros recorded a slight increase in the first quarter. However, in the last quarter, the country registered a high increase in fixed telephone subscriptions per hundred. Eritrea registered an increase between 1989-2019. Ethiopia recorded a positive increase in fixed telephone subscriptions per hundred between 1989-2019, performed fairly well overall.

Gabon registered a sharp increase in fixed telephone subscriptions per hundred between 1989-1999. However, in the last quarter Gabon recorded a slight decrease. Ghana showed a steady increase throughout the period, and Guinea recorded a small increase in the first quarter.

Gambia, recorded a positive increase in fixed telephone subscriptions per hundred from 1989-1999 but from then on, up to the end of the last quarter, the country recorded minor fluctuations. Guinea-Bissau registered a slight decrease in the first quarter and then recorded a sharp increase. Equatorial Guinea recorded a sharp increase in the first quarter, but showed a slight drop in the last quarter. Kenya registered a steady increase for the period under observation, and Liberia recorded a slight decrease between 1989-2019.

Lesotho recorded some fluctuations in fixed telephone subscriptions per hundred in all three quarters, and Mali registered consistent growth in the first quarter. Further growth was recorded in the last quarter. Mozambique registered a slight increase in the first quarter, but recorded a decrease in the last quarter.

Mauritania recorded consistent growth between 1989-1999. However, in the last quarter, there were fluctuations. Malawi recorded a high increase between 1989-1999, but recorded a decrease in the last quarter.

Namibia recorded a consistent increase in fixed telephone subscriptions per hundred in the first quarter. However, a small decrease was recorded in the last quarter. Niger also recorded a consistent increase between 1988-1999, but a slight decrease in the last quarter.

Nigeria registered a double increase per hundred in the first quarter, but later recorded a small decrease. Rwanda recorded a consistent increase between 1989-1999, but registered a slight decrease per hundred in the last quarter. Sudan had low fixed telephone subscriptions per hundred values between 1989-1999, but experienced small fluctuations in the last quarter.

Senegal recorded a consistent increase in fixed telephone subscriptions per hundred for the entire period covered in this research, and Sierra Leone registered a small increase between 1989-1999. The country later experienced small fluctuations between 2011-2019. Somalia had low levels in fixed telephone subscriptions per hundred for the entire 30-year period.

Seychelles recorded a high increase in fixed telephone subscriptions per hundred in the first quarter. However, small fluctuations were registered in the last quarter. São Tomé and Principe recorded a high increase in the last quarter (2011-2019), and an insignificant decrease in the last quarter. Eswatini showed a high increase in the first quarter, but registered slow growth in the last quarter. The same applied to Togo, which showed a sharp increase in fixed telephone subscriptions per hundred between 1989-1999 and 2000-2010, but recorded a significant decrease in the last quarter.

South Africa recorded an extremely high increase in fixed telephone subscriptions per hundred between 1989-1999, but registered a decrease in the last quarter. Zambia recorded a high increase in the first quarter, but later showed a decrease. Lastly, Zimbabwe recorded a steady increase in the first quarter, and later recorded a slight decrease in fixed telephone subscriptions per hundred.

5.2.2 Mobile phone usage in SSA

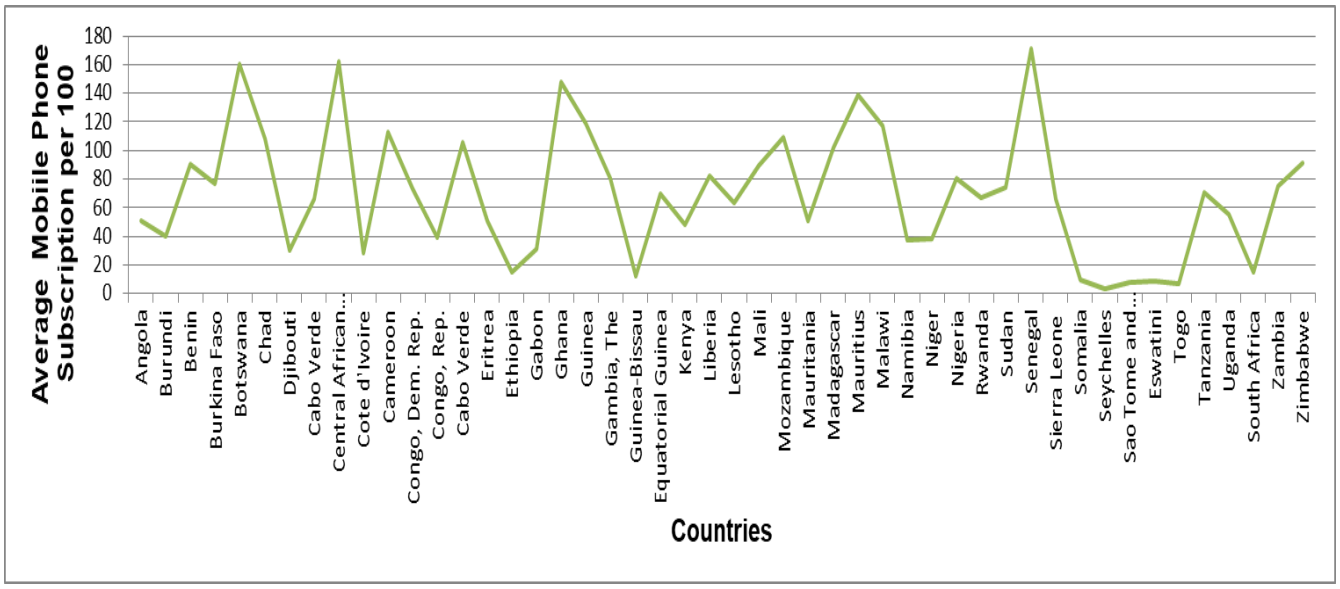

Figure 5.3: Average Mobile phone usage in SSA 1989-2019 (Panel A)

Source: Researcher's calculations (2020)

Figure 5.3 shows that a number of countries in Sub-Saharan Africa have a fairly large rate of mobile phone subscriptions. In Sub-Saharan Africa, the highest value in mobile phone subscriptions was observed in countries such as Mauritius, Senegal, Botswana, Central African Republic, Cameroon, Cabo Verde, Ghana, Madagascar and Mozambique. The lowest value recorded was in Somalia, Togo, Niger, Mali, Ethiopia, Angola, Burundi, Gabon, Guinea-Bissau and Namibia. The trend of mobile phone subscriptions in Sub-Saharan Africa fluctuates sharply. A detailed analysis based on each country is presented in Figure 5.4 below.

Figure 5.3 above shows that the top performing economies in Sub-Saharan Africa in mobile phone subscriptions per hundred people from 1989 to 2019 were Botswana, the Central African Republic, Ghana, Mauritius and Senegal. These countries had values above 100. This can be attributed to increased usage of mobile phones for diverse activities such as communication, online purchases, and banking among others.

Angola recorded a sharp increase in mobile phone subscriptions per hundred people in the first quarter, with high increases in the second and last quarter. Burundi recorded consistent increases in mobile phone subscriptions per hundred people for the entire 30-year period, and Benin registered a slight increase in the first quarter. In the second and third quarter, Benin recorded a high increase with a value above 80%.

Burkina Faso had mobile phone subscriptions per hundred people of 78% at the end of the 30-year period. The country registered slight increases in the first quarter and in the second and third quarter there was a sharp increase. Chad had a double increase in mobile phone subscriptions per hundred people in the second and third quarter – a high increase relative to the first quarter.

Cabo Verde experienced exponential growth between 1989-2019 and had a 64% value at the end of 2019. Côte d'Ivoire had a low rate overall for the 30-year period. In the first quarter, the country had extremely low rates of increase however, the rates peaked in the second and third quarter.

Cameroon had a low value in mobile phone subscriptions per hundred people in the first quarter but its subscriptions per hundred people doubled in the second and third quarter. In the first quarter, the DRC had extremely low value overall. However, in the second and third quarter the rate of increase more than doubled.

Congo had an consistent increases in mobile phone subscriptions per hundred people in the first quarter and substantial increases in the second and third quarter. At the end of 2019, the Congo had a value of 39%. Eritrea performed better than Congo. At the end of 2019, their value stood at 46%. However, in terms of quarterly performance, Eritrea had extremely high increases in the second and third quarter.

Ethiopia was one of the lowest performing countries in terms of mobile phone subscriptions per hundred people in the first quarter. However, there was a sharp drop in the second and third quarter, and at the end of 2019, the nation had a 18,9% value.

Gabon recorded extremely low values in mobile phone subscriptions per hundred people in the first quarter. However, in the second and third quarter Gabon saw a

substantial increase in mobile phone subscriptions per hundred people. Ghana had a significant increase in the second and last quarters and overall, the country had a very high value. The same applied to Guinea, which had more than a triple increase in mobile phone subscriptions per hundred people in the second and last quarter.

Gambia recorded a sharp increase in mobile phone subscriptions per hundred people in the second and last quarter. In the first quarter, the rate of increase was low. Guinea-Bissau recorded a small increase in the first quarter, and had a consistent increase in the second and last quarter.

Equatorial Guinea recorded a steady increase in mobile phone subscriptions per hundred people over the 30-year period. Kenya had low rates in the first quarter, but recorded significant increases in in the last two quarters. Liberia had fairly large increases in the second and third quarter only.

Lesotho had significant fluctuations in mobile phone subscriptions per hundred people over the 30-year period. Mali performed very well, especially in the second and last quarter. Mozambique experienced sluggish growth in the first quarter, but in the second and third quarter, there were substantial increases. The same applied in Madagascar. These two countries had an almost identical growth pattern. However, Mozambique performed slightly better than Madagascar.

Mauritania had a slight increase in in the first quarter, and the second and last quarter, recorded a sharp increase in mobile phone subscriptions per hundred people. Mauritius also recorded a slight increase in the first quarter, but saw higher values in the second and last quarter.

Namibia and Niger were almost on a par as both experienced high increases in mobile phone subscriptions per hundred people in the second and last quarter. Nigeria had a sharp increase in mobile phone subscriptions per hundred people in the second and last quarter. Rwanda and Sudan showed similar trends in that both had significant increases in mobile phone subscriptions per hundred people in the second and third quarter.

Sudan and Sierra Leone performed fairly well, with both showing a steady rise over the 30-year period. Somalia, Seychelles, Eswatini, São Tomé and Principe

performed poorly in terms of mobile phone subscriptions per hundred people. These countries recorded extremely low growth rates in all the quarters. Tanzania and Uganda registered a sharp increases in the last quarter, and South Africa experienced a fairly large increase over the 30-year period. Finally, Zimbabwe and Zambia recorded acute increases in the second and last quarter. In terms of comparison, the former performed better than the latter.

Figure 5.4: Average Mobile phone usage in SSA 1989-2019 (Panel B)

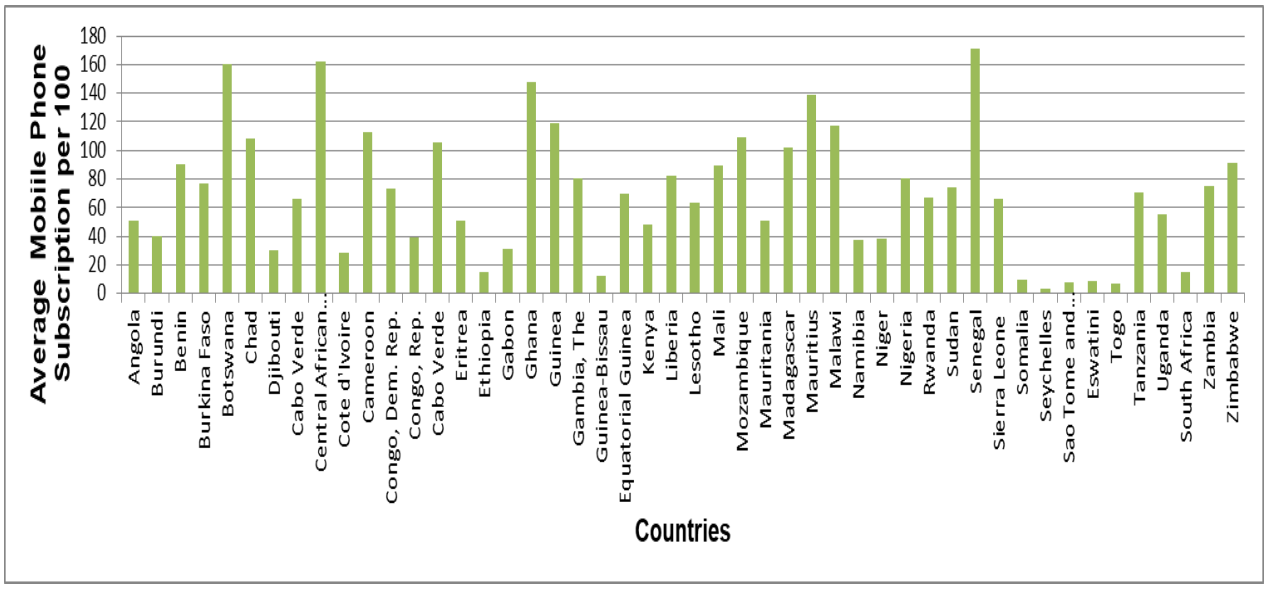

Figure 5.4: Average Mobile phone usage in SSA 1989-2019 (Panel B)

Source: Researcher's calculations (2020)

Figure 5.4 shows that Mauritius, Senegal, Botswana, the Central African Republic, Cameroon, Cabo Verde, Mali, Benin, Guinea, Nigeria, Ghana, Madagascar and Mozambique had the highest mobile phone subscription rates. All these countries had mobile phone subscription rates per hundred people of more than 80% for the period 1989-2019.

The lowest values were recorded in Somalia, Togo, Niger, Mali, Ethiopia, Eswatini, Angola, Burundi, Gabon, Guinea-Bissau and Namibia. These countries had values of mobile phone subscriptions per hundred people that were below 40%. This implies that for the period 1989-2019, few people in these countries had access to mobile

phones. Overall, mobile phone subscriptions per hundred people in Sub-Saharan Africa were fairly good.

5.2.3 Fixed Internet Usage in SSA

Figure 5.5 shows the trend of fixed internet usage in Sub-Saharan Africa. From the figure below it is clear that more than half of the economies in Sub-Saharan Africa had low internet usage rates for the period 1989-2019.

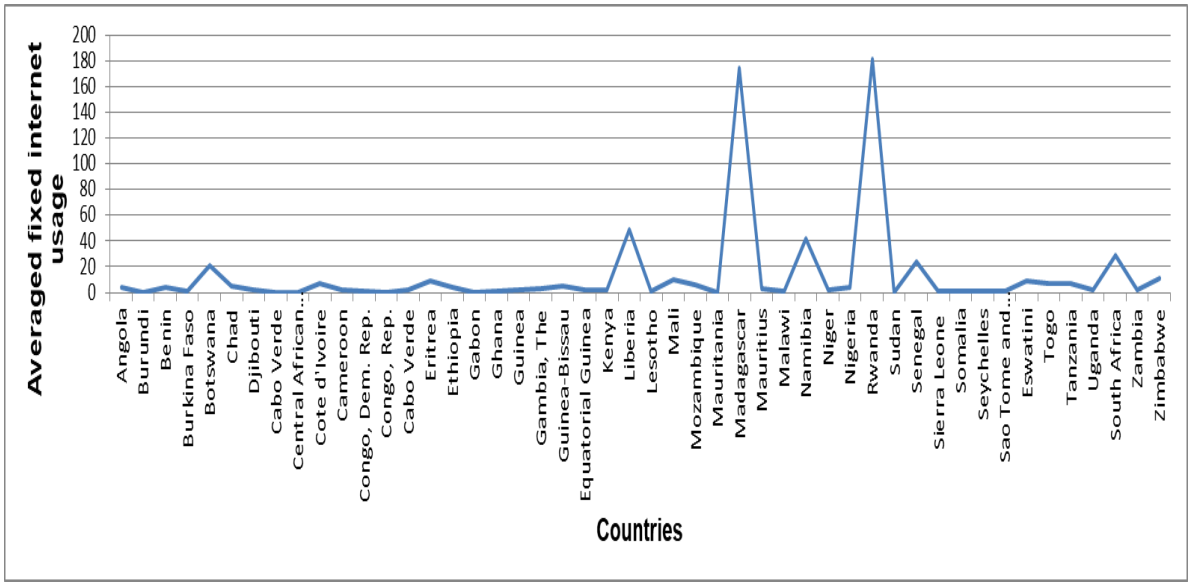

Figure 5.5: Average Fixed Internet Usage in SSA 1980-2019 (Panel A)

Source: Researcher's calculations (2020)

The graph shows fluctuations and that a few economies in Sub-Saharan Africa have better rates of internet usage. Thus, a small fraction of the entire population in SSA enjoys the benefits of the internet. As can be seen in Figure 5.5,the trend supports discussions in previous chapters on the lack of ICT usage in SSA and confirms that the problem statement was well-formulated. The next discussion is based on a country analysis of internet usage.

Angola registered a positive increase in fixed internet usage between 2010-2019, although the country made slow progress in fixed internet usage between 1989-2009.

Benin registered fixed internet usage increases between 2010-2019, but the overall value was very low. Botswana showed a fairly good performance over the 30-year period with increases in fixed internet usage recorded in the second and third quarter.

Burkina Faso, Burundi and Cameroon showed similar trends of very low increases in fixed internet usage between 1989-2019. Cape Verde recorded significant positive increases between the second and last quarter.

Chad, Comoros, the Congo and DRC suffered low growth in fixed internet usage over the 30-year period, and all had a uniform trend of slow growth. Côte d'Ivoire registered positive increases in fixed internet usage in the second quarter only.

Djibouti had extremely low growth in fixed internet usage. Between 2010-2019, the country only had minor positive changes in fixed internet usage. Equatorial Guinea experienced extremely low growth in the first quarter, and in the second and third quarter registered slight increases. Eritrea also had extremely low growth in fixed internet usage in the first quarter. The country experienced small positive changes between 2010-2019.

Ethiopia registered significant changes in fixed internet usage only between 2010-2019. Gambia, Guinea Bissau and Equatorial-Guinea had similar trends and all registered small increases between 2010-2019.

Kenya performed well in fixed internet usage between 2010-2019. However, from the initial years between 1989-2009, the country showed slow progress. The same applies to Ghana, where there were positive increases in fixed internet usage in the last quarter. Lesotho struggled to improve its fixed internet usage between1989-2009 and managed a peak after 2010. Madagascar showed positive changes, especially from 2010-2019. It is one of the countries that performed well for the 30-year period covered in this study. Liberia performed fairly well in terms of fixed internet usage although an increase was recorded only in the second and last quarter.

Malawi, Niger and Nigeria results were almost on a par. They had positive increases in fixed internet usage values in the second and last quarter. However, Nigeria

performed better relative to Malawi between 1989-2009. Mali also registered significant increases between 2010-2019. Mauritania and Mauritius showed poor performances in the first quarter, with Mauritius performing better than Mauritania over the entire period of 1989-2019.

Mozambique showed poor performance 1989-2009 but had a slow positive change in fixed internet usage between 2010-2019. Overall, the economy did not perform well for the period 1989-2019. Namibia recorded insignificant growth between 1989-2009, but showed significant progress between 2010-2019.

Rwanda showed fairly good performance in fixed internet usage between 2010-2019. São Tomé and Principe recorded minor positive changes in fixed internet usage between 1989-2019. Overall, the country had poor performance in fixed internet usage. Senegal performed well between 2010-2019 but in the first and second quarter, their rates were very low.

The Seychelles were low-performing, with significant positive increases only recorded in 2010-2019. South Sudan and Somalia were the lowest performing countries in SSA between 1989-2019. This could be attributed to the political instability and war that raged in both countries. According to the World Bank (2016), political instability and war normally affect a country's development

South Africa showed positive changes in fixed internet usage between 1989-2009 though the change was small. However, usage improved from 2010-2019.

Togo, Uganda and Tanzania were on a par in the period 2010-2019. However, Togo displayed better performance in fixed internet usage compared to Tanzania for the period 1989-2019. Zambia had slow growth in fixed internet usage throughout the 30-year period. Lastly, Zimbabwe performed much better between 2010-2019 compared to the period 1989-2009.

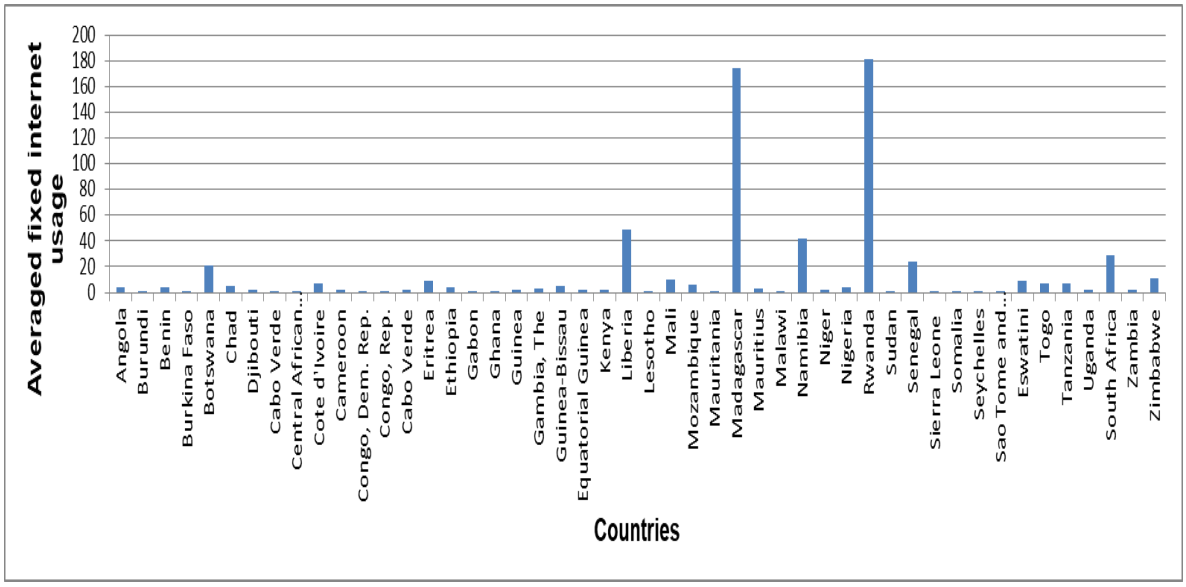

Figure 5.6: Fixed Internet Usage SSA 1989-2019 (Panel B)

Source: Researcher's calculations (2020)

Figure 5.6 shows fixed internet usage and subscriptions in Sub-Saharan Africa. Madagascar, Liberia, Namibia, Botswana and Rwanda were the five countries with high fixed internet subscriptions in the entire Sub-Saharan Index. All other economies such as Comoros, Ghana, Lesotho, Niger, Somalia, Sudan, Tanzania and Zimbabwe among others, had low indices. These findings correlate with the presentation that was made in Chapter 1 where it was stated presented that most SSA countries have low ICT usage and high poverty levels. This implies that the countries with low internet usage do not benefit from using the internet for commercial or economic purposes, and that for them, such activities remain unattainable. Further analysis will show how ICT can be used as a mechanism for poverty reduction in the Sub-Saharan Africa.

5.2.4 ICT Composite Index in SSA

To examine the performance of ICT in SSA, a composite index was used. The index was based on fixed telephone usage, internet usage and mobile telephone usage.. This is restated in algebraic form below:

$$CIT = \alpha Mobilelines + \alpha FixedTelephone + \alpha Internetaccess \quad \text{.....10}$$

The Figure 5.7 below shows the composite index trend for all economies in Sub-Saharan Africa.

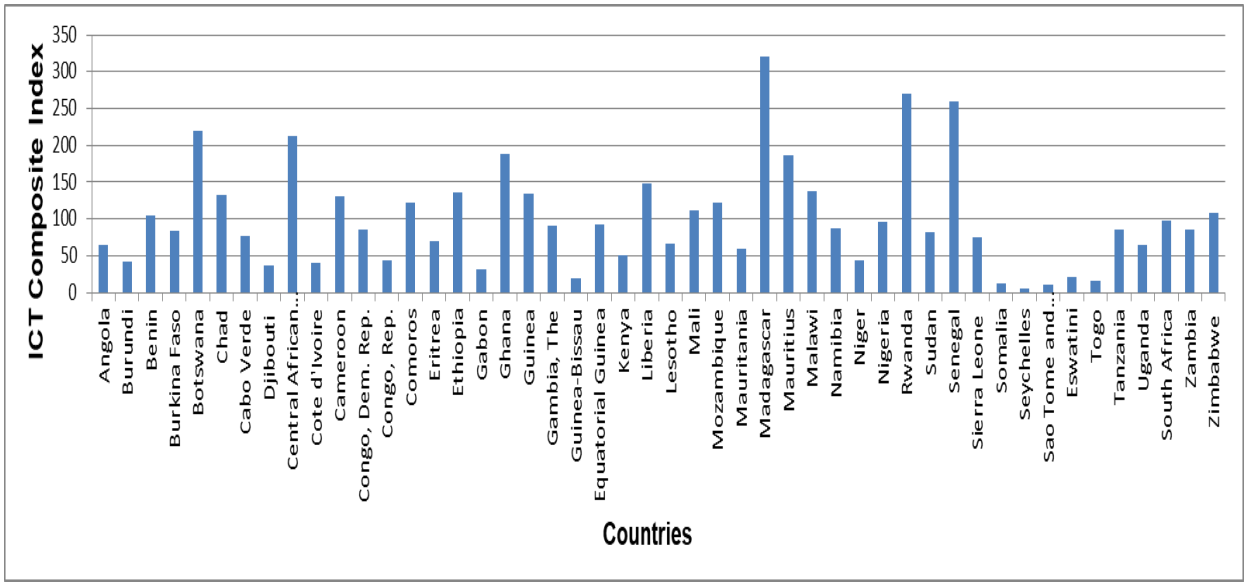

Figure 5.7: Composite Index Sub-Saharan Africa 1989-2019 (Panel A)

Source: Researcher's calculation (2020)

Figure 5.7 shows that Madagascar had an index of 321, and was the country with the highest index. Thus in terms of ICT usage, Madagascar performed very well compared to other countries in the SSA region.

Botswana, the Central African Republic, Rwanda, Senegal, Ghana, Liberia and Cameroon had values of 219, 270, 259, 148 and 130, respectively. This implies that a significant number of people in each country had access to the internet, fixed telephones and mobile phones. This can be attributed to sound ICT policies and meaningful investment in the ICT sectors of these countries.

Angola, Burundi, Djibouti, Eritrea, Côte d'Ivoire, Congo, Gabon, Kenya, Lesotho, Mauritania, Niger, Somalia, Seychelles, São Tomé and Principe, Eswatini, Togo and Guinea-Bissau were some of countries the with the lowest ICT composite index, all having values below 100. This implies that limited populations enjoy the benefits of using mobile phones, fixed telephones and internet.

Benin, Chad, Ethiopia, Sudan, Uganda, Zambia, Comoros, Mali, Sierra-Leone, Mozambique, Mauritius, and Malawi all had an index above 100 but below 150. These countries performed much better in terms of the composite index compared to Angola, Burundi, the Congo and Lesotho. Nigeria and Namibia were on par in terms of the ICT composite index, however, Nigeria performed much better than Namibia.

Nigeria had an index of 96.91, while Namibia had 86.6. Sudan also had a low ICT index and that matches analyses carried out in previous chapters. In the literature review it was established that political instability and wars in South Sudan have affected the growth of ICT. These countries have high poverty levels and low ICT usage levels, and there is need for them to increase investment in ICT to ensure that they attain higher levels on composite index. A higher ICT composite index implies that these countries will have the opportunity to maximize the associated benefits that come with high ICT usage. One of these benefits is poverty reduction.

Low levels on the ICT composite index can be attributed to diverse factors such as poor ICT policies, low levels of income, lack of access to the internet and exorbitant charges for the internet as well as the existence of monopolies in the ICT sectors of the respective countries.

South Africa and Zimbabwe were on a par, although Zimbabwe performed much better in terms of ICT usage. Thus, the types of benefits that come with ICT usage for both countries may be similar as they had almost identical ICT composite index values. These figures show that the two countries have fairly good ICT usage, although poverty remains rife. As such, the need for increasing ICT usage cannot be overemphasized.

Based on the above facts, it is clear that only a few countries in the SSA region have high ICT usage values. The rest have low values and therefore increasing ICT usage remains an integral aspect for poverty alleviation in the Sub-Saharan Africa region. Thus, SSA economies need to harness ICT and use it as a tool for poverty alleviation.

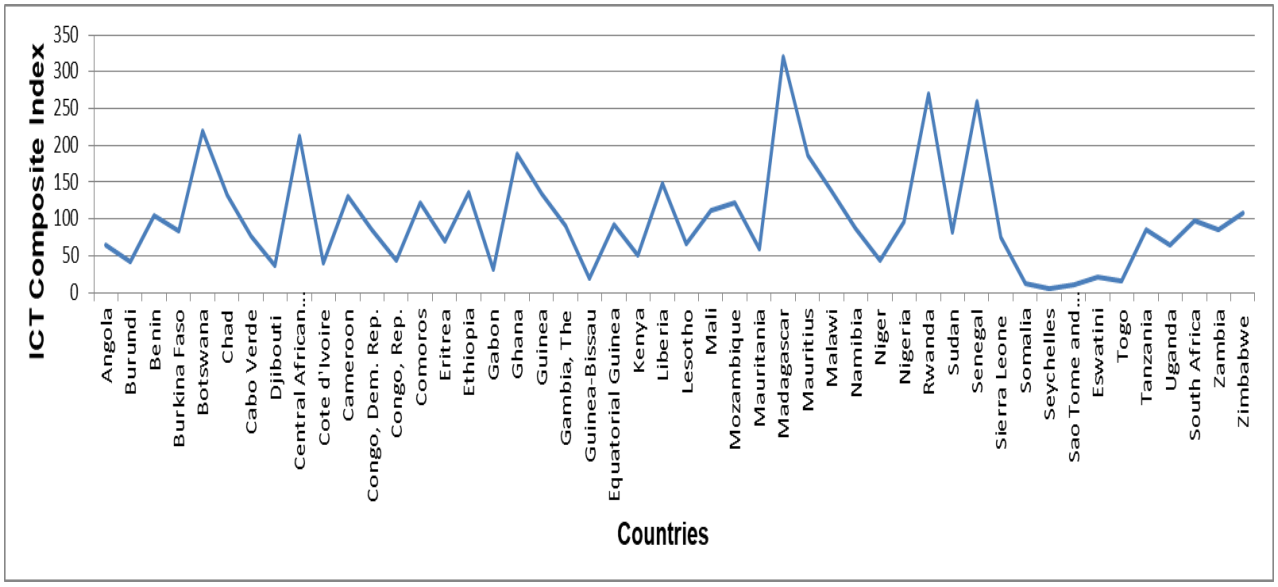

Figure 5.8: ICT COMPOSITE INDEX 1989-2019 (PANEL B)

Source: Researcher's calculation (2021)

Figure 5.8 shows an overview of the ICT Composite Index for SSA from 1989-2019. From the graph, it is clear that most of the countries had low levels on the Index. This means that the economic activities and benefits that come with the use of technology are limited. Specifically, ICT can provide assets such as entrepreneurial activities, e-commerce, and economic growth. Although some countries rated high on the ICT Composite Index, this did not necessarily mean that their poverty levels were low. Based on the above figure, it can be concluded that more need to be done in harnessing ICT and ensuring that it is used as a tool for poverty alleviation. ICT should be adopted and diffused into the diverse sectors such as manufacturing, mining, agricultural sector, services sector just to mention a few.

5.3 RANKING OF INFORMATION COMMUNICATION TECHNOLOGY INDEX IN SUB-SAHARAN AFRICA

Table 5.2 below shows the rankings of the Information Communication Technology Index for Sub-Saharan Africa. These rankings were based on three ICT indicators: mobile telephone subscriptions, fixed telephone subscriptions and internet access subscriptions.

Table 5.2: Rankings of the Information Communication Technology Index for Sub-Saharan Africa

Sub-Saharan Africa Region countries	MOBILE TELEPHONE SUBSCRIPTIONS		FIXED TELEPHONE SUBSCRIPTIONS		INTERNET ACCESS SUBSCRIPTIONS	
COUNTRY	**INDEX**	**RANK**	**INDEX**	**RANK**	**INDEX**	**RANK**
Angola	4,12	19	0,41	17	59,55	34
Burundi	0,5	44	0,05	42	41,95	38
Benin	4,23	18	0,42	16	100,19	16
Burkina Faso	1,33	36	0,13	36	81,95	25
Botswana	21,2	7	0,71	13	197,43	4
Chad	4,93	16	0,49	14	126,74	12
Cabo Verde	2,04	28	0,048	44	74,99	27
Djibouti	2,38	25	0,28	21	34,5	41
Central African Republic	0,04	48	0,04	47	213,3	3
Côte d'Ivoire	7,44	12	0,74	11	31,89	43
Cameroon	1,93	30	0,19	29	128,8	10
Congo, Dem. Rep.	0,82	39	0,08	39	84,33	22

Congo, Rep of.	0,26	46	0,02	45	44	37
Comoros	0,51	43	0,2	26	120,6	13
Eritrea	8,96	11	0,89	10	60,6	33
Ethiopia	3,54	21	3,54	5	128,6	11
Gabon	0,18	47	0,018	46	32,07	42
Ghana	1,39	34	0,139	34	186,9	5
Guinea	1,68	31	0,45	15	132,5	8
Gambia	3,14	22	0,31	20	87,92	21
Guinea-Bissau	4,9	17	0,16	30	13,92	44
Equatorial Guinea	2,01	29	0,201	28	90,03	20
Kenya	1,6	32	0,16	31	48,62	36
Liberia	48,4	3	5,01	3	94,76	18
Lesotho	1,17	38	0,11	38	64,65	31
Mali	10,3	9	1,03	8	100,5	15
Mozambique	5,51	15	0,39	18	116,03	14
Mauritania	0,52	42	0,06	41	58,01	35

Madagascar	174	2	17,42	2	129,6	9
Mauritius	2,63	23	0,26	22	183,3	6
Malawi	1,5	33	0,15	32	136,67	7
Namibia	41,9	4	4,19	4	40,73	40
Niger	2,4	24	0,24	23	41,3	39
Nigeria	3,76	20	0,37	19	92,06	19
Rwanda	182	1	18,17	1	70,51	29
Sudan	0,48	45	0,048	43	82,1	24
Senegal	24,3	6	2,05	7	233	2
Sierra Leone	0,7	41	0,07	41	74,41	28
Somalia	0,74	40	0,07	40	11,43	45
Seychelles	1,31	37	0,131	37	3,17	1
São Tomé and Principe	1,39	35	0,139	35	9,4	47
Eswatini	9,18	10	0,91	9	10,73	46
Togo	7,42	13	0,742	12	7,48	48
Tanzania	6,81	14	0,14	33	79,27	26

Uganda	2,27	26	0,22	24	62,33	32
South Africa	28,6	5	2,86	6	66,11	30
Zambia	2,19	27	0,21	25	83,25	23
Zimbabwe	10,9	8	0,2	27	97,19	17

Source: Researcher's calculation (2020)

Table 5.2 shows that in terms of mobile telephone subscriptions, the top five performing economies in SSA were Liberia, Madagascar, Namibia, Rwanda and South Africa, and that these countries had high numbers of people using mobile telephones. The lowest performing countries were Burundi, Congo, the Central African Republic, Gabon and Sudan. This implies that few people in these countries have access to mobile phones. The respective values of all the economies were discussed under the heading 5.2.2: Mobile phone usage in SSA.

In terms of fixed telephone subscriptions, the top five countries in Sub-Saharan Africa with highest values were Ethiopia, Liberia, Madagascar, Namibia and Rwanda. This implies that a bigger number of the total population in those countries had access to fixed lines. The lowest performing economies were the Central African Republic, Cabo Verde, Congo, Gabon and Sudan. This implies that a smaller number of the total population in those countries had access to fixed lines. The respective values of all the countries were discussed under the heading 5.2: Fixed Telephone Subscriptions in SSA.

In terms of internet access subscriptions, the top performing countries were the Central African Republic, Botswana, Ghana, Senegal and Seychelles. These countries had high values of internet subscriptions and it can be concluded that more people in these economies had access to the internet. The lowest performing economies in Sub-Saharan Africa in terms of internet access subscriptions were Eswatini, Guinea Bissau, São Tomé and Principe, Somalia and Togo. As such, the benefits that accrue to the citizens of these nations are meagre. The respective values of all the countries were discussed under the heading 5.2.3 Fixed Internet Usage, SSA.

5.4 POVERTY TRENDS IN SUB-SAHARAN AFRICA

This section presents poverty trends in SSA.

5.4.1 Poverty Trends in Sub-Saharan Africa

In this research poverty was measured through real GDP per capita. Figure 5.10 below was constructed for Sub-Saharan Africa for the period 1989-2019.

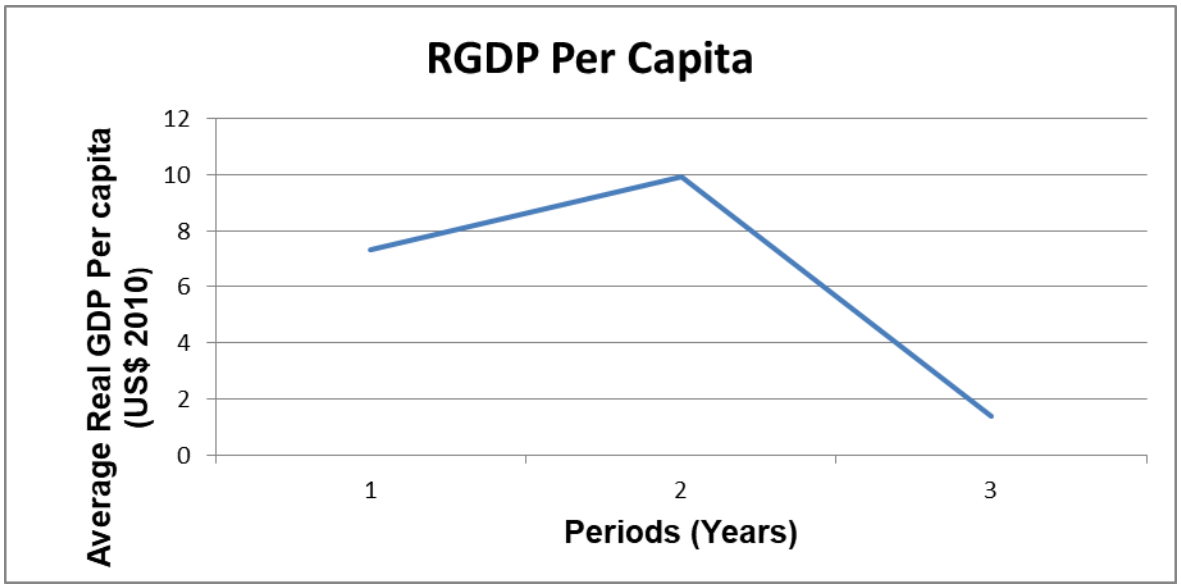

Figure 5.9: Poverty trends in Sub-Saharan Africa

Source: Researcher's Calculation (2020)

Figure 5.9 shows that the average real GDP per capita for the Sub-Saharan Africa region increased from 1989-2009. Period 1 refers to the years 1989-1999, period 2 refers to 1999-2009, and period 3 refers to 2009-2019. From period 1 to period 2, there was an increase in real GDP per capita for the region. An increase in real GDP per capita shows that people's living standards were better during that period. In another context, an increase in living standards implies a decrease in poverty. However, from period 2 to period 3, poverty in Sub-Saharan Africa experienced a sharp decline.

This implies that there was a fall in living standards in the Sub-Saharan Africa region. It can therefore be concluded that although from the above figure there is evidence of a high increase in the average real GDP per capita for Sub-Saharan Africa in period 1, this does not necessarily mean that all economies had high rates of real GDP per capita. As outlined in Chapter 2 and 3, there are a number of countries in abject poverty. There is a disconnect between the relatively high levels of the average real GDP per capita at regional level in Sub-Saharan Africa, and the low levels of the average real GDP per capita at country level in SSA.

5.5 IMPACT OF ICT ON POVERTY IN SSA

Figure 5.10 shows the impact of ICT on poverty in Sub-Saharan Africa for the period 1989-2019.

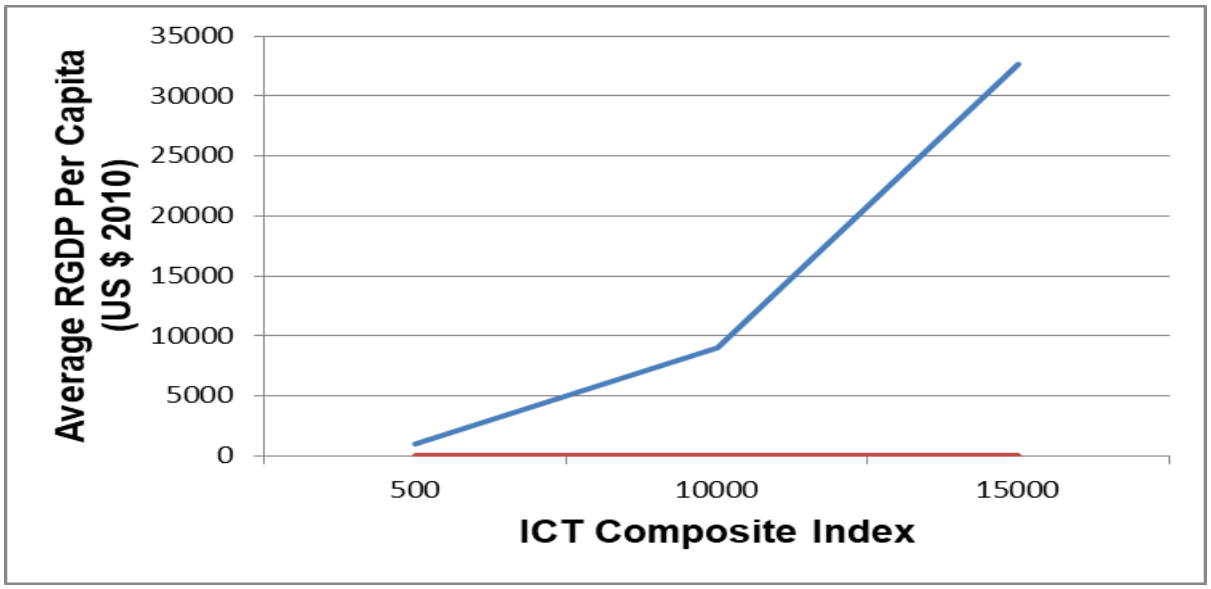

Figure 5.10: Impact of ICT on Poverty in Sub-Saharan Africa, 1980-2019

Source: Researcher's Calculation (2020)

Figure 5.10 shows that a positive direct relationship exists between real GDP per capita and ICT. This implies that an increase in ICT usage increases real GDP per capita. From this perspective, it implies that increases in mobile phone usage, internet usage and fixed telephone usage increase people's living standards in Sub-Saharan Africa. This validates the assertion made in Chapter 1 on the importance of ICT in poverty reduction in Sub-Saharan Africa. To reduce poverty, ICT usage must be increased in the Sub-Saharan Africa region.

5.6 TRENDS OF OTHER MACRO-ECONOMIC INDICATORS

This section presents an analysis of the trends of other macro-economic indicators that were used in the study. These indicators are development aid, foreign direct investment, primary school enrolment, real gross domestic product per capita, remittances, and private domestic credit.

5.6.1 DEVELOPMENT AID

Figure 5.12 shows the trends of development aid in Sub-Saharan Africa for the period 1989-2019.

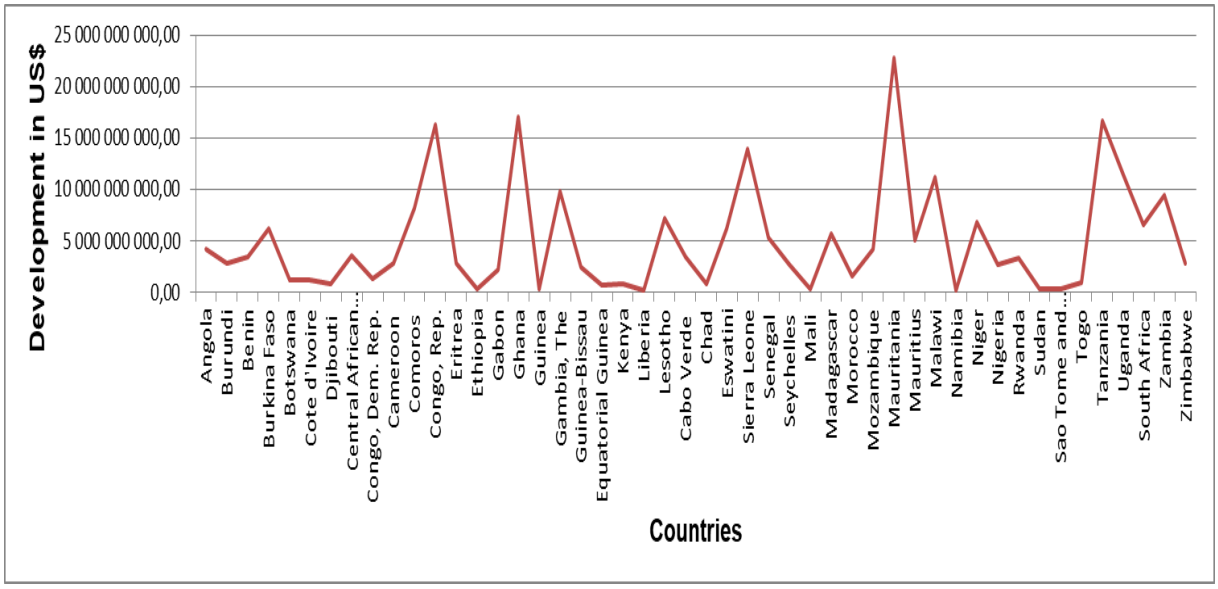

Figure 5.11: Average Development Aid to SSA countries 1989-2019 (Panel A)

Source: Researcher's Calculation (2020)

The graph shows that there were sharp fluctuations in development aid for Sub-Saharan Africa from 1989-2019. This implies that economies in the SSA region have received varying amounts of development aid over the 30-year period. A detailed analysis that shows the associated value in development aid of the 48 economies in Sub-Saharan Africa from 1989-2019 is presented below.

Angola experienced a substantial increase in development aid levels from 1989-2009, but from 2010-2019, the country realized a drop in development aid. Benin experienced a sharp increase in development aid levels from 1989 to the end of 2019. Botswana experienced a sharp increase in development aid levels between 2010-2019. From 1989-2009, there was positive growth in development aid levels, but the rate was lower relative to the 2010-2019 period. Burkina Faso also experienced a significant increase in development aid levels between 2010-2019.

Burundi registered steady growth in development aid levels from 1989-1999. Increases in development aid levels were recorded in the second and last quarter. The same applied for Cameroon, which experienced higher development aid levels between 2010-2019. Although the country recorded a positive increase in development aid levels between 1989-2009, the rate of increase was less compared to the last period. Cape Verde recorded high development aid levels between 1989-2009, and from 2010-2019, there was a sharp increase in development aid levels.

The Central African Republic experienced a decrease in development aid levels in the first quarter. However, from 2010-2019, there was a sharp increase in development aid levels. Comoros registered a steady increase in development aid levels between 1989-1999. In the last quarter, the country recorded high increases in development aid levels. In Congo, there was a decrease in development aid levels between 1989-1999, but between 2010-2019, the economy registered an increase in development aid levels.

The Côte d'Ivoire recorded an exponential increase in development aid levels for the second and third quarter. However, it was one of the countries in SSA that received a low value of development aid. Eswatini recorded a gradual increase in development aid levels between the years 1989-2019. Ethiopia had low values of development aid and the registered a significant decrease in development aid in the second quarter.

Eritrea experienced high levels of development aid, with a significant increase registered between 2010-2019. Gabon recorded a gradual increase in development aid levels from 1989-2018. For Gambia, there was a steady increase in development aid levels between 1989-2009, and from 2010-2019, the economy recorded a high increase in development aid levels. The same applied Ghana, which had a high increase in development aid levels between 2010-2019 compared to that of 1989-2009. Guinea, recorded low levels of development aid between 1989-2009. However, between 2010-2019 the country recorded higher development aid levels. Guinea- Bissau experienced extremely high development aid levels between 2010-2019, but development aid levels for the period 1989-1999 were low. Kenya

recorded a sharp increase in development aid levels for the first quarter, but in the last quarter, the rate of increase was lower compared to that of the first quarter.

Lesotho recorded a sharp increase in development aid levels between 2010-2019. For the prior period (1989-2009) the rate of increase was moderate. Liberia recorded a moderate decrease in development aid levels between 1989-2019. Madagascar recorded a small rise in development aid levels between 1989-2009. However, from 2010-2019 there was a sharp increase in development aid levels.

Malawi recorded a moderate increase in development aid levels between 1989-2009. However, from 2010-2019, the country recorded a higher increase in development aid levels. Mali recorded a gradual decrease in development aid levels for the first quarter only; in the second and third quarter there was a substantial increase in development aid levels. Mauritania experienced a gradual increase in development aid levels from 1989-2019.

Mauritius recorded a gradual increase in development aid levels between 1989-2009, with a higher increase in development aid levels recorded between 2010-2019. Mozambique recorded a significantly higher increase in development aid levels from 1989-2019. Namibia recorded a small decrease in development aid levels between 1989-2009, however, from 2010-2019 a bigger increase in development aid levels was recorded. The same applied to Niger, which had a significant increase in development aid levels 2010-2019. From 1989-2009, the country recorded small increases in development aid levels. Nigeria had a significant increase in development aid levels from 2010-2019, but there was a drop in development aid levels in the first quarter.

Rwanda recorded a high increase in development aid levels between 1989-2009. and from 2010-2019, the country recorded even higher levels of development aid. São Tomé and Principe recorded a significant decline in development aid levels between 1989-2009. However, there was an increase in development aid levels between 2010-2020. Senegal experienced a gradual increase in development aid levels over the 30-year period.

Seychelles recorded a slight increase in development aid levels between 1989-2009. However, there was a higher increase in development aid levels between 2010-2019. Sierra Leone recorded a gradual increase in development aid levels from 1989-2019. Somalia faced a decline in development aid levels between 1989-2009. However, from 2010-2019 the country experienced high increases in development aid levels. South Africa recorded exponential growth in development aid levels over the 30-year period. Togo saw a slight increase in development aid levels between 1989-2009. However, the economy recorded higher development aid levels between 2010-2019.

Uganda recorded higher development aid levels for the 30-year period. Tanzania on the other hand, recorded a gradual increase in development aid levels between 1989-2009, but the country recorded higher development aid levels between 2010-2019. Zambia had a significant increase in development aid levels for the 30-years period. Lastly, Zimbabwe recorded a slight decrease in development aid levels between 1989-2009, however, the economy showed an increase in development aid levels from 2010-2019.

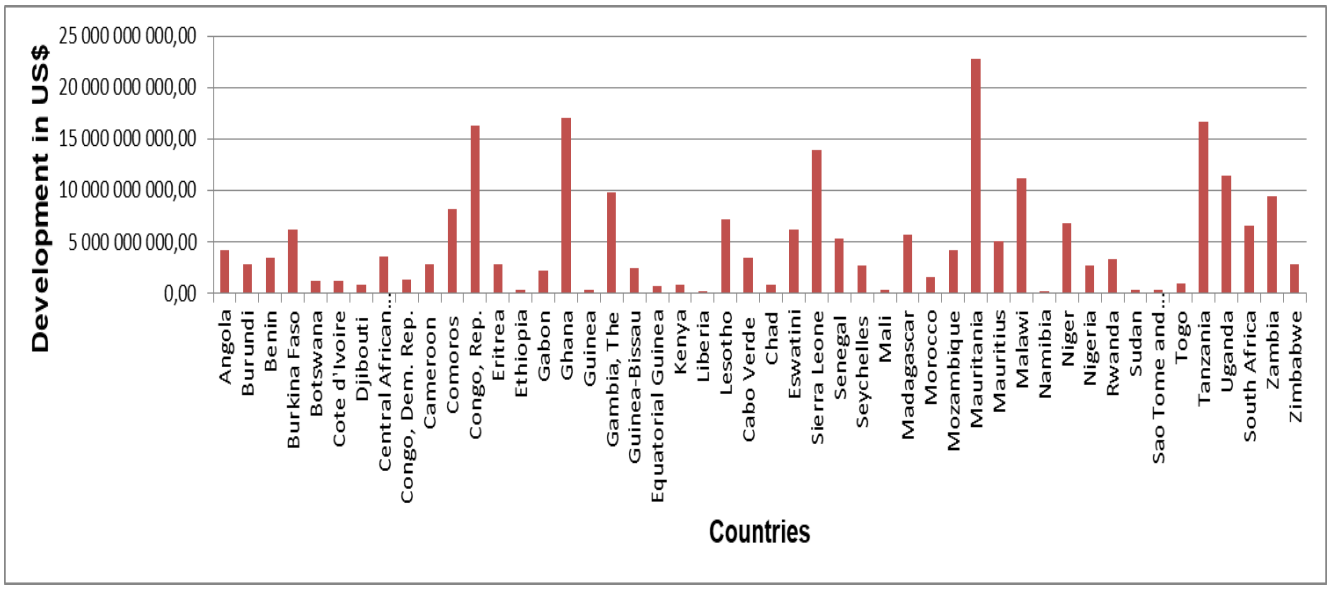

Figure 5.12: Average Development Aid to SSA countries 1989-2019 (Panel B)

Source: Researcher's calculation (2020)

Figure 5.12 shows that SSA countries that had the highest values in terms of development aid were Mauritania, Congo, Gambia, Ghana, Malawi, Mauritania, Sierra-Leone, Tanzania, Uganda, and Zambia. These countries received a total of more than US$10billion. Development aid should help poverty alleviation if channelled towards productive sectors. Some countries that received lower values of development aid were Chad, Burundi, Gabon, Liberia, Morocco and Togo. The total was below US$6billion. Overall, in terms of development aid levels in SSA countries for the period 1989-2019, amounts of aid varied and some SSA countries received significantly higher amounts of development aid than others.

5.6.2 Foreign Direct Investment SSA

Economies in Sub-Saharan Africa have been receiving foreign direct investment (FDI). Figure 5.13 shows the trend of foreign direct investment from 1989-20109 for the Sub-Saharan Africa region. The trend depicts that more than half of 48 economies in the SSA had low levels of foreign direct investment. In monetary terms, these economies attracted FDI of less than US$10 billion. Few countries managed to attract meaningful foreign direct investment. These economies managed to attract FDI of more than US$20 billion.

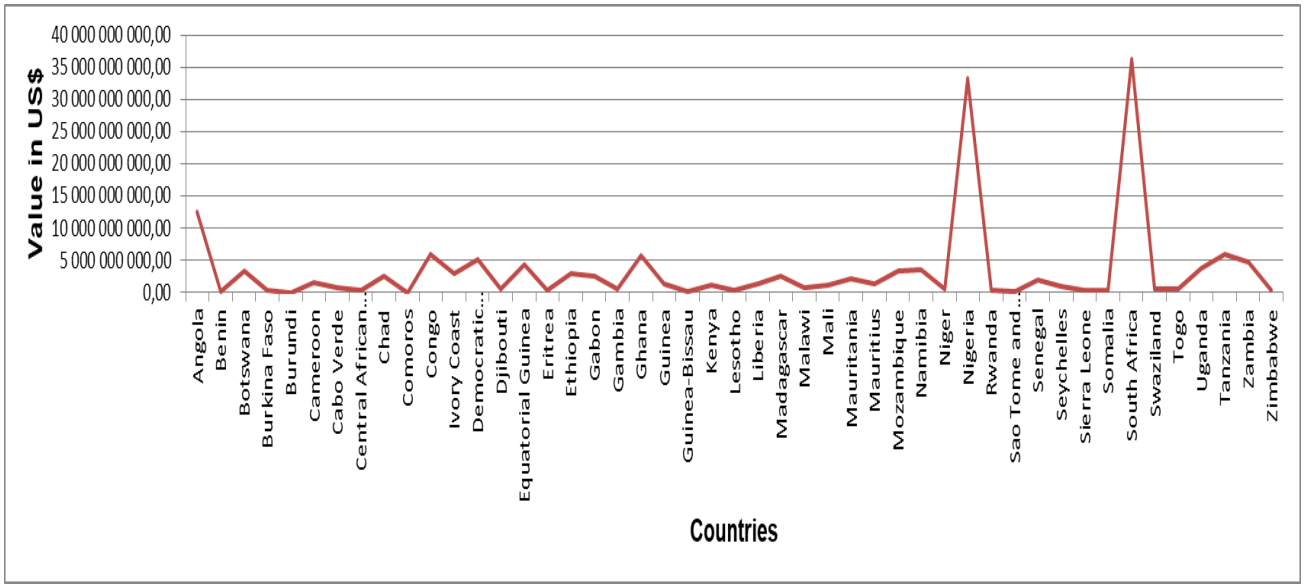

Figure 5.13: Foreign Direct Investment SSA 1989-2019 (Panel A)

Source: Researcher's calculation (2020)

Limited foreign direct investment can affect the economy in adverse ways. FDI is useful in increasing economic growth, which raises people's living standards. Thus, increased foreign direct investment can increase the real GDP per capita and reduced FDI can limit a nation's economic growth and result in dwindling living standards and increased poverty levels.

Angola experienced a sharp decrease in FDI levels between 1989-2009. From 2010-2019, there was a steady decline in the FDI levels. Benin recorded an increase in FDI levels between 1989-2009, and a doubled increase in FDI levels between 2010-2019. Botswana realized an exponential increase in FDI levels from 1989-1999. From 2010-2019 there was a slight drop in FDI levels.

Burkina Faso registered an increase in FDI levels between 1989-2009, with a significant increase in FDI levels between 2010-2019. From 1989-1999, Burundi recorded a double increase in FDI levels. This was followed by slower growth in FDI levels between 2010-2019.

Cameroon had an increase in in FDI levels between 1989-2009, and the increase doubled from 2010-2019. Cabo Verde recorded a sevenfold increase in FDI levels between 1989-2009. From 2010 -2019, the country recorded a steady increase in FDI levels and it remained with a positive FDI balance.

The Central African Republic also experienced an exponential increase in FDI levels between 1989-2019, and Comoros recorded a high increase in FDI levels between 1989-1999, with a sharp increase between 2010-2019. Congo recorded a double increase in FDI levels between 1989-2009. From 2010-2019, there was a steady increase in FDI levels, though the value remained positive at over US$24 million. The Côte d'Ivoire had a double increase in FDI levels for the 30-year period in question. DRC recorded an increase between 1989-2009. From 2010-2019, the economy recorded a further increase was recorded, to the value of US$1,596,560,187. Equatorial Guinea experienced a sharp increase in FDI levels between 1989-2009, and the economy recorded a further increase from 2010-2019.

Eritrea experienced a double decrease in FDI levels between 1989-2009 with a sharp increase from 2010-2019. In Ethiopia there was a sharp increase in FDI levels

over the 30-year period covered in the research. From 1989-2019, Gabon improved its negative FDI level and recorded a double increase from 2010-2019. Gambia, Guinea, Lesotho and Kenya depicted similar trends in FDI levels. These countries showed a steady increase in the period 1989-2019. Guinea Bissau recorded an increase in FDI levels between 1989-2009. In Liberia, increases in FDI levels were recorded from 1989-2019as the country received substantial amounts of FDI. Madagascar had a double increase in FDI levels between 1989-2009 and from 2010-2019.

Malawi experienced a steady increase in FDI levels between 1989-2009. From 2010-2019, the economy recorded a further increase. Mali and Mauritania showed similar trends. Both economies showed a steady increase in FDI levels for the entire 30-year period. Mauritius showed a sharp increase in FDI levels throughout the years 1989-2019.

Mozambique recorded a lower increase in FDI levels between 2010-2019, but between 1989-2009, the country had recorded high increases. Namibia experienced sharp growth in FDI levels between 1989-2009 and 2010-2019. Niger recorded a high increase in FDI levels between 1989-2009, with a steady increase from 2010 to 2019. Nigeria showed exponential growth in FDI levels between 1989-2019.

Rwanda experienced a sharp increase in FDI levels between 1989-2009, and a steady increase was recorded between 2010-2019. São Tomé and Principe showed sharp fluctuations in FDI levels and recorded extreme increases in FDI levels between 1989-2009. with a steady increase from 2010-2019. Senegal and Seychelles showed similar trends. Both countries recorded an increase in FDI levels between 1989-2019. However, Seychelles results were poor relative to Senegal in terms of FDI levels. Sierra Leone, Somalia, South Africa, Togo, Uganda and Zimbabwe showed low increases in FDI levels for the 30-year period. Eswatini showed very small increases in FDI levels between 1989-2019. Tanzania and Zambia had almost equal increases in FDI levels, though the former performed much better compared to the latter.

Figure 5.14 shows an in-depth view of each country's FDI value for the period 1989-2019.

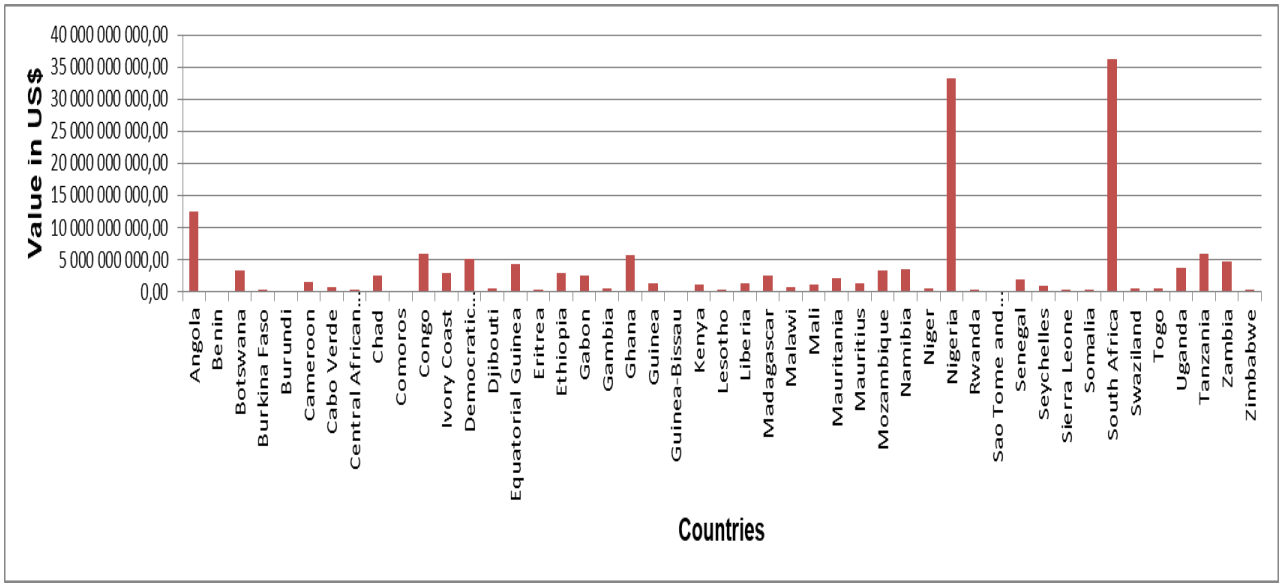

Figure 5.14: Foreign Direct Investment SSA 1989-2019 (Panel B)

Source: Researcher's calculation (2020)

Nigeria and South Africa had the highest FDI values of US$5,6 billion US$5.01 billion, respectively. Both countries have abundant minerals and oil reserves, hence their mining sectors have attracted large foreign direct investment. Angola has received US$10 billion in FDI, and Liberia recorded an average of US$1 billion for the period 1989-2019.

Congo, DRC, Ghana and Tanzania have each received more than US$5 billion in FDI. On the other hand, countries that received below US$5 billion were Benin, Burkina Faso, Botswana, Cameroon, Cabo Verde, the Central African Republic, Chad, Comoros, Djibouti and Eritrea. Ethiopia, Gabon, Gambia, Guinea, Guinea Bissau, Kenya, Lesotho, Malawi, Mali, Mauritius, Mozambique, Namibia, Niger, São Tomé and Principe and Senegal, as well as Seychelles, Sierra Leone, Somalia, South Africa, Tanzania, Togo, Uganda, Zambia and Zimbabwe. Ghana and Congo had FDI levels of above US$5 billion for the period 1989-219. Overall, levels of foreign direct investment in Sub-Saharan Africa were very low for the period 1989-2019.

5.6.3 PRIMARY SCHOOL ENROLMENT IN SSA

The level of education plays an important role in poverty reduction, as explained in previous chapters. Figure 1.16 below shows the primary school enrolment that was used as a proxy for education for the SSA region for the period 1989-2019.

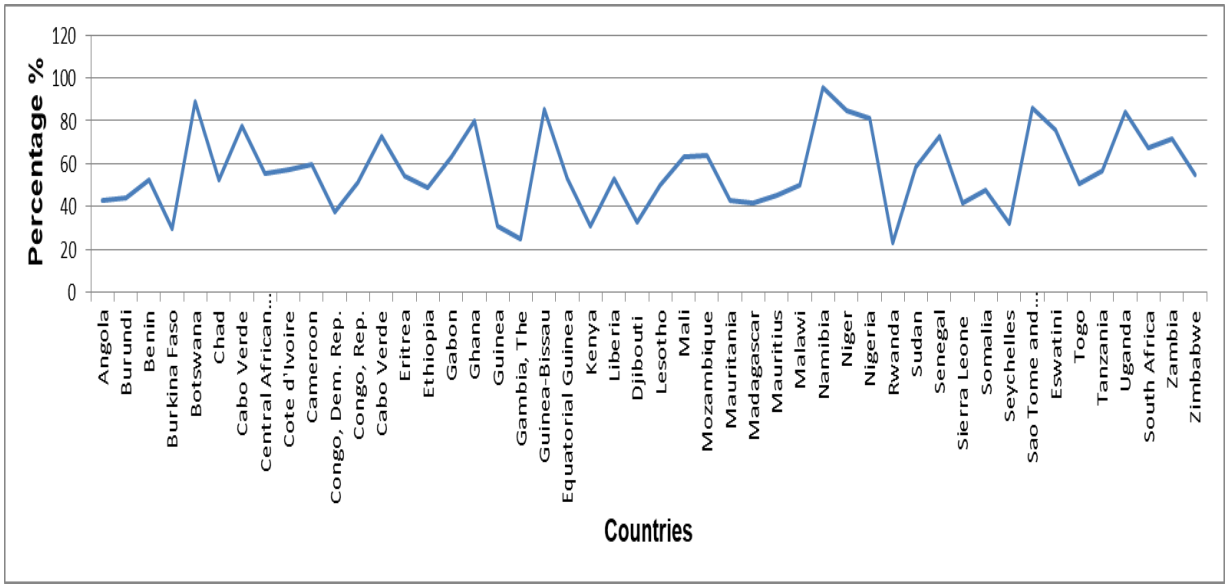

Figure 5.15: Average Primary School Enrolment SSA 1989-2019 (Panel A)

Source: Researcher's calculation (2020)

The figure above shows that the levels of primary school enrolment fluctuated sharply for the entire SSA region between 1989-2019. This correlates with the discussion in the literature review, where it was established that a number of countries in the SSA region are affected by war and civil unrest, which has affected educational activities. However, overall the region experienced high levels of primary school enrolment for the period 1989-2019.

Angola registered a gradual increase in primary school enrolment for the 30-year period covered in the research. Benin recorded a significantly lower increase in primary school enrolment between 1989-2009 compared to that of 2010-2019. Botswana, registered a decrease in primary school enrolment between 1989-2009, with a gradual increase in enrolment between 2010-2019.

Burkina Faso recorded a high increase in primary school enrolment between 1989-2009, and from 2010-2019 recorded a steady increase in enrolment. Burundi and Cameroon showed similar trends in increased in primary school enrolment between 1989-2019. Cabo Verde had a steady increase in primary school enrolment across the 30-year period. The Central African Republic recorded a high primary school enrolment between 1989-2009, but for the years 2010-2019, it recorded lower increases. Chad experienced a moderate increase in primary school enrolment between 1989-2019.

Comoros recorded an increase in primary school enrolment between 1989-2009. From 2010-2018 however, enrolment dropped. The Congo recorded an increase in primary school enrolment between 1989-2009, with a further increase in primary school enrolment in 2010-2019. Côte d'Ivoire recorded small increases in enrolment between 1989-2009 and 2010-2019. In the Democratic Republic of Congo and Djibouti, there was a steady increase in primary school enrolment between 1989-2019.

Equatorial Guinea recorded a steady increase in primary school enrolment throughout the 30-year period. Eritrea recorded a slight decrease in enrolment between 1989-2009, and recorded a further drop. Ethiopia had a high increase in primary school enrolment between 1989-2009 and continued to experience increases between 2010-2019. Gabon experienced a steady increase in enrolment for the 30-year period covered in this research.

Gambia experienced a double increase in primary school enrolment from 1989 to 1999, but from 2000 to the end of 2019, the increase rate was moderate. Kenya also recorded steady increases in primary school enrolment between 1989-2019. Lesotho, Liberia and Madagascar recorded similar trends. Malawi recorded a high increase in enrolment between 1989-2009, and the rate continued to increase at a steady rate. Mali recorded a decrease in primary school enrolment between 1989-2009, and from 2010-2019, recorded a further slight decrease.

Mauritania recorded a positive significant increase in primary school enrolment between 2010-2019, with a slight increase in the first quarter. Enrolment in Mauritius consistently increased between 1989-2019. Mozambique recorded a sharp increase

between 1989-2009, but registered a low increase from 2010-2019. Namibia registered a decrease in primary school enrolment between 1989-2009. However, from 2010-2019, there was a slight increase. Niger recorded increased primary school enrolment between 1989-2009, but enrolment dropped in 2010-2019.

Nigeria showed a high increase the 30-year period. São Tomé and Principe registered a gradual increase between 1989-2019. In Senegal, there was a high increase in enrolment between 1989-2019. Seychelles experienced a steady decrease in primary school enrolment between 1989-2019, and Sierra Leone recorded a steady increase between 1989-2019.

South Africa registered a gradual increase in primary school enrolment between 1988-2019. Eswatini and Togo recorded steady increases in primary school enrolment between 1989-2019. Eswatini performed better than Togo. Tanzania and Uganda recorded sharp increases between 1989-2009 and slight increases from 2010-2019. Lastly, Zambia and Zimbabwe recorded positive increases in primary school enrolment between 1989-2019. However, Zimbabwe suffered from a slight drop in enrolment in the second quarter.

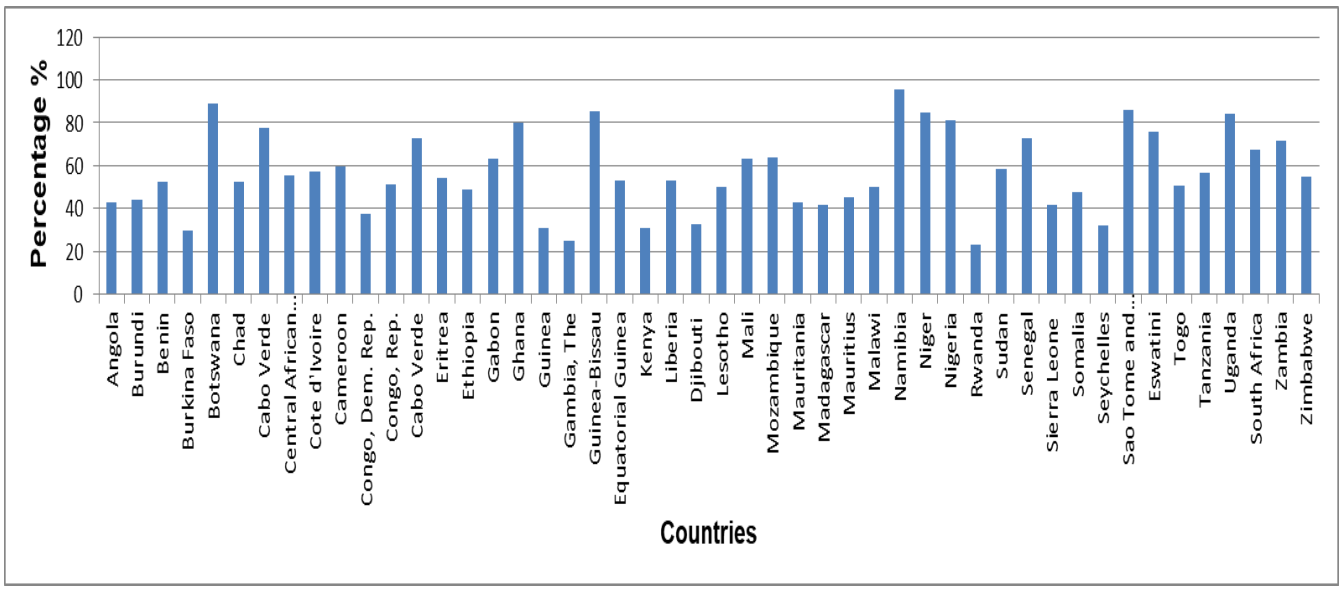

Figure 5.16: Average Primary school enrolment SSA 1989-2019 (Panel B)

Source: Researcher's calculation (2020)

Figure 5.16 shows that Namibia, Botswana, Guinea Bissau, Namibia and São Tomé and Principe had high primary school enrolment rates. Angola had a rate of 41%,

while Botswana's rate was 93%. Burkina Faso had a low value of 30% while Burundi and Cameroon had values of 42% and 60%, respectively. Among other things, high rates of primary school enrolment can be associated with substantial investment in the education sector.

Central African Republic, Chad, Congo, DRC and Côte d'Ivoire had fairly high values in primary school enrollment showing 55%, 52%, 51%, 37% and 57%, respectively. Djibouti, Equatorial Guinea, Eritrea, Ethiopia, Gambia and Ghana has values of 32%, 53%, 54%, 48%, 25% and 80%.

Guinea had the lowest value of 30%, while Guinea-Bissau, Kenya, Lesotho, Liberia Madagascar, Malawi and Mali recorded values of 85%, 30%, 50%, 53%, 41%, 50% and 3%, respectively. Furthermore, Mauritania, Mauritius, Mozambique, Namibia, Niger, Nigeria, Rwanda, Senegal and Sierra –Leone recorded primary enrolment values of 61%, 104%, 42%, 45%, 63%, 95%, 84%, 23%, 72% and 41%, respectively. South Africa, Eswatini, Togo, Uganda, Tanzania, Zambia and Zimbabwe also recorded high values of 67%, 50%, 83%, 56%, 71% and 54%, respectively. Overall, most SSA countries had high primary enrolment percentages.

5.6.4 Real Gross Domestic Product Per Capita in SSA Countries

In this research, poverty was measured using real gross domestic product per capita.

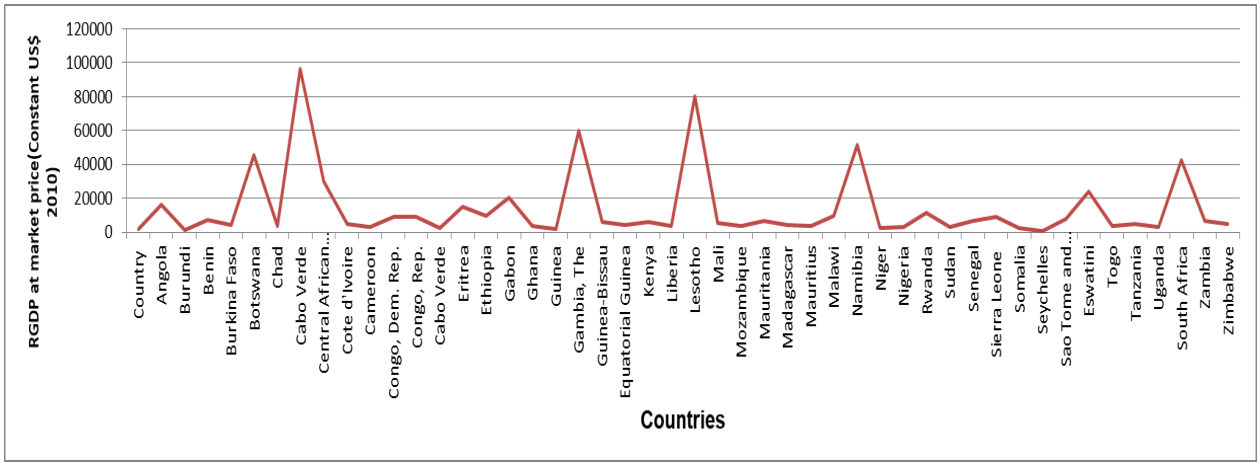

Figure 5.17: Real Gross domestic product per capita in SSA 1989-2019 (Panel A)

Source: Researcher's calculation (2020)

Figure 5.17 shows that the real gross domestic product per capita for Sub-Saharan African countries was very low, with only a few countries registering significantly high real GDP per capita. This implies that the low real GDP per capita meant that high poverty levels were experienced in the period 1989-2019 and that the people of those countries were subjected to poor living standards.

Angola recorded a gradual increase in real GDP per capita levels from 1989-2009. From 2010-2019, Angola had a further increase in real GDP per capita. Benin registered a sharp increase in real GDP per capita between 1989-2009. From 2010-2019, the economy further recorded a higher increase in real GDP per capita. Botswana registered a high increase in real GDP per capita between 1989-209. From 2010-2019, the economy recorded a steady rise in real GDP per capita. Burkina Faso recorded a steady increase in real GDP per capita for the 30-year period covered in this research.

Burundi recorded a slight increase in real GDP per capita between 189-2009, and the country recorded a very high increase in real GDP per capita from 2010-2019. Cameroon recorded an almost uniform positive increase in real GDP per capita between 1989-2019. Cabo Verde registered a significant increase in in real GDP per capita between 1989-2009and from 2010-2019 recorded a steady increase in real GDP per capita. Cameroon recorded a positive increase in real GDP per capita for the 30-year period.

Cabo Verde experienced a slight increase in real GDP per capita between 1989-2009, and a significantly high increase from 2010-2019. A significantly high increase in real GDP per capita was recorded for the Central African Republic between 1989-2009. From 2010-2019, a further increase in real GDP per capita was registered. Chad, registered a double increase in real GDP per capita for the 30-year period.

Comoros recorded a high value in real GDP per capita between 2010-2019 compared to the period 1989-2009. Congo recorded a high increase in real GDP per

capita between 1989-2009. From 2010-2019, a further growth in real GDP per capita was registered. Côte d'Ivoire registered a stable increase between 1989-2019. Equatorial Guinea recorded a high increase per capita between 1989-2009. From 2010-2019, the increase was slight. Eritrea recorded a gradual increase in real GDP per capita between 1989-2019. Ethiopia recorded a slight increase between 1989-2009, and a sharp increase from 2010-2019 in real GDP per capita.

Gabon recorded a significant increase in real GDP per capita between 1989-2009. From 2010-2019, a high increase was recorded. Gambia recorded a high increase in between 1989-2019. Ghana saw a small increase between 1989-2009. From 2010-2019, Ghana recorded a sudden increase in real GDP per capita. There was a slight increase in real GDP per capita for Guinea between 1989-2009. However, from 2010-2019, a sharp increase was recorded. The rate of increase of real GDP per capita for Kenya was almost uniform over the 30-year period.

Lesotho recorded a minor increase in real GDP per capita between 1989-2009. However, from 2010-2019 Lesotho recorded a sharp increase. Liberia registered a high increase in real GDP per capita between 2010-2019, and Madagascar had exponential growth in real GDP per capita between 1989-2019.

Malawi showed a positive uniform increase in real GDP per capita between 1989-2009 and from 2010-2019. Mali recorded a small increase in real GDP per capita between 1989-2009 compared to the period 2010-2019. Mauritania recorded a slight increase in real GDP per capita between 1989-2009. However, from 2010-2019 the economy recorded a sharp increase in real GDP per capita. Mauritania recorded a sharp increase over the 30-year period covered in this study. Mauritius recorded a significant increase in real GDP per capita between 1989-2019.

Mozambique registered a double increase in real GDP per capita between 1989-2009 and from 2010-2019, the country recorded a more than double increase. Namibia recorded a double increase in real GDP per capita between 1989-2019. Niger recorded a slight increase between 1989-2009 and recorded a double increase from 2010-2019. Nigeria recorded a slight increase in real GDP per capita between 1989-2009, and from 2010-2019, a sharp increase was recorded.

Rwanda had a double increase in real GDP per capita for the 30-year period covered in this research. São Tomé and Principe registered a positive increase in real GDP per capita between 2010-2019. Senegal registered a positive increase in real GDP per capita from 1989-2019. Seychelles recorded a double increase throughout-2019. Sierra Leone registered a slight increase in real GDP per capita between 1989-2009. From 2010-2019, a sharp increase was recorded. Somalia recorded a slight increase in real GDP per capita between 1989-2009, and a double increase from 2010-2019.

South Africa showed a steady increase in real GDP per capita for the 30-year period. Sudan recorded a sharp increase in real GDP per capita between 2010-2019. Eswatini recorded a steady uniform increase between 1989-2019. Togo recorded consistent levels in real GDP per capita between 1980-2009, and a sharp increase in 2010-2019. Togo recorded a minor increase between 1989-1999.

Uganda registered a slight increase in real GDP per capita between 1989-2019, and a sharp increase from 2010-2019. Tanzania also recorded a slight increase in real GDP per capita from 1989-2019, and registered a sharp increase from 2010-2019. Zambia recorded a significant increase in real GDP per capita between 1989-2019. Zimbabwe registered a steady increase in real GDP per capita for the 30-year period.

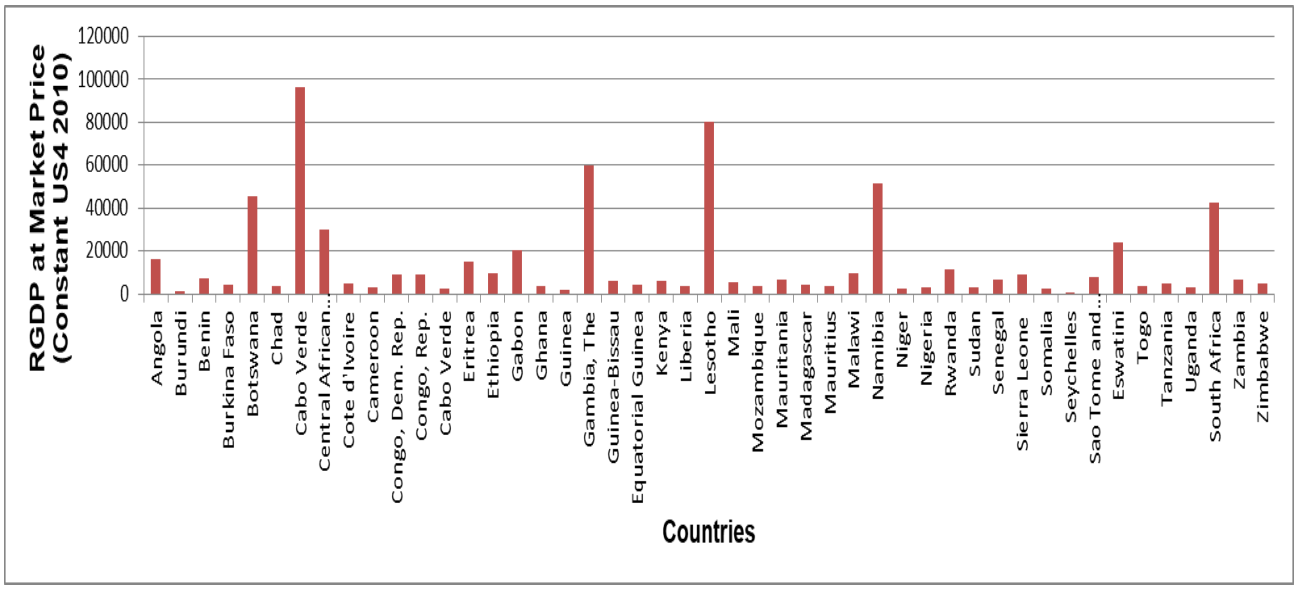

Figure 5.18: Real Gross domestic product per capita in SSA 1989-2019 (Panel B)

Source: Researcher's Calculation (2020)

Figure 5.18 shows that Cabo Verde, Namibia and Lesotho had the highest levels of real GDP per capita over the 30-year period of US$96,407 billion, US$51,265 and US$80,292 billion, respectively. This shows that the living standards of some people in these nations were fairly good. Although Lesotho had a high real GDP per capita it did not necessarily translate into an improvement of the living standards for all the people of Lesotho. Despite GDP levels being high, there was poverty at the household level.

Angola, Eritrea, Eswatini, Gabon and South Africa had fairly large values of real GDP per capita. Angola had a real GDP per capita value of US$16,287 billion for the period 1989-2019. Eritrea, Eswatini, Gabon and South Africa had values of $42 709 billion, US$23,786 billion, US$20,564 billion and US$16,287 billion, respectively. From figure 1.19 it is clear that a total of 45 economies in Sub-Saharan Africa region had real GDP per capita below US$2 billion. This means that all these economies were battling high levels of poverty during the period. This assertion concurs with the views discussed in Chapter 1 of the study, which asserted that SSA is plagued with colossal poverty levels.

5.6.5 Remittances in SSA

Remittances can be useful in improving people's living standards, thus reducing poverty. Figure 5.19 shows that only four economies in SSA had high remittance levels between 1989-2019.

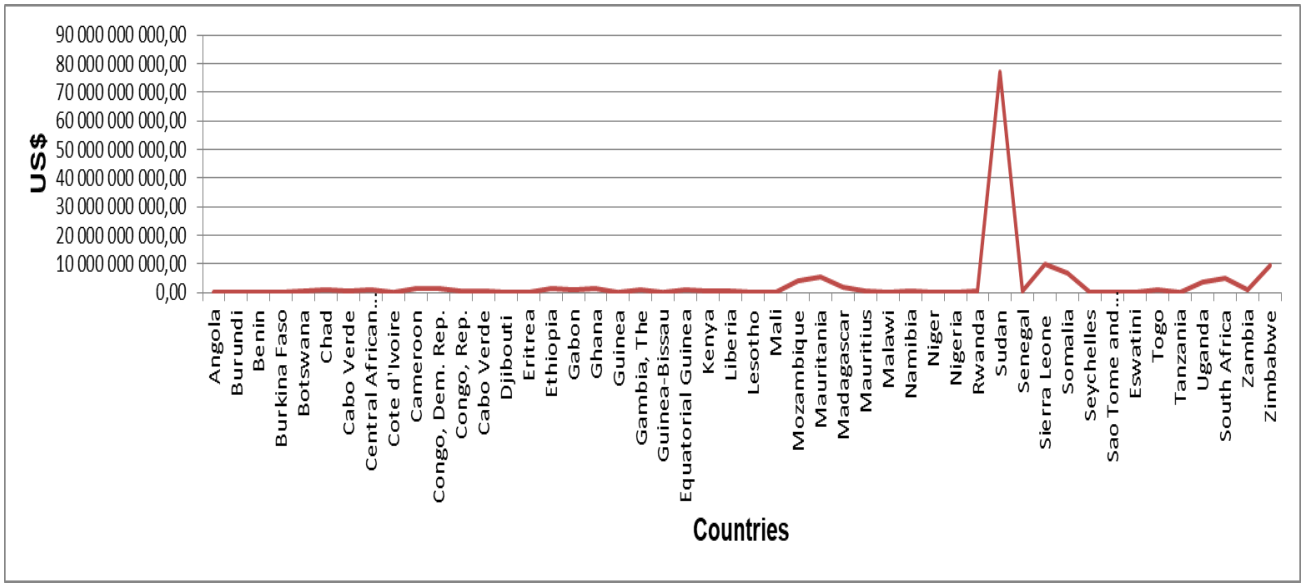

Figure 5.19: Remittances in the SSA region 1989-2019 (Panel A)

Source: Researcher's calculation (2020)

Angola registered a steady increase in its level of remittances between 1989-2019. In Benin, there was an upward trend in the level of remittances between 1989-2019. Botswana, a steady increase in the level of remittances in the last quarter. In the first and second quarters, Botswana recorded high levels of remittances. Burkina Faso had a sharp increase in the level of remittances between 1989-2019. Burundi registered a positive increase in levels of remittance between 1989-2019. Cameroon recorded a sharp increase in the first and second quarters. From 2010-2019, Cameroon experienced a steady rise in the level of remittances.

Cabo Verde recorded a gradual increase in the level of remittances between 1989-2009. From 2010-2019, Cabo Verde recorded a further increase in the level of remittances. Comoros recorded a sharp increase in the level of remittances from 1989-2019. The same applied to Congo, which recorded a sharp increase in the level of remittances for the 30-year period covered in this research. Côte d'Ivoire recorded a substantial increase in the level of remittances in the last quarter only. DRC recorded a positive increase in the level of remittances between 1989-2009. From 2010-2019, the economy recorded a further increase in the level of remittances.

Djibouti registered a steady increase in the level of remittances for the 30 years. Eritrea recorded a gradual increase in the level of remittances between 1989-2019. Ethiopia registered a high increase between 1989-2009. However, from 2010-2019, a sharp increase in the country's level of remittances was registered. The level of remittances in Gabon doubled between 1989-2009. From 2010, Gabon recorded a steady increase. Gambia had a significant increase in the level of remittances between 2009-2010.

Ghana recorded a sharp increase in the level of remittances between 1989-2019. The same applied to Guinea, where a significantly high increase in the level of remittances between 1989-2019 was recorded. The Guinea Bissau levels doubled between 1989-1999. From 2010-2019, the lever further increased. Kenya registered a significant increase in the level of remittances over the 30-year period.

Liberia recorded a steady increase in the level of remittances between 1989-2009, with a further increase from 2010-2019. Madagascar registered a sizeable increase in the level of remittances between 1989-2019 with a high increase registered in the last quarter. Malawi recorded a fair increase in the level of remittances between 1989-2009. From 2010-2019, the increase more than doubled. Mauritania recorded a slight decrease in the level of remittances in the first quarter, but there was a steady increase in the level of remittances in the second quarter.

Mauritius registered a steady increase in the level of remittances between 1989-2019. Mozambique recorded a nominal increase in the level of remittances between 1989-2019. Niger showed a low increase between 1989-2009. However, from 2010-2019, Niger recorded a sharp increase in the level of remittances.

Nigeria experienced a sharp increase in the level of remittances in the last quarter. In the first and second quarters, the rate of increase was moderate. Rwanda had a steady increase over the entire 30-year period. São Tomé and Principe registered a sharp increase in the level of remittances between 1989-2019. Senegal recorded an extremely high increase in the level of remittances in the first quarter, and in the second and third quarter, the increase was steady.

The Seychelles a positive increase in the level of remittances between 1989-2009, and substantial increases from 2010-2019. Sierra Leone recorded a steady increase between 1989-2009. From 2010-2019, there was a further increase. South Africa had a steady but high increase over the entire 30-year period in question.

Eswatini registered a high increase in the level of remittances between 1989-2009. From 2010-2019, steady growth was recorded in the level of remittances. Togo had a significantly high increase in the level of remittances for the entire 30-year period. The same applies for Uganda, which performed well over the 30 years covered in this research. Tanzania registered a positive increase in in the level of remittances between 1989-2009, with further increases recorded between 2010-2019. Zambia recorded positive growth in the level of remittances between 2010-2019. Lastly, Zimbabwe registered a sharp increase in the level of remittances between 1989-2009 and 2010-219.

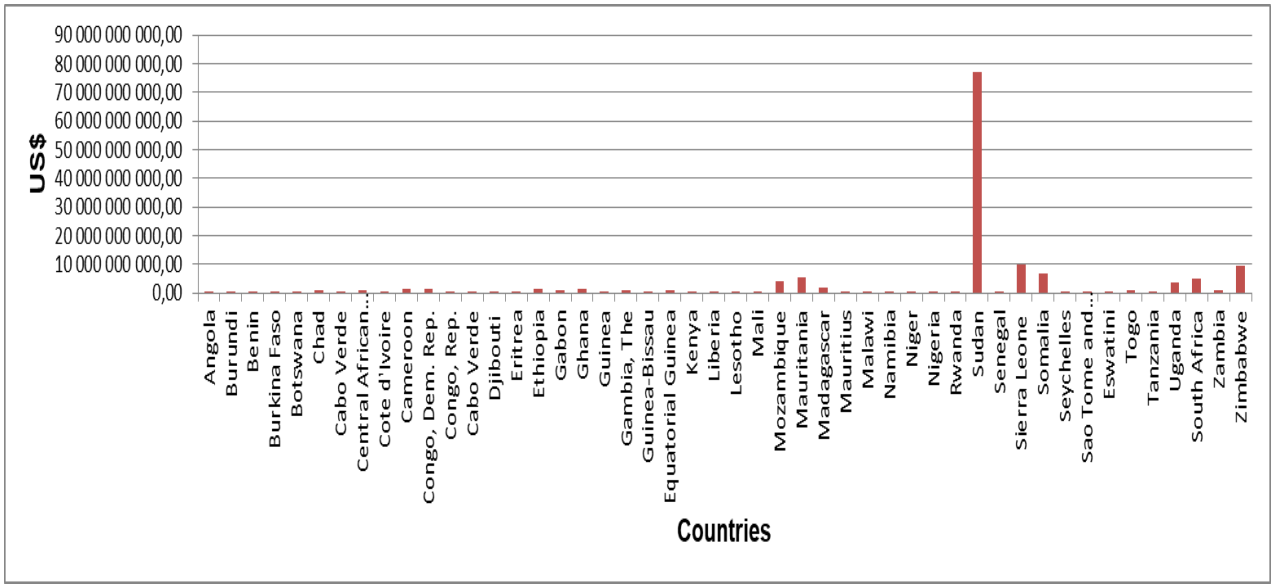

Figure 5.20 Remittances in the SSA region (Panel B)

Source: Researcher's Calculation (2020)

Figure 5.20 shows that Sudan had the highest level of remittances between 1989-2019. The country received a total of US$70 billion remittances. Zimbabwe was in second position with US$10 billion, while Sierra Leone had US49,7 billion. Eritrea,

Kenya, Mali, Niger, Togo and Uganda among others had remittance levels of less than US$10 billion.

Remittances can help families or dependants who are left in their countries of origin. For example, due to economic hardships in Zimbabwe, there was brain drain, and these expatriates in foreign lands send money home (remittances) to support their families.

5.6.6 Private domestic credit SSA

Private domestic credit can help small businesses and entrepreneurs with capital for business expansion. Figure 5.22 below shows that the Central African Republic, Malawi and South Africa had the highest value of private domestic credit expressed as a percentage of GDP. All other countries had low values of private domestic credit. This implies that these SSA countries could not attract meaningful credit for supporting economic activities.

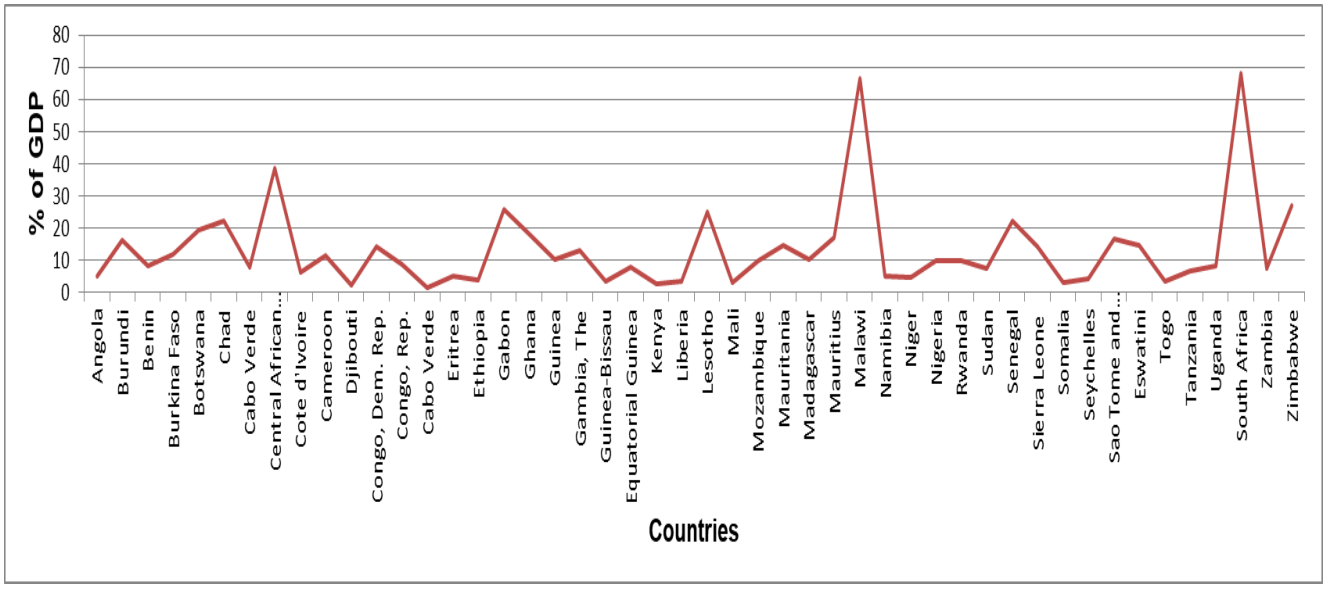

Figure 5.21: Private Domestic Credit SSA 1989-2019 (Panel A)

Source: Researcher's Calculation (2020)

Angola recorded a high increase in private domestic credit between 2010-2019. Benin registered a decrease in private domestic credit between 1989-2009. From 2010-2019, Benin recorded a sharp increase from 2010-2019. Botswana registered

a high increase in private domestic credit between 1989-2009. From 2010-2019, the country continued to experience a rise in private domestic credit. Burkina Faso recorded a slight increase in private domestic credit between 1989-2009. From 2010-2019, there was a double increase in private domestic credit. Burundi recorded a steady increase in private domestic credit between 1989-2019.

Cameroon registered a slight increase in private domestic credit between 1989-1999. From 2010-2019, there was a further increase. Cabo Verde registered a slight decrease between 1989-1999. From 2010-2019, the country continued to experience a rise in private domestic credit. The Central African Republic recorded a substantial increase in 1989-2009. From 2010-2019, the country registered a sharp increase in private domestic credit. Chad recorded a high increase between 1989-2009. From 2010-2019, the country recorded a sharp increase in private domestic credit. Comoros recorded a minor decrease between 1989-2009. From 2010-2019, Comoros recorded a sharp rise.

Congo recorded a sharp decline in private domestic credit in the first quarter. In the second and third quarter, there was a steady increase. From 2010-2019 the Côte d'Ivoire recorded a slight rise, however, between 2010-2019, the country showed a slight recovery in private domestic credit. DRC recorded a major decrease in private domestic credit between 1989-1999. From 2010-2019, the economy recorded a sharp increase. Djibouti recorded a steady decrease in private domestic credit between 1989-2019.

Equatorial Guinea recorded a steady rise in private domestic credit between 1989-2019. Eritrea recorded a notable decline from 1989-2009. From 2010-2019, the country recorded a major increase. Ethiopia experienced a sharp decrease in private domestic credit in the second quarter. Gabon recorded a rise in the level i of private domestic credit between 1989-2009, but from 2010-2019, a decrease was recorded. Gambia recorded a substantial increase in the first quarter compared to the second quarter.

Ghana recorded a sharp increase in private domestic credit between 1989-2009. From 2010-2019, Ghana saw slight decrease in private domestic credit. Guinea Bissau recorded a slight decrease between 1989-1999. From 2010-2019, the

economy registered a slight increase. Overall, there were fluctuations in private domestic credit. In the second quarter, Kenya recorded a drop in private domestic credit between 1989-2009. Thereafter, a steady increase continued to the end of 2019. Lesotho recorded a steady increase over the 30-year period.

Liberia recorded a sharp decrease in private domestic credit in the first quarter, however, there was a sharp increase in the second and third quarters. Madagascar had as a slow increase in the first quarter, but registered a significant increase in in the second and last quarter. Malawi recorded a sharp increase for the 30-year period. Mali registered a minor increase between 1989-2019. From 2010-2019, Mali recorded a fair increase in private domestic credit.

Mauritania registered a steady rise in private domestic credit between 1989-2019. Mauritius had a minor decrease in private domestic credit for the entire 30-year period. Mozambique registered a slight increase between 1989-1999. From 2010-2019, the country registered a sharp increase in private domestic credit. Namibia showed a positive increase although there was a drop in the first quarter.

Niger recorded a slight decrease in private domestic credit in the first quarter. However, the country showed a rise in private domestic credit in the last quarter. Rwanda recorded a slight increase between 1989-2009. From 2010-2019, Rwanda recorded a substantial increase in private domestic credit.

São Tomé and Principe recorded a high increase in private domestic credit between 1989-2019. Senegal recorded a sharp decrease between 1989-2019. Seychelles recorded a slight increase between 1989-2009. Sierra Leone had a small drop in between 1989-2009. From 2010-2019 however, the country recorded a relatively high increase. South Africa experienced a rise in private domestic credit for the entire 30-year period.

Eswatini recorded a slight decrease in private domestic credit in the first quarter. However, there was an increase in the last quarter. Togo registered a sharp decline in 1989-2009, but from 2010-2019, the country recorded a sharp rise. Uganda registered a fair increase in private domestic credit for the entire 30-year period in question. Tanzania registered a slight increase in private domestic credit between

1989-2009, but recorded a decrease from 2010-2019. Zambia recorded a fair increase between 1989-2019. Lastly, Zimbabwe recorded a sharp increase in private domestic credit between 1989-2009, but experienced a decrease from 2010-2019.

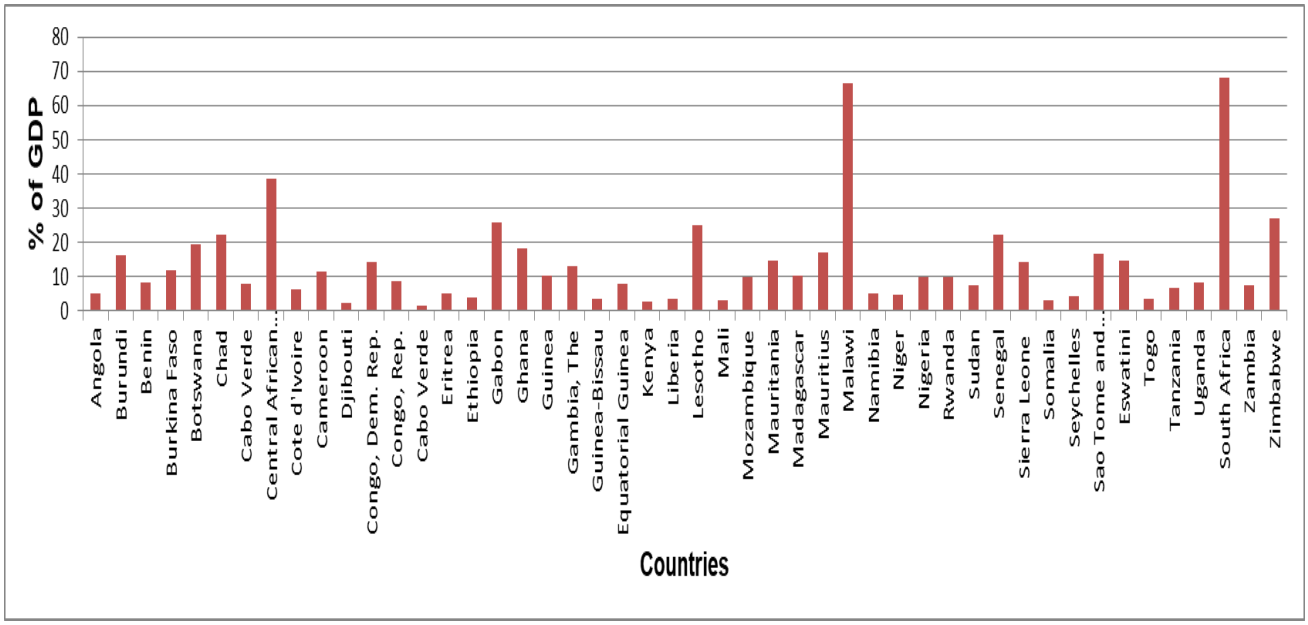

Figure 5.22: Private Domestic Credit in SSA 1989-2019 (Panel B)

Source: Researcher's calculation (2020)

Figure 5.22 shows that only the Central African Republic, Gabon, Lesotho Malawi, South Africa and Zimbabwe had the highest value of private domestic credit in the Sub-Saharan Africa region. All countries had values below 30%. It can therefore be said that the 42 countries in Sub-Saharan Africa have extremely low rates of private domestic credit.

5.10 CONCLUSION

This chapter sought to present the stylized facts of descriptive statistics related to ICT, poverty, economic development, employment, and other variables used in the study. The first discussion was based on the performance of information communication technology in SSA. In this discussion, the three indicators presented

were mobile phone subscriptions, fixed telephone subscriptions, and internet usage in Sub-Saharan Africa. The chapter examined the performance of ICT in SSA, using a composite index. Further, the Information Communication Technology Index in Sub-Saharan Africa was ranked, and an analysis done on information communication technology growth in Sub-Saharan Africa. Poverty trends in Sub-Saharan Africa were presented and discussed, and the impact of ICT on poverty in SSA was presented.. The main thrust of the chapter was to ascertain how ICT affected poverty from 1989-2019. Trends of other macro-economic indicators were presented, and a partial correlation analysis was done. The chapter established that an increase in ICT usage increases real GDP per capita. The following chapter contains the empirical results analysis, estimated results, a results discussion, and the building of new knowledge from the results.

CHAPTER SIX: ANALYSIS OF EMPIRICAL RESULTS

6.1 INTRODUCTION

This chapter presents the empirical analysis. The first discussion is based on the panel data stationarity results. The chapter presents a panel co-integration analysis, a panel causality results analysis, and a variance decomposition analysis. There is a discussion on impulse response analysis and fixed and random effects analysis. A model specification test is carried out, and heteroscedasticity and serial correlation tests are done. Finally, there is a presentation on panel vector auto regression estimation analysis.

6.2 PANEL DATA STATIONARITY RESULTS ANALYSIS

To test for stationarity in this research, the following hypothesis was used.

$H_0 =$ **Panel contains unit root.**

H_1=**Panel does not contain unit root.**

Table 6.1: Panel Data Stationarity Results Analysis

Method	Variable	Statistic	Probability
The test Levin–Lin–Chu	PDC	-28.18	0.0000
The test Levin–Lin–Chu	DA	-38.30	0.0000
The test Levin–Lin–Chu	FDI	-37.74	0.0000
The test Levin–Lin–Chu	REM	-8.83	0.0000

The test	Levin–Lin–Chu	PSE	-26.49	0.0000
The test	Levin–Lin–Chu	ICT	-11.44	0.0000
The test	Levin–Lin–Chu	RGDP	4.26	0.0000

Source: Researcher's construct (2021)

The Levin–Lin–Chu test was used to test for stationarity. Based on the above results, it shows that the data is stationary, therefore a null hypothesis is rejected. The following variable was stationary at level: remittances. In addition, the following variables were stationary after they were integrated of order 1: real GDP per capita, private domestic credit, Information and communication technology, foreign direct investment and development aid, and primary school enrolment (see Appendix A1 for full results).

6.3 PANEL COINTEGRATION ANALYSIS

Panel co-integration in this research was tested using the Johansen-Fisher co-Integration test. The test was performed to ascertain the long-run relationship among the variables used in the research. The hypothesis is specified below:

$H_0 =$ **There is no cointegration.**

$H_1 =$ **There is cointegration.**

Below are the results for the cointegration tests are seen below.

Table 6.2: PANEL CO-INTERGRATION ANALYSIS

Hypothesized No of Ce(s)	Fisher Stat(from trace test)	Prob	Fisher Stat.(from max-Eigen	Prob

			test)	
None*	1994	0.00	1477	0.00
At most 1	1255	0.00	643.7	0.00
At most 2	743.2	0.00	364.1	0.00
At most 3	457.4	0.00	253.1	0.00
At most 4	269.9	0.00	177.3	0.00
At most 5	174.7	0.00	146.2	0.00
At most 6	157.1	0.00	157.1	0.00

Source: Researcher's construct (2021)

The above results above show that there is cointegration, thus the H_0 (no cointegration) hypothesis is rejected. This implies that there is a long-run relationship between ICT usage (fixed telephone, mobile telephone and internet usage), foreign direct investment, development aid, primary school enrolment, real GDP per capita, remittances, and private domestic credit. In other words, even if in the short-run there are any shocks, there is high likelihood of a convergence of these factors in the long-run.

6.4 PANEL CAUSALITY RESULTS ANALYSIS

This section presents the panel causality results analysis. The Dumitrescu and Hurlin (2012) test was used for this analysis.

6.4.1 The Dumitrescu and Hurlin (2012) Test

This is an advanced form of the Granger causality test, and was used to examine the relationship between variables from the panel data.

Table 6.3: The Dumitrescu and Hurlin Test (2012)

Null Hypothesis	W-Statistic	Probability
ICT does not homogeneously cause RGDP	5.99	0.00
RGDP does not homogeneously cause ICT	8.18	0.00
FDI does not homogeneously cause RGDP	4.20	7.E-09
RGDP does not homogeneously cause FDI	4.77	1.E-13
PDC does not homogeneously cause RGDP	56.8	0.00
RGDP does not homogeneously cause PDC	9.10	0.00

DA does not homogeneously Granger Cause RGDP	4.83	3.E-14
RGDP does not homogeneously cause DA	4.02	1.E-07
PSE does not homogeneously cause RGDP	126.26	0.00
RGDP Does not homogeneously Granger Cause PSE	3.93	5.E-07
REM does not homogeneously cause RGDP	7.69	0.00
RGDP Does not homogeneously cause REM	4.62	2.E-12
FDI does not homogeneously cause ICT	9.22	0.00
ICT does not homogeneously r cause FDI	6.51	0.00
PDC does not homogeneously cause ICT	3.47	0.00
ICT does not homogeneously cause PDC	6.92	0.00

DA does not homogeneously cause ICT	6.33	0.00
ICT does not homogeneously cause DA	4.69	6.E-13
PSE does not homogeneously cause ICT	5.55	0.00
ICT does not homogeneously cause PSE	4.41	1.E-10
REM does not homogeneously cause ICT	7.82	0.00
ICT Does not homogeneously r cause REM	6.87	0.00
FDI does not homogeneously cause PDC	4.18	1.E-08
PDC does not homogeneously cause ICT	5.04	2.E-16
DA does not homogeneously cause FDI	4.61	3.E-12
FDI does not homogeneously cause DA	4.04	9.E-08
PSE does not homogeneously	4.31	9.E-10

cause FDI		
FDI does not homogeneously cause PSE	4.07	5.E-08
REM does not homogeneously cause FDI	6.46	0.00
FDI does not homogeneously cause REM	3.78	4.E-06
DA does not homogeneously Granger Cause PDC	4.37	3.E-10
PDC does not homogeneously cause DA	3.30	0.00
PSE does not homogeneously cause PDC	5.76	0.00
PDC does not homogeneously cause PSE	5.92	0.00
REM does not homogeneously cause PDC	6.12	0.00
PDC does not homogeneously cause REM	3.84	2.E-06
PSE Does not homogeneously Granger Cause DA	6.40	0.00

DA does not homogeneously cause PSE	4.17	1.E-08
REM does not homogeneously Granger cause DA	5.18	0.00
DA does not homogeneously cause REM	4.72	3.E-13
REM does not homogeneously G cause PSE	3.94	4.E-07
PSE does not homogeneously cause REM	4.93	3.E-15

Source: Researcher's construct (2021)

On the first equations regarding ICT and RGDP, the p-value is less than 5% for both, hence it can be concluded that the null hypothesis is rejected. Therefore, ICT does homogeneously causes RGDP and RGDP does homogeneously cause ICT. There is a bi-directional causality between the two variables. On the second equations for FDI and RGDP, the p-values are greater than 5% hence it can be concluded that the null hypothesis is accepted for both equations. Therefore, FDI does not homogeneously cause RGDP and RGDP does not homogeneously cause FDI.

On the third equation for PDC and RGDP, the p-values are less than 5%, hence it can be concluded that the null hypothesis is rejected. Thus, PDC does homogeneously cause RGDP and RGDP does homogeneously cause RGDP. On the fourth equation of DA and RGDP, the p-values are greater than 5%. It can be concluded that the null hypothesis is accepted for both equations. Thus, DA does not homogeneously r cause RGDP and RGDP does not homogeneously r cause DA.

For PSE and RGDP, the first equation has a p-value that is less than 5%. It can be concluded that the null hypothesis is rejected. Thus, PSE does homogeneously cause RGDP. The second equation has a p-value above 5% and it can be concluded that the null hypothesis is accepted. To sum up, the direction of causality is one way. For remittances and RGDP, the p-value is less than 5%, thus it can be concluded that the null hypothesis is rejected. Thus, REM does homogeneously cause RGDP. However, for the second equation, the p-value above 5% and it can be concluded that the null hypothesis is accepted. Overall, there is uni-directional causation between the two variables.

For FDI and ICT, for both equations, the p-values are below 5%, It can be concluded that the null hypothesis is rejected. Thus FDI does homogeneously r cause ICT and vice versa. The direction of causality is bi-directional. For PDC and ICT, the p-values for both equations are below 5%. It can be concluded that the null hypothesis is rejected. Thus, PDC does homogeneously r cause ICT and vice versa. Therefore, the direction of causality is bi-directional

For DA and ICT, only the first equation has a p-value below 5%. It can be concluded that the null hypothesis is rejected. Thus, DA does homogeneously cause ICT. However, for the second equation, the p-value is above 5% and it can be concluded that the null hypothesis is accepted. Overall, there is unidirectional causation between the two variables. For PSE and ICT, only the first equation has a p-value below 5%, It can be concluded that the null hypothesis is rejected. PSE does homogeneously cause ICT. However, for the second equation, the p-value above 5% and it can be concluded that the null hypothesis is accepted. Overall, there is unidirectional causation between the two variables.

For REM and ICT, for both equations, the p-values are below 5%. It can be concluded that the null hypothesis is rejected. Thus, REM does homogeneously cause ICT and vice versa. As such, there is a bi-directional causality. For FDI and PDC, the p-values are greater than 5%, hence it can be concluded that the null hypothesis is accepted for both equations. Thus, FDI does not homogeneously cause PDC.

For DA and FDI, the p-values are greater than 5%, hence it can be concluded that the null hypothesis is accepted for both equations. All in all, DA does not homogeneously cause FDI. For PSE and FDI, the p-values are greater than 5% hence it can be concluded that the null hypothesis is accepted for both equations. Thus, PSE does not homogeneously cause FDI.

For REM and FDI, only the first equation has a p-value below 5%. It can be concluded that the null hypothesis is rejected. Thus, REM does homogeneously cause FDI. However, for the second equation, the p-value above 5% and it can be concluded that the null hypothesis is accepted. Overall, there is unidirectional causation between the two variables.

For DA and PDC, only the second equation has a p-value below 5., It can be concluded that the null hypothesis is rejected. Thus, PDC does homogeneously cause DA. However, for the first equation, the p-value is above 5% and it can be concluded that the null hypothesis is accepted. For PSE and PDC, for both equations, the p-values are below 5%. It can be concluded that the null hypothesis is

rejected. Thus, PSE does homogeneously cause PDC and vice versa. Also, then direction of causality is bi-directional.

On REM and PDC, only the first equation has a p-value below 5%. It can be concluded that the null hypothesis is rejected. Thus, REM does homogeneously r cause PDC. However, for the second equation, the p-value above is 5% and it can be concluded that the null hypothesis is accepted. On PSE and DA, the first equation has a p-value of less than 5%. It can be concluded that the null hypothesis is rejected. Therefore, PSE does homogeneously cause DA. However, for the second equation, the p-value above is 5% and it can be concluded that the null hypothesis is accepted. On REM and DA, only the first equation has a p-value below 5%. It can be concluded that the null hypothesis is rejected. Thus, REM does homogeneously cause DA. However, in the second equation, the p-value is above 5% and it can be concluded that the null hypothesis is accepted.

Lastly, on REM and PSE, the p-values are greater than 5%, hence it can be concluded that the null hypothesis is accepted for both equations. Thus, REM does not homogenously cause PSE and vice-versa.

6.5 Vector Error Correction Estimates

This section seeks to present the Vector Error Correction Estimates. This is where the variance decomposition will be derived from.

Table 6.4: Vector Error Correction Estimates

Error Correction	Co-efficient	T-statistics
Development Aid	-4.88	-0.14
Information and communication technology	-0.005	-18.85
Remittances	-3.14	-0.23
Foreign direct investment	1.06	0.38
Primary school enrolment	-281	-0.23

Private domestic credit	-677.30	-0.44

Source: Researcher's construct (2021)

A percentage change in development aid is associated with a 4.88 % decrease in real gross domestic product per capita on average in the short run. A percentage change in ICT is associated with a 0.5% decrease in real gross domestic product per capita on average in the short run. A percentage change in remittances is associated with a 3.14% decrease in real gross domestic product per capita on average in the short run. A percentage change in foreign direct investment is associated with a 1.06% decrease in real gross domestic product per capita on average in the short run. A percentage change in primary school enrolment is associated with a 281% decrease in real gross domestic product per capita on average in the short run. A percentage change in private domestic credit is associated with a 677% increase in real gross domestic product per capita on average in the short run (for full results see Appendices).

6.6 VARIANCE DECOMPOSITION ANALYSIS

Table 6.5 shows the variance decomposition analysis. This was carried out using the impulse response analysis of the unrestricted VAR estimation process, and the orthogonalized Cholesky ordering technique. This was done for the variables below: foreign direct investment, private domestic credit, real GDP per capita, primary school enrolment, development aid, and remittances. Period 3 is assumed to be the short-run period while period 10 is assumed to be the long-run period.

Table 6.5: Variance Decomposition Analysis

Variance Decomposition: RGDP

Period	RGDP	ICT	FDI	PDC	DA	PSE	REM
1	100	0.00	0.00	0.00	0.00	0.00	0.00
2	99.84	0.0001	0.0079	0.1514	0.0001	0.0860	0.0130
3	99.46	0.0006	0.0434	0.0444	0.0132	0.4119	0.0235

4	99.28	0.0009	0.0634	0.0544	0.0193	0.5322	0.0434
5	99.24	0.0013	0.0588	0.0550	0.0202	0.5631	0.0529
6	99.21	0.0016	0.0580	0.0558	0.0227	0.5888	0.0573
7	99.18	0.0018	0.0603	0.0573	0.0245	0.6118	0.0618
8	99.16	0.0021	0.0607	0.0583	0.0252	0.6279	0.0650
9	99.14	0.0023	0.0606	0.0589	0.0260	0.6396	0.0671
10	99.13	0.0025	0.0610	0.0595	0.0267	0.6492	0.0690

Source: Researcher's construct (2021)

Analysis

Table 6.5 shows that in the short-run, shocks to RGDP per capita account for 99.46% variation of the fluctuation in real GDP per capita, while in the long-run it accounts for 99.13%. In the short-run, shocks to ICT account for 0.06% variation in real GDP per capita, while in the long-run shocks in ICT cause 0.025% in real GDP per capita. In the short-run, shocks to foreign direct investment account for 0.04% variation in real GDP per capita while in the long-run they account for 0.06% fluctuation in real GDP per capita. In the short-run, private domestic credit, development aid, primary school enrolment and remittances, respectively account for 0.04%, 0.01%, 41% and 0.02% variation in real GDP per capita. In the long run, private domestic credit, development aid, primary school enrolment and remittances, respectively account for 0.05%, 0.02%, 64% and 0.06% variation in real GDP per capita.

Table 6.6: Variance Decomposition: ICT

Period	RGDP	ICT	FDI	PDC	DA	PSE	REM
1	3.33	99.99	0.0000	0.0000	0.0000	0.0000	0.0000
2	7.01	99.91	0.0018	0.0054	0.0002	0.0700	0.0095
3	9.85	99.90	0.0037	0.0238	0.0015	0.0560	0.0111

4	0.0035	99.89	0.0125	0.0267	0.0046	0.0478	0.0150
5	0.0039	99.87	0.0259	0.0242	0.0065	0.0470	0.0186
6	0.0015	99.85	0.0418	0.0223	0.0093	0.0466	0.0210
7	0.0022	99.83	0.0621	0.0209	0.0133	0.0468	0.0241
8	0.0029	99.79	0.0874	0.0201	0.0175	0.0482	0.0273
9	0.0037	99.75	0.1167	0.0200	0.0222	0.0505	0.0305
10	0.0046	99.70	0.1499	0.0207	0.0276	0.0533	0.0338

Source: Researcher's Construct (2021)

Table 6.10 shows that in the short-run, shocks to RGDP per capita account for 9.85% variation of the fluctuation in ICT, while in the long-run they account for 0.046%. In the short-run, shocks to ICT account for 99,9% while in the long-run they account for 99.7% fluctuation in ICT. In the short-run, shocks to foreign direct investment, private domestic credit, development aid, primary school enrolment and remittances account for 0.03%, 0.02%, 0.01%, 0.05%, and 0.011% fluctuation in ICT, respectively. However, in the long-run, shocks to foreign direct investment, private domestic credit, development aid, primary school enrolment and remittances account for 0.14%, 0.02%, 0.02%, 0.05% and 0.03% fluctuation in ICT, respectively.

Table 6.7: Variance Decomposition: FDI

Period	RGDP	ICT	FDI	PDC	DA	PSE	REM
1	0.3548	0.0003	99.64	0.0000	0.0000	0.0000	0.0000
2	0.2319	0.0006	99.50	0.0001	0.0044	0.0135	0.2442
3	0.4148	0.0005	99.01	0.0610	0.0431	0.0212	0.4435
4	0.3896	0.0006	98.87	0.0771	0.0935	0.0222	0.5377
5	0.3445	0.0006	98.86	0.0700	0.0887	0.0267	0.6017
6	0.3422	0.0006	98.81	0.0725	0.0892	0.0297	0.6517

7	0.3402	0.0006	98.76	0.0774	0.0992	0.0306	0.6916
8	0.3306	0.0007	98.73	0.0782	0.1026	0.0318	0.7229
9	0.3247	0.0007	98.71	0.0788	0.1036	0.0331	0.7467
10	0.3215	0.0007	98.69	0.0801	0.1062	0.0339	0.7668

Source: Researcher's construct (2021)

Table 6.7 shows that in the short-run, shocks to RGDP per capita account for 0.41% variation of the fluctuation in foreign direct investment, while in the long-run they account for 0.32%. In the short-run, shocks to ICT account for 0.05%, while in the long -run they account for 0.07% fluctuation in foreign direct investment. In the short-run, shocks to foreign direct investment, private domestic credit, development aid, primary school enrolment and remittances account for 99%, 0.06%, 0.04%, 0.02%, and 0.44% fluctuation in foreign direct investment, respectively. However, in the long-run, shocks to foreign direct investment, private domestic credit, development aid, primary school enrolment and remittances account for 98.6%, 0.08%, 0.1%, 0.03% and 0.76% fluctuation in foreign direct investment, respectively.

Table 6.8: Variance Decomposition: PDC

Period	RGDP	ICT	FDI	PDC	DA	PSE	REM
1	0.1567	0.0272	0.3411	99.47	0.0000	0.0000	0.0000
2	0.0766	0.0238	0.3572	99.47	5.2500	0.0622	0.0012
3	0.0999	0.0212	0.3749	99.42	0.0202	0.0497	0.0050
4	0.1194	0.0180	0.3862	99.38	0.0323	0.0386	0.0168
5	0.1230	0.0160	0.3937	99.38	0.0325	0.0323	0.0216
6	0.1246	0.0146	0.3994	99.37	0.0344	0.0285	0.0233
7	0.1263	0.0136	0.4035	99.36	0.0368	0.0256	0.0255
8	0.1277	0.0128	0.4062	99.36	0.0378	0.0234	0.0272

9	0.1288	0.0122	0.4083	99.36	0.0387	0.0216	0.0283
10	0.1296	0.0111	0.4110	99.35	0.0395	0.0202	0.0292

Source: Researcher's construct (2021)

Table 6.8 shows that in the short-run, shocks to RGDP per capita account for 0.09% variation of the fluctuation in private domestic credit, while in the long-run they account for 0.12% variation. In the short-run, shocks to ICT account for 0.02%, while in the long-run they account for 0.01% fluctuation in private domestic credit. In the short-run, shocks to foreign direct investment, private domestic credit, development aid, primary school enrolment and remittances account for 0.37%, 99.42%, 0.02%, 0.04 and 0.05% fluctuation in private domestic credit, respectively. However, in the long-run, shocks to foreign direct investment, private domestic credit, development aid, primary school enrolment and remittances account for 0.41%, 99.35%, 0.03%, 0.02% and 0.02% fluctuation in private domestic credit, respectively.

Table 6.9: Variance Decomposition: DA

Period	RGDP	ICT	FDI	PDC	DA	PSE	REM
1	0.0136	0.0320	0.0080	0.0797	99.86	0.0000	0.0000
2	0.0085	0.0474	0.1812	0.1542	93.36	0.0030	6.2427
3	0.0129	0.0532	0.1609	0.1804	93.16	0.0025	6.4213
4	0.0124	0.0652	0.1302	0.1740	94.05	0.0050	5.5601
5	0.0132	0.0733	0.1303	0.1799	94.09	0.0042	5.500
6	0.0136	0.0802	0.1151	0.1881	94.11	0.0037	5.4819
7	0.0135	0.0881	0.1017	0.1897	94.28	0.0034	4.3173
8	0.0137	0.0955	0.0943	0.1917	94.36	0.0032	5.2233
9	0.0139	0.1024	0.0877	0.1945	94.41	0.0029	5.1867
10	0.0139	0.1092	0.0813	0.1963	94.46	0.0027	5.1284

Source: Researcher's construct (2021)

Table 6.9 shows that in the short-run, shocks to RGDP per capita account for 0.01% variation of the fluctuation in private domestic credit, while in the long-run they account for 0.013% variation. In the short-run, shocks to ICT account for 0.05% while in the long-run they account for 0.10% fluctuation in development aid. In the short-run, shocks to foreign direct investment, private domestic credit, development aid, primary school enrolment and remittances account for 0.16%, 0.18%, 93%, 0.025% and 6.42% fluctuation in development aid, respectively. However, in the long-run, shocks to foreign direct investment, private domestic credit, development aid, primary school enrolment and remittances account for 0.08%, 0.19%, 94%, 0.002% and 5.12% fluctuation in development aid, respectively.

Table 6.10: Variance Decomposition: PSE

Period	RGDP	ICT	FDI	PDC	DA	PSE	REM
1	0.0208	0.0021	0.0010	0.0658	0.9668	98.81	0.0000
2	0.0143	0.0067	0.0025	0.0444	0.2280	99.67	0.0258
3	0.0178	0.0053	0.0348	0.1135	0.2920	99.51	0.0223
4	0.0263	0.0042	0.0424	0.1234	0.2726	99.50	0.0221
5	0.0322	0.0036	0.0400	0.1182	0.2651	99.51	0.0278
6	0.0348	0.0032	0.0414	0.1185	0.2710	99.50	0.0291
7	0.0367	0.0028	0.0440	0.1200	0.2709	99.49	0.0293
8	0.0384	0.0026	0.0447	0.1205	0.2695	99.49	0.0302
9	0.0398	0.0024	0.0451	0.1208	0.2697	99.49	0.0309
10	0.0409	0.0023	0.0457	0.1212	0.2698	99.48	0.0331

Source: Researcher's Construct (2021)

Table 6.10 shows that in the short-run, shocks to RGDP per capita account for 0.017% variation of the fluctuation in primary school enrolment, while in the long-run

they account for 0.04% variation. In the short-run, shocks to ICT account for 0.05%, while in the long-run they account for 0.023% fluctuation in development aid. In the short-run, shocks to foreign direct investment, private domestic credit, development aid, primary school enrolment and remittances account for 0.03%, 0.11%, 0.29%, 99.51% and 0.02% fluctuation, respectively. However, in the long-run, shocks to foreign direct investment, private domestic credit, development aid, primary school enrolment and remittances account for 0.04%, 0.12%, 0.26%, 99.48% and 0.03% fluctuation, respectively.

Table 6.11: Variance Decomposition: REM

Period	RGDP	ICT	FDI	PDC	DA	PSE	REM
1	0.0369	0.0712	0.7048	0.0234	16.10	0.0024	83.03
2	0.0371	0.0446	0.7667	0.0324	16.34	0.0319	82.72
3	0.0396	0.0469	0.7777	0.0318	17.82	0.0202	81.25
4	0.0406	0.0480	0.7780	0.0311	18.32	0.0147	80.76
5	0.0410	0.0477	0.7770	0.0311	18.44	0.0121	80.65
6	0.0412	0.0476	0.7677	0.0311	18.60	0.0104	80.49
7	0.0413	0.0473	0.7685	0.0310	18.71	0.0091	80.38
8	0.0414	0.0469	0.7574	0.0310	18.77	0.0083	80.32
9	0.0415	0.0465	0.7661	0.0310	18.83	0.0076	80.27
10	0.0416	0.0461	0.7657	0.0309	18.87	0.0070	80.22

Source: Researcher's construct (2021)

Table 6.11 shows that in the short-run, shocks to RGDP per capita account for 0.03% variation of the fluctuation in remittances, while in the long-run they account for 0.04% variation. In the short-run, shocks to ICT account for 0.04% while in the long-run they account for 0.046% fluctuation in remittances. In the short-run, shocks

to foreign direct investment, private domestic credit, development aid, primary school enrolment and remittances account for 0.77%, 0.03%, 17.82%, 0.02% and 81.25% fluctuation in remittances, respectively. However, in the long-run, shocks to foreign direct investment, private domestic credit, development aid, primary school enrolment and remittances account for 0.75%, 0.03%, 18.87%, 0.007% and 80.22% fluctuation in remittances, respectively.

6.7 IMPULSE RESPONSE ANALYSIS

Impulse response is useful for the measurement of the unit shock applied to each series, and its overall effect on the VAR system at large (David, 2017). Impulse response analysis was used in this research to identify the degree of reaction of endogenous variables in the VAR model. The figures below show the reactions of the VAR model to standard deviation.

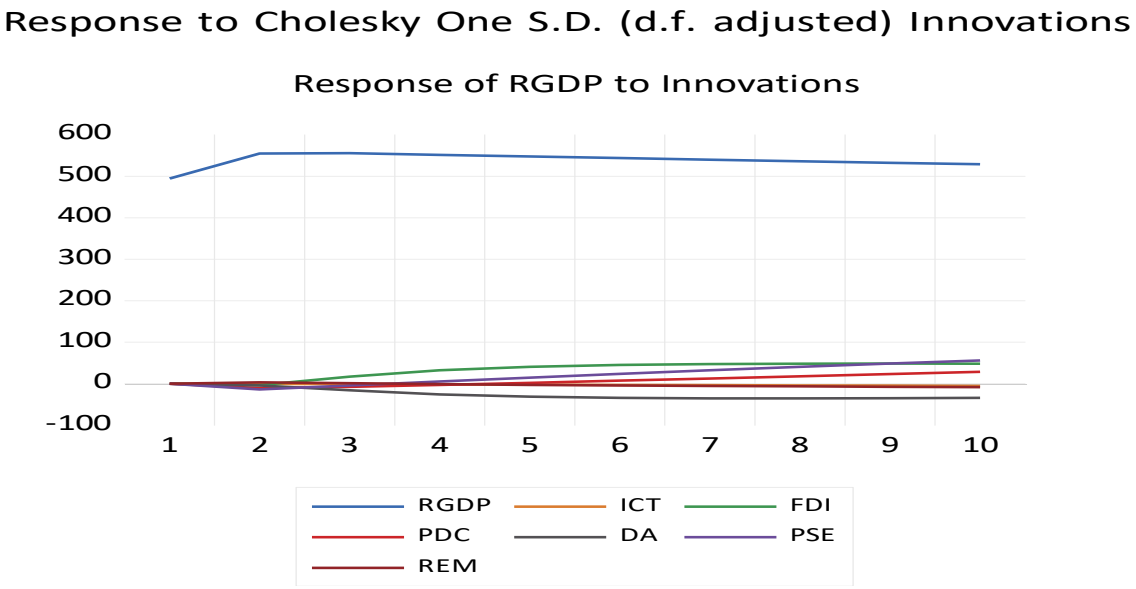

Figure 6.1: Response to RGDP

Source: Researcher's construct (2021)

The above figure shows the response of real gross domestic product per capita to innovations. From period 1-2, the figure shows an increase in real GDP per capita. However, from the end of period 2 to period 10, the variable shows a positive trend but with minor fluctuations. This shows a positive response to one standard shock of innovation given to RGDP both in the short-run and the long-run period.

The figure below shows the impulse response of ICT to innovations. A one standard unit shock applied to ICT results in a fairly stable increase between period 1 and 2 only. However, from period 3-10, a one standard shock of innovation given to ICT results in a gradual decline of ICT up to period 10.

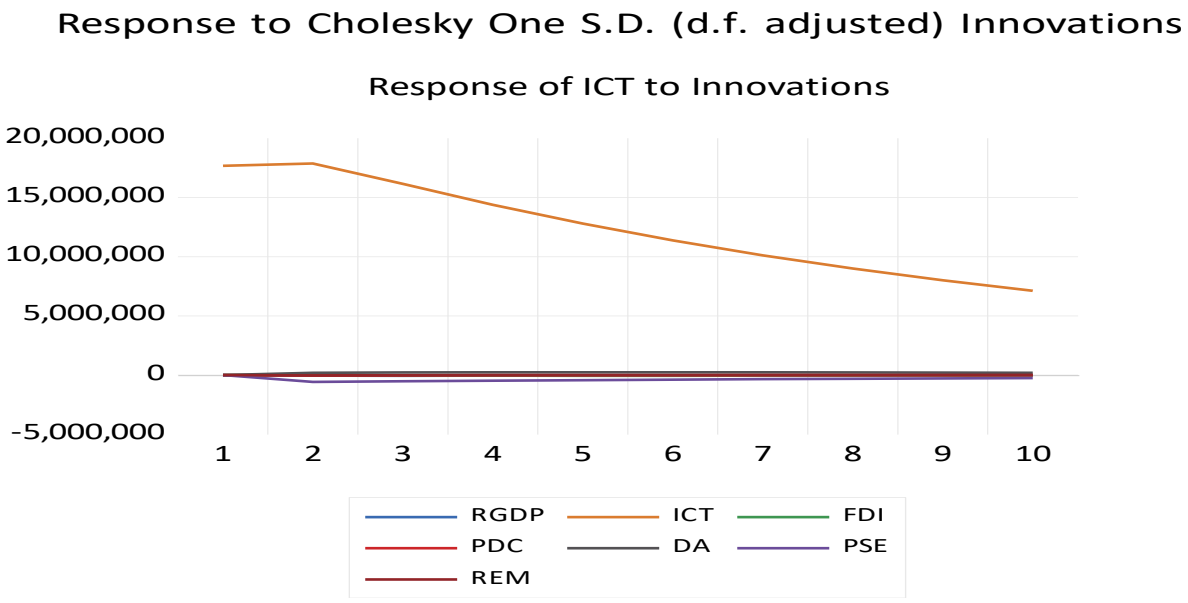

Figure 6.2: Response to ICT

Source: Researcher's construct (2021)

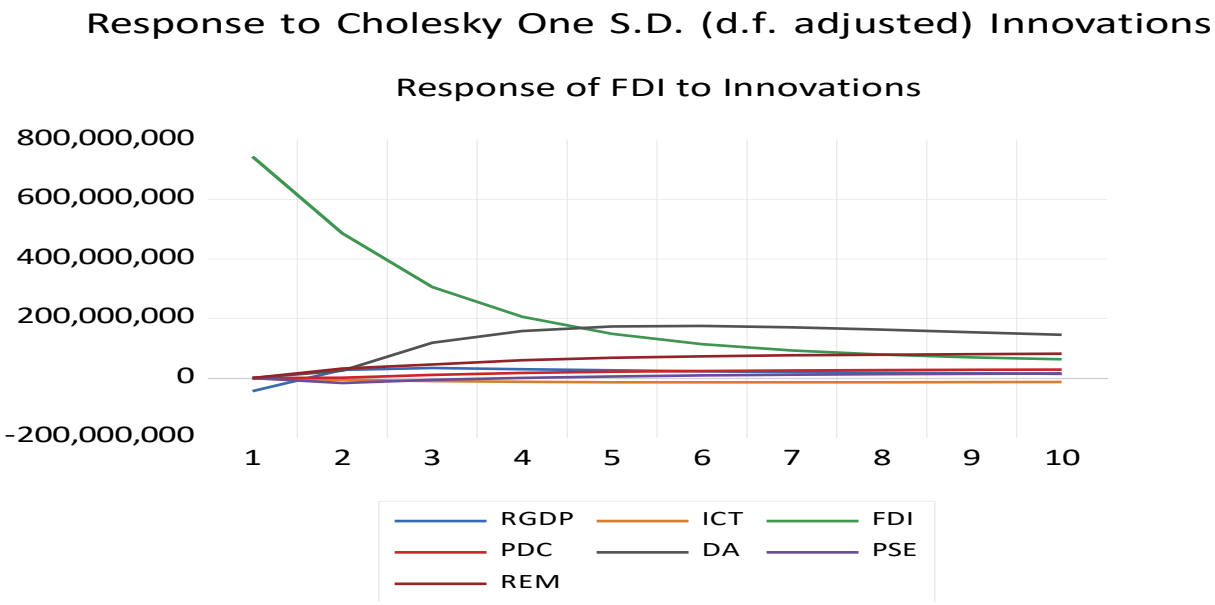

Figure 6.3: Response to FDI

Source: Researcher's construct (2021)

The above figure shows the response of FDI to innovations. A one standard shock of innovation given to foreign direct investment results in a gradual decline in foreign direct investment from period 1-10. However, foreign direct investment remains positive and does not reach a negative.

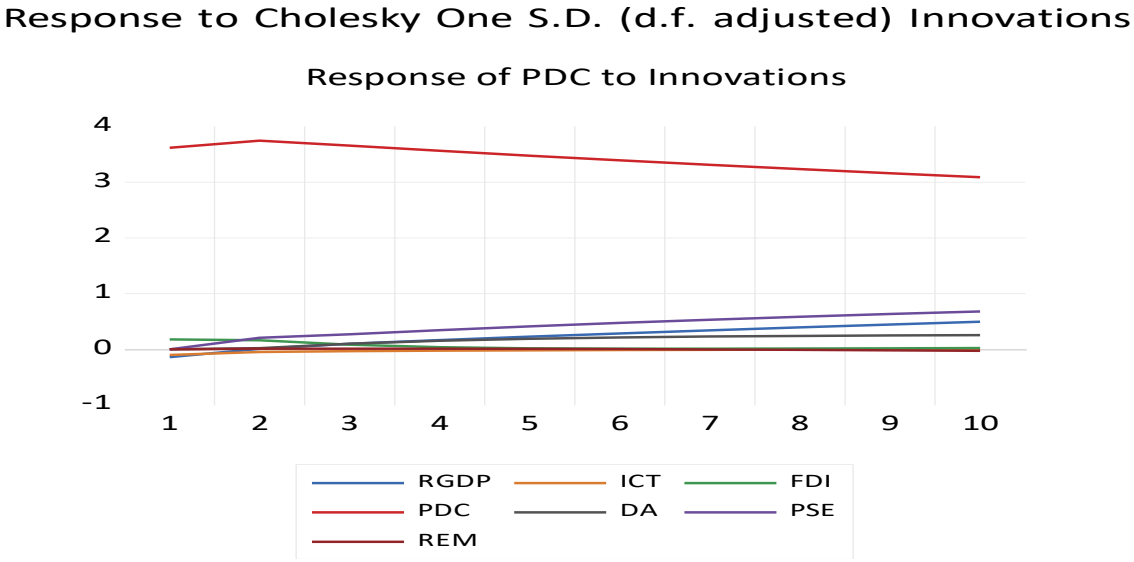

Figure 6.4: Response to PDC

Source: Researcher's construct (2021)

The figure above shows the response of private domestic credit to innovations. A one standard shock of innovation given to private domestic credit results in a slight gradual decline in foreign direct investment from period 1-10. The reaction remains positive both in the short-run and long-run.

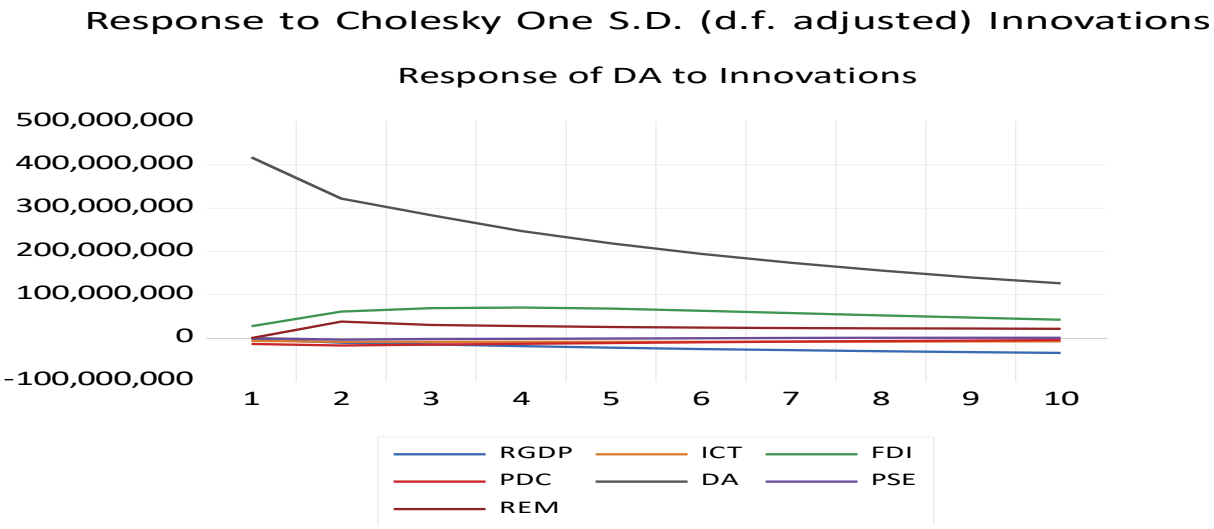

Figure 6.5: Response to DA

Source: Researcher's construct (2021)

The above figure shows the response of development aid to innovations. A one standard shock of innovation given to development aid results in a sharp decline in development aid between period 1 and 2. From period 3 to period 10 there is a gradual decrease in development aid and it remains positive.

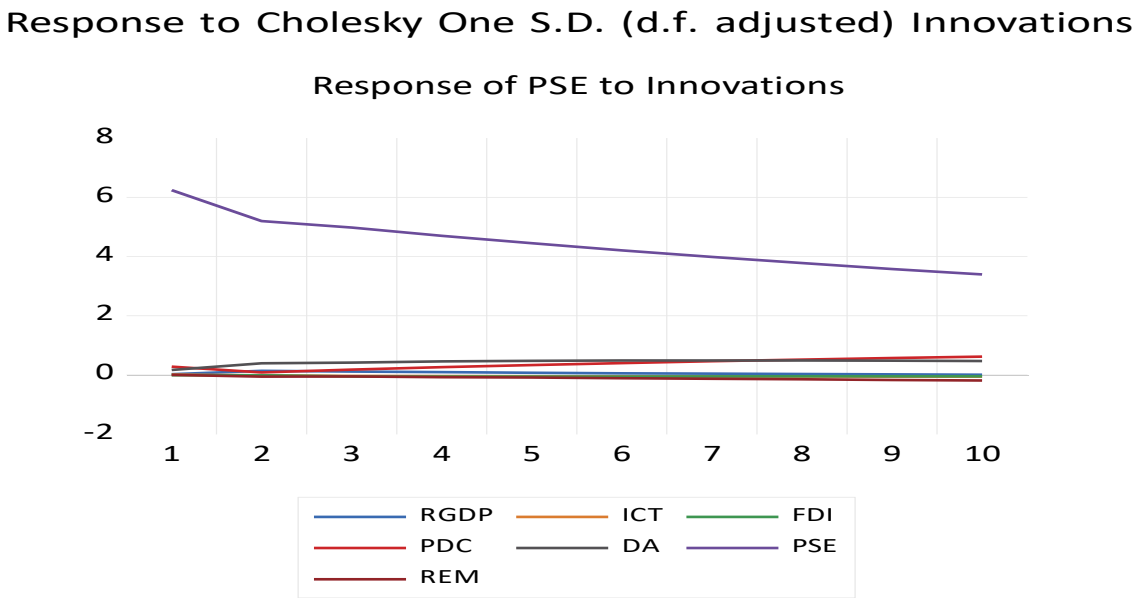

Figure 6.6: Response to PSE

Source: Researcher's construct (2021)

The above figure shows the response of primary school enrolment to innovations. A one standard shock of innovation given to primary school enrolment results in a significant decline in primary school enrolment between period 1 and 2. From period 3 to period 10, there is a gradual decrease in primary school enrolment and it remains positive.

The figure below shows the response of remittances to innovations. A one standard shock of innovation given to remittances results in a gradual increase in remittances both in the short-run and long-run.

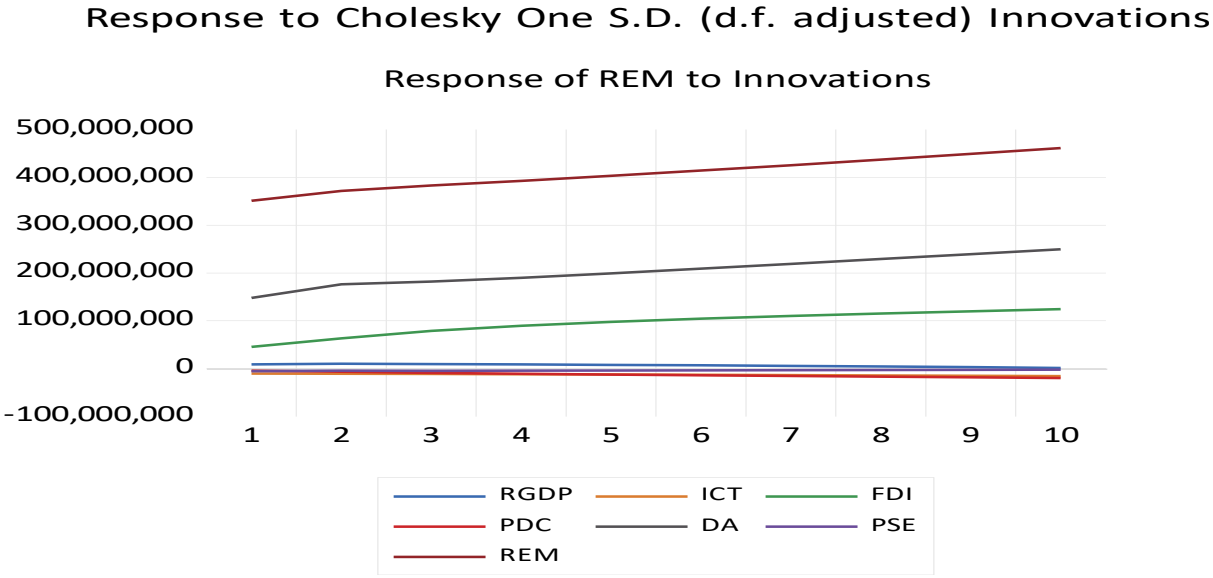

Figure 6.7: Responses to REM

Source: Researcher's construct (2021)

6.8 MODEL SPECIFICATION TEST

This section presents the model specification test. Fixed effects and random effects were used as a basis for the Hausman Test.

6.8.1 Pre Estimation Diagnostics

The table below shows the fixed effects results.

Table 6.12: Fixed Effects Results

Variable	T-statistic	P-value
Constant	3.61	0.00
ICT	-0.28	0.77
FDI	3.98	0.00
PDC	10.4	0.00
DA	0.11	0.90
PSE	-0.29	0.76
REM	1.53	0.12

Source: Researcher's Construct

The above results show negative impacts between information and communication technology, foreign direct investment, private domestic credit, development aid, primary school enrolment and remittances. This conforms, *a priori,* to economic expectations (Bohlin, Hanafizadez & Vu, 2017; Mushtaq & Bruneau, 2019). However, foreign direct investment showed a positive impact on real GDP per capita. The results show that a 1% rise in the ICT composite index will result in a -0.28 decrease in poverty levels in the Sub-Saharan Africa region. However, a 1% increase in foreign direct investment will result in a 3.98% increase in real GDP per capita. If private domestic credit rises by 1% will have a 10.4% impact on real GDP per capita. A 1% increase in development aid will have a 0,11% positive impact on real GDP per capita. A 1% fall in primary school enrolment will cause a 0.29% increase in real GDP per capita, and if remittances rise by 1%, it will have a 1.53% on impact on real GDP per capita.

The fixed effects results show that foreign direct investment and private domestic credit were statistically significant to real GDP per capita at the 10% level. However, information and communication technology, development aid, primary school enrolment and remittances were statistically insignificant at 10% of real GDP per capita.

Random Effects

The table below shows the random effects results.

Table 6.13: Random Effects Results

Variable	T-value	P-value
Constant	1.97	0.04
ICT	-0.41	0.67
FDI	4.01	0.00
PDC	10.8	0.00
DA	-0.40	0.68
PSE	0.13	0.89
REM	1.62	0.10

Source: Researcher's construct

The random effects results show that information and communication technology is statistically insignificant at the 10% level to real GDP per capita. A 1% increase in information and communication technology will lead to a 0.41% decrease in poverty levels in the SSA region. Foreign direct investment, private domestic credit and remittances were statistically significant at the1% level to real GDP per capita. A 1% increase in foreign direct investment will adjust real GDP per capita by 4.01%, while a 1% increase in private domestic credit will adjust real GDP per capita by 10.8%. For development aid, a 1% rise will lead to an adjustment of 0.40% in real GDP per capita. For primary school enrolment, a 1% rise will result in 0.13% adjustment in real GDP per capita in Sub-Saharan Africa. Lastly, for remittances, a 1% increase will lead to a 1.62% adjustment in real GDP per capita.

6.8.2 Hausman Test

To determine the test to run between fixed effects and random effects, a Hausman test was employed in this research. This test was used to ascertain the best method for running the long-run regression analysis. The hypothesis is stated below:

H_0= **Random effects are independent of explanatory factors.**

H_1= **Random effects are dependant of explanatory factors.**

The results are presented in the table below:

Table 6.14: Hausman Test

Test Summary	Chi-Square Statistic	Chi-Square Diff	Probability
Cross-Section random	12.81	6	0.04

Source: Researcher's construct (2021)

The results show that the chi-square statistic is 12.81 and that the probability value is statistically significant, thus the null hypothesis is rejected. The fixed effects were used to estimate the model.

6.9 HETEROSCEDASTICITY AND SERIAL CORRELATION TEST

The Breusch-Pagan Test was used to test for heteroscedasticity in this research. The hypothesis is specified below:

H_0= **There is heteroscedasticity.**

H_1= **There is homoscedasticity.**

The heteroscedasticity test showed a 0.94 probability value. It is clear that the 0.94 result is greater than the 0.05 level, hence it can be concluded that that there was no heteroscedasticity, hence the null hypothesis is rejected (See Appendix for full results). The presence of homoscedasticity enables the regression predictors to be efficient and consistent. This was achieved after changing the functional form of the model by incorporating log forms to the variables.

6.9.1 SERIAL CORRELATION TEST

To test for serial correlation the Generalised least squares was used. The results proved that there was no autocorrelation in the research.

6.10 PANEL VECTOR AUTOREGRESSION ESTIMATION ANALYSIS

This discussion is based on the analysis of the panel vector autoregression estimation.

Table 6.15: Panel Vector Autoregression Results

	RGDP	ICT	FDI	PDC	DA	PSE	REM
RGDP(-1)	41.29	-0.04	2.72	1.51	-0.70	0.67	0.17
RGDP(-2)	-4.64	0.05	-2.21	-0.87	0.07	-0.67	-0.27
ICT(-1)	-0.07	69.56	-0.31	1.04	-0.50	-0.32	0.07
ICT(-2)	-0.015	-7.45	-0.03	-0.79	0.30	0.21	-0.05
FDI(-1)	-0.23	-0.01	23.60	-0.21	3.19	-0.04	1.30
FDI(-2)	1.69	-0.11	0.98	0.65	-0.36	-0.37	0.26
PDC(-1)	-0.71	-0.03	0.11	36.73	-0.57	-0.81	-0.14
PDC(-2)	0.94	0.04	0.56	-1.99	0.49	1.34	-0.01
DA(-1)	-0.37	0.45	0.55	0.10	26.29	1.60	1.86
DA(-2)	-0.44	-0.26	3.92	0.58	3.66	-0.70	-1.40
PSE(-1)	-0.97	-1.14	-0.75	1.98	-0.26	29.09	0.09
PSE(-2)	1.64	1.07	0.90	-1.03	0.31	3.69	-0.02
REM(-1)	0.42	-0.14	2.83	0.19	-6.02	0.67	-2.25
REM(-2)	-0.68	0.14	-0.96	-0.19	-6.29	0.42	0.26

Source: Researcher's construct (2021)

The above table shows the Vector Autoregression estimates for all variables used in the study. Looking at the one period lag of real GDP per capita, the table shows that the significant variables are foreign direct investment and RGDP. This is because the variables have a t-statistical value greater than 2. Thus, changes in the 1 period lag affect foreign direct investment and real GDP per capita in the long run. On the 2

period lag of RGDP, all variables had t- values below 2, hence they were not significant. For ICT at 1 period lag, the only significant variable was ICT. On the 2 period lag of RGDP, all variables had t-values below 2, hence they were not significant.

For foreign direct investment at a 1 period lag, significant variables were development and FDI. Thus, changes in the 1 period lag affect foreign direct investment and development aid in the long run. On the 2 period lag of foreign direct investment, all variables had t- values below 2, hence they were not significant. For private domestic product at 1 period lag, PDC was significant. On the 2 period lag of private domestic credit, all variables had t-values below 2, hence they were not significant. For development aid, at 1 and 2 period lags only development aid was significant. For primary school enrolment at 1 and 2 period lags, only primary school enrolment was significant. Other variables had t-values below 2. Lastly, for remittances at 1 period lag, foreign direct investment was the only significant variable. This implies that changes in one period lag affect foreign direct investment in the long run.

6.11 Estimation of Generalised Method of Moments (GMM)

The GMM was used to establish the dynamic relationship that exists among the key variables used in the research, with a specific focus on Sub-Saharan Africa. This helped in evaluating the effect of information and communication technology, private domestic credit, primary school enrolment, development aid, foreign direct investment, and remittances to countries in Sub-Saharan Africa. A one-step difference GMM and a two-step difference GMM was carried out in the study. This was done to ascertain the relationship between poverty and the independent variables used in the research (David, 2017). Thus, the GMM helped to evaluate the effects of information and communication technology, development aid, remittances, foreign direct investment, primary school enrolment and private domestic credit on poverty for all SSA countries (David, 2017).

6.11.1 One-Step Difference Generalised Method of Moments

The following results were obtained after running the One-Step Difference Generalised Method of Moments.

Table 6.16: One-Step Difference, Generalised Method of Moments

Variable	Coefficient	P-Value
RGDP	0.10	0.00
DA	-1.04	0.00
ICT	-1.05	0.175
FDI	3.41	0.00
REM	3.94	0.168
PSE	25.79	0.00
PDC	52.30	0.00
Constant	-349.18	0.09

Source: Researcher's construct (2021)

The table above shows that real GDP per capita, development aid, foreign direct investment, primary school enrolment and private domestic product are significant at the 1% level. Results show that the lag of real gross domestic product per capita, remittances, primary school enrolment and private domestic product had a positive effect on real gross domestic product per capita in the short run. However, development aid and the composite index of ICT had a negative impact on real gross domestic product per capita in the short run.

6.11. 2 Two-Step Difference Generalised Method of Moments

The following results were obtained after running the Two-Step Difference Generalised Method of Moments.

Table 6.17: Two-Step Difference Generalised Method of Moments

Variable	Coefficient	P-Value
Lagged RGDP	0.82	0.00
DA	0.06	0.00

ICT	0.01	0.00
FDI	0.02	0.00
REM	0.01	0.00
PSE	0.014	0.675
PDC	-0.05	0.00
Constant	-0.54	0.01

Source: Researcher's construct (2021)

The table above shows that real GDP per capita, development aid, foreign direct investment, composite index of ICT, remittances and private domestic product were significant at the 1% level. Thus, the lag of real gross domestic product per capita, development aid, foreign direct investment, the composite index of ICT, and remittances had a positive effect on real gross domestic product per capita in the short run. However, private domestic product had a negative effect on gross domestic product per capita in the short run.

The empirical results of the one-step Generalised Method of Moments proved that a lag of real gross domestic product per capita, remittances, primary school enrolment and private domestic product had a positive effect on real gross domestic product per capita in the short run. On the other hand, the two-step Generalised Method of Moments showed that the lag of real gross domestic product per capita, development aid, foreign direct investment, primary school enrolment, the composite index of ICT, and remittances had a positive effect on real gross domestic product per capita in the short run. This differed with the one-step Generalised Method of Moments which proved that development aid and the composite index of ICT had a negative impact on real gross domestic product per capita in the short run.

6.12 Post-Estimation Tests for Two-step Difference GMM Estimation

This section presents the diagnostic tests for the GMM estimation. The Arellano-Bond test for zero autocorrelation and the Sargan test were used to validate the instruments of the models used in this research. Results are presented in the table below.

Table 6.18: Post-Estimation Tests for Two-step Difference GMM Estimation

Test	Chi-square value / Z value	Prob. > Chi(2)
Arellano Bond test for zero autocorrelation	-3.288	0.01
Sargan test of over identifying restrictions	45.45	1.00

Source: Researcher's construct

Arellano and Bond (1991) posit that dynamic panel models should be free from serial correlation, but that first order serial correlation is acceptable. The results above show that the Z value is -3.288 with a p value of 0.01. It can thus be concluded that there is no autocorrelation. This is in line with the key assumptions of the Arellano and Bond test for autocorrelation. The results also show that the Sargan test for over identifying restrictions had a chi-square value of 45.44 and Prob. > Chi(2) of 1.00. We therefore did not reject the null hypothesis, concluding that the over identifying restrictions are valid.

6.13 CONCLUSION

This chapter presented the empirical analyses. The first discussion was based on the panel data stationarity results, and the panel causality analysis and variance decomposition analysis results were discussed. The impulse response analysis and fixed and random effects analysis as well as the serial correlation tests and heteroscedasticity were also discussed. Panel cointegration analysis showed a long-run relationship between ICT usage, foreign direct investment, development aid, primary school enrolment, real GDP per capita, remittances, and private domestic credit. Finally, a panel vector autoregression estimation analysis was done. The following chapter presents a summary and the conclusions of the study.

CHAPTER SEVEN: SUMMARY, CONCLUSION AND POLICY RECOMMENDATIONS

7.1 INTRODUCTION

This chapter presents the summary, recommendations and conclusions of the study. Recommendations are based on the research outcomes and are aligned to poverty reduction through ICT diffusion. Areas for further research are also examined.

7.2 SUMMARY

This study started with a brief overview of Sub-Saharan Africa and a description of ICT usage. A link between ICT and poverty was established in the research. A number of theories were used to substantiate the importance of ICT in poverty reduction. Technology was regarded as a key enabler in promoting entrepreneurial activities that in turn increase employment and thus reduce poverty levels through the multiplier effect. Thus, the research confirmed the importance of ICT in poverty reduction.

The research was based on assessing ICT diffusion for poverty alleviation from a regional level perspective. Sub-Saharan African countries remain plagued by dire and imminent poverty levels and show low rates of ICT usage. The aim of the study was to determine how ICT can be used as a tool for poverty reduction in SSA. The low rates of internet usage to promote economic activities in SSA countries have been attributed to government monopolies in the ICT sector, poor ICT policies, and limited resources for attracting modern ICT, among other reasons. However, some SSA countries are reducing their monopolistic power in the ICT sector, and this is improving economic activities such as e-commerce. The literature review highlighted the importance of harnessing ICT towards poverty reduction.

Empirical analysis of the study depicted the stylized facts used in the research. The Levin–Lin–Chu test was used to test for stationarity. Panel co-integration in this research was tested using the Johansen-Fisher Cointegration test, which was performed to ascertain the long-run relationship among the variables used in the research. An advanced form of the Granger causality test was used to examine the relationship between the panel data variables. This was the Dumitrescu and Hurlin

test. The results depicted that there was a bi-directional relationship between the variables used in the study.

Vector Error Correction Estimates were carried out to derive the variance decomposition. To determine which test to run between fixed effects and random effects, the Hausman test was used to ascertain the best method for running the long-run regression analysis.

Impulse response analysis was used in the research for the purpose of identifying the degree of reaction of endogenous variables in the VAR model. Dynamic panel models of generalised methods of moments were employed for evaluating ICT effects on the independent variables.

7.3 CONCLUSION

The descriptive results of the study depicted low usage of ICT in SSA. In terms of poverty trends, Sub-Saharan Africa experienced a sharp decline in Real GDP per capita. In terms of development aid, economies in SSA received varying amounts and from the study it was ascertained that the development aid has not significantly helped in poverty reduction. Foreign direct investment wise, SSA has received money from diverse institutions but the region remains choked with poverty and other macro-economic challenges. In terms of primary school enrollment, some economies still have low rates and as such it is key for ICT to be introduced in all educational sectors in SSA so as to solve digital poverty or reduce digital illiteracy. Apart from that, the empirical results of this research proved that the ICT composite index was significant at the 1% level. This means that there is greater than 99% that the ICT composite index is a genuine coefficient of poverty in SSA, after taking into account other macro-economic factors. This in line with the research findings of Bohlin, Hanafizadez and Vu (2017). The results of the one-step Generalised Method of Moments proved that a lag of real gross domestic product per capita, remittances, primary school enrolment and private domestic product have a positive effect on real gross domestic product per capita in the short run. These results tally with the research findings of Mushtaq and Bruneau (2019). The two-step Generalised Method of Moments showed that the lag of real gross domestic product per capita, development aid, foreign direct investment, primary school enrolment, the composite

index of ICT and remittances, have a positive effect on real gross domestic product per capita in the short run. These results are on a par with the views of Andrew, Hlalefang, Nicolene, Thando, Simba and Nomahlubi (2017). This differs from the one-step Generalised Method of Moments, which proved that development aid and the composite index of ICT has a negative impact on real gross domestic product per capita in the short-run. Results from the panel vector auto regression estimation, looking at one period lag of real GDP per capita, showed that the significant variables were foreign direct investment and RGDP. This is because the variables had a t-statistical value greater than 2. Thus, changes in one period lag affect foreign direct investment and real GDP per capita in the long run. These research findings are similar to the research outcome of Sokang (2018). Based on the results, not only was the study able to tell how ICT reduces poverty in SSA, but it further proposed the specific ICT components that have the most poverty reducing effects and that should be the components which policymakers should focus on the most

7.4 POLICY RECOMMENDATIONS

The following policy recommendations are suggested to ensure that dire poverty levels are reduced in the Sub-Saharan African region through the use of ICT.

7.4.1 Liberalization of the ICT sector

There is a need of liberalization of the ICT sector in the Sub-Saharan Africa region. Monopolies have led to poor resource allocation in the ICT sector as well as sluggish growth. Governments in the SSA need to abolish monopolies and allow more players to penetrate the ICT sector. This will allow competition among players and efficiency will be attained. More innovation could be attained when efficiency is high. The role of the government should be limited in respect of the ICT sector. The government should be there for regulation purposes and ensuring free trade practises among business entities.

The state should act as a regulator and not have full control on the operations of firms in the ICT sector. The study revealed that some governments in SSA still use state- owned firms to run the ICT sector. Such countries in SSA showed low ICT usage and high poverty levels. A solution to this would be to eliminate monopolies in

the ICT sector and allow more participants to take part in the industry. It is therefore highly recommended that Sub-Saharan African countries abolish monopolies and promote the entry of more companies into the ICT sector for substantial gains in ICT usage to be realized.

7.4.2 Creation of a Conducive Environment for Investment Attraction

Sub-Saharan African countries need to create a safe and conducive environment to attract investors. Research results show that some of the politically unstable and war- torn countries such as the DRC, Mozambique, Nigeria, Somalia and the Sudan among others, have low rates of ICT usage. Due to war, military coups and political turmoil, much ICT infrastructure has been destroyed and as such, potential investors decline to invest in these countries.

Thus, there is a strong need for strategic planning by respective governments in SSA to address the political climate challenges and ensure that safe, conducive and sustainable environments are created to attract investors. Other factors to be addressed are poor economic policies, poor infrastructure, and lack of labour availability to mention a few, so that foreign direct investment and domestic investment will be attracted to the SSA region.

7.4.3 Investment in the ICT sector

Governments in SSA need to seriously invest in ICT. This should be from a grassroots level. For example, there is need to inject financial resources into the development of robust and efficient ICT modules in the education sector, starting from primary schools up to and including tertiary schools. This will strengthen and encourage the development of high ICT usage. The required funding should be sourced from government, private partnerships, civil society, non-governmental organisations and international institutions.

7.4.4 ICT Policy Formulation and Implementation

Nations in the SSA region need to develop sound and efficient ICT policies that will help boost the ICT industry at large. The study showed that poor policies can cripple an economy and the any gains from the use of ICT will be meagre. The ability of

SSA countries to use ICT for poverty alleviation will be doomed if there is no clear ICT policy at regional level.

Thus, the development and implementation of ICT policies should be tailor made to meet the specific needs of each country in the SSA region. This can be achieved by ensuring that all key players in government, educational institutions, business forums, and other crucial stakeholders are involved in the development of ICT policies at regional and national level. To ensure a successful outcome, universities and other key institutions should also develop their ICT policies to mirror a broad national ICT policy. This will be beneficial in supporting ICT usage from a SSA regional and country-specific perspective, and even at the grassroots level.

7.4.5 University Exchange Programmes

Educational institutions in Sub-Saharan Africa need to develop partnerships with well-developed institutions globally, so that exchange programmes can be introduced. These programmes should be designed to harness modern ICT financial and non-financial resources, which will go a long way towards improving the poverty-stricken SSA region as well as uplifting the rate of ICT usage. The exchange programmes could be designed in such a way that tertiary students can learn in foreign universities for a prescribed period. Some specialised skills could be brought in to offer their services to educational institutions in SSA. Such transfer of human capital is a necessary ingredient for solving the digital divide in Sub-Saharan Africa.

7.5 AREAS FOR FURTHER RESEARCH

Further studies on the nexus between ICT diffusion and poverty in Sub-Saharan Africa could focus on ascertaining other factors with which to measure the key terms in this work. It would be beneficial if other studies were used to capture ICT diffusion and poverty on a comparison basis with other regions such as Asia, Europe, or even on a global scale. This will help in ascertaining the effects of ICT diffusion on poverty from a global perspective.

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APPENDICES

Appendix A1: Unit Root Tests

Null Hypothesis: Unit root (common unit root process)
Series: D(PSE)
Date: 08/01/21 Time: 20:28
Sample: 1989 2019
Exogenous variables: Individual effects
Automatic selection of maximum lags
Automatic lag length selection based on SIC: 0 to 6
Newey-West automatic bandwidth selection and Bartlett kernel
Total number of observations: 1340
Cross-sections included: 47

Method	Statistic	Prob.**
Levin, Lin & Chu t*	-26.4974	0.0000

Null Hypothesis: Unit root (common unit root process)
Series: D(ICT)
Date: 08/01/21 Time: 20:26
Sample: 1989 2019
Exogenous variables: Individual effects
Automatic selection of maximum lags
Automatic lag length selection based on SIC: 0 to 6
Newey-West automatic bandwidth selection and Bartlett kernel
Total number of observations: 1308
Cross-sections included: 47

Method	Statistic	Prob.**
Levin, Lin & Chu t*	-11.4475	0.0000

Null Hypothesis: Unit root (common unit root process)
Series: D(FDI)
Date: 08/01/21 Time: 20:32
Sample: 1989 2019
Exogenous variables: Individual effects
Automatic selection of maximum lags
Automatic lag length selection based on SIC: 0 to 6
Newey-West automatic bandwidth selection and Bartlett kernel
Total number of observations: 1331
Cross-sections included: 47

Method	Statistic	Prob.**
Levin, Lin & Chu t*	-37.7442	0.0000

Null Hypothesis: Unit root (common unit root process)
Series: REM
Date: 08/01/21 Time: 20:31
Sample: 1989 2019
Exogenous variables: Individual effects
Automatic selection of maximum lags
Automatic lag length selection based on SIC: 0 to 6
Newey-West automatic bandwidth selection and Bartlett kernel
Total number of observations: 1321
Cross-sections included: 46 (1 dropped)

Method	Statistic	Prob.**
Levin, Lin & Chu t*	-8.83550	0.0000

** Probabilities are computed assuming asympotic normality

Null Hypothesis: Unit root (common unit root process)
Series: D(DA)
Date: 08/01/21 Time: 20:33
Sample: 1989 2019
Exogenous variables: Individual effects
Automatic selection of maximum lags
Automatic lag length selection based on SIC: 0 to 4
Newey-West automatic bandwidth selection and Bartlett kernel
Total number of observations: 1322
Cross-sections included: 46 (1 dropped)

Method	Statistic	Prob.**
Levin, Lin & Chu t*	-38.3090	0.0000

** Probabilities are computed assuming asympotic normality

Null Hypothesis: Unit root (common unit root process)
Series: RGDP
Date: 08/01/21 Time: 20:22
Sample: 1989 2019
Exogenous variables: Individual effects
Automatic selection of maximum lags
Automatic lag length selection based on SIC: 0 to 6
Newey-West automatic bandwidth selection and Bartlett kernel
Total number of observations: 1363
Cross-sections included: 46 (1 dropped)

Method	Statistic	Prob.**
Levin, Lin & Chu t*	4.26290	1.0000

Null Hypothesis: Unit root (common unit root process)
Series: D(PDC)
Date: 08/01/21 Time: 20:35
Sample: 1989 2019
Exogenous variables: Individual effects
Automatic selection of maximum lags
Automatic lag length selection based on SIC: 0 to 4
Newey-West automatic bandwidth selection and Bartlett kernel
Total number of observations: 1355
Cross-sections included: 47

Method	Statistic	Prob.**
Levin, Lin & Chu t*	-28.1863	0.0000

A2: PANEL CO-INTERGRATION ANALYSIS

Johansen Fisher Panel Cointegration Test
Series: RGDP ICT FDI PDC DA PSE REM
Date: 08/01/21 Time: 21:08
Sample: 1989 2019
Included observations: 1457
Trend assumption: Linear deterministic trend
Lags interval (in first differences): 1 1

Unrestricted Cointegration Rank Test (Trace and Maximum Eigenvalue)

Hypothesized No. of CE(s)	Fisher Stat.* (from trace test)	Prob.	Fisher Stat.* (from max-eigen test)	Prob.
None	1994.	0.0000	1477.	0.0000
At most 1	1255.	0.0000	643.7	0.0000
At most 2	743.2	0.0000	364.1	0.0000
At most 3	457.4	0.0000	253.1	0.0000
At most 4	269.9	0.0000	177.3	0.0000
At most 5	174.7	0.0000	146.2	0.0005
At most 6	157.1	0.0000	157.1	0.0000

* Probabilities are computed using asymptotic Chi-square distribution.

A3: Dumitrescu and Hurlin Test

Pairwise Dumitrescu Hurlin Panel Causality Tests
Date: 08/01/21 Time: 21:32
Sample: 1989 2019
Lags: 2

Null Hypothesis:	W-Stat.	Zbar-Stat.	Prob.
ICT does not homogeneously cause RGDP	5.99768	10.9454	0.0000
RGDP does not homogeneously cause ICT	8.18333	17.2147	0.0000
FDI does not homogeneously cause RGDP	4.20461	5.80216	7.E-09
RGDP does not homogeneously cause FDI	4.77089	7.42651	1.E-13
PDC does not homogeneously cause RGDP	56.8447	156.795	0.0000
RGDP does not homogeneously cause PDC	9.10535	19.8595	0.0000
DA does not homogeneously cause RGDP	4.83722	7.61674	3.E-14
RGDP does not homogeneously cause DA	4.02753	5.29425	1.E-07
PSE does not homogeneously cause RGDP	126.268	355.930	0.0000
RGDP does not homogeneously cause PSE	3.93996	5.04307	5.E-07
REM does not homogeneously cause RGDP	7.69563	15.8158	0.0000
RGDP does not homogeneously cause REM	4.62613	7.01128	2.E-12
FDI does not homogeneously cause ICT	9.22814	20.2117	0.0000
ICT does not homogeneously cause FDI	6.51583	12.4317	0.0000
PDC does not homogeneously cause ICT	3.47769	3.71708	0.0002
ICT does not homogeneously cause PDC	6.92291	13.5993	0.0000
DA does not homogeneously cause ICT	6.33333	11.9082	0.0000
ICT does not homogeneously cause DA	4.69200	7.20020	6.E-13
PSE does not homogeneously cause ICT	5.55283	9.66940	0.0000
ICT does not homogeneously cause PSE	4.41647	6.40988	1.E-10
REM does not homogeneously cause ICT	7.82874	16.1976	0.0000
ICT does not homogeneously cause REM	6.87761	13.4694	0.0000
PDC does not homogeneously cause FDI	4.18185	5.73690	1.E-08
FDI does not homogeneously cause PDC	5.04346	8.20833	2.E-16
DA does not homogeneously cause FDI	4.61632	6.98312	3.E-12
FDI does not homogeneously cause DA	4.04394	5.34131	9.E-08
PSE does not homogeneously cause FDI	4.31936	6.13132	9.E-10
FDI does not homogeneously cause PSE	4.07868	5.44096	5.E-08
REM does not homogeneously cause FDI	6.46679	12.2910	0.0000
FDI does not homogeneously cause REM	3.78765	4.60618	4.E-06
DA does not homogeneously cause PDC	4.37925	6.30313	3.E-10
PDC does not homogeneously cause DA	3.30208	3.21337	0.0013
PSE does not homogeneously cause PDC	5.76408	10.2754	0.0000
PDC does not homogeneously cause PSE	5.92611	10.7401	0.0000
REM does not homogeneously cause PDC	6.12834	11.3202	0.0000
PDC does not homogeneously cause REM	3.84311	4.76524	2.E-06
PSE does not homogeneously cause DA	6.40507	12.1140	0.0000
DA does not homogeneously cause PSE	4.17699	5.72297	1.E-08
REM does not homogeneously cause DA	5.18864	8.62476	0.0000
DA does not homogeneously cause REM	4.72855	7.30506	3.E-13
REM does not homogeneously cause PSE	3.94857	5.06776	4.E-07
PSE does not homogeneously cause REM	4.93112	7.88609	3.E-15

A4: Vector Error Correction Estimates

Vector Error Correction Estimates
Date: 08/05/21 Time: 22:20
Sample (adjusted): 1992 2019
Included observations: 1316 after adjustments
Standard errors in ( ) & t-statistics in [ ]

Cointegrating Eq:	CointEq1
RGDP(-1)	1.000000
ICT(-1)	-0.005088 (0.00027) [-18.8504]
FDI(-1)	1.06E-05 (2.8E-05) [0.38072]
PDC(-1)	-677.3016 (1537.22) [-0.44060]
DA(-1)	-4.88E-06 (3.4E-05) [-0.14473]
PSE(-1)	-281.3589 (1176.27) [-0.23920]
REM(-1)	-3.14E-06 (1.3E-05) [-0.23969]
C	65496.24

Error Correction:	D(RGDP)	D(ICT)	D(FDI)	D(PDC)	D(DA)	D(PSE)	D(REM)
CointEq1	5.83E-06 (3.7E-05) [0.15710]	23.10664 (1.21850) [18.9632]	-5.570024 (57.5420) [-0.09680]	-1.31E-07 (2.7E-07) [-0.48528]	22.03803 (28.7234) [0.76725]	7.92E-08 (4.7E-07) [0.16934]	-5.583466 (28.8273) [-0.19369]
D(RGDP(-1))	0.135801 (0.02795) [4.85787]	-15.41163 (917.496) [-0.01680]	85135.54 (43327.5) [1.96493]	0.000254 (0.00020) [1.24609]	-15124.41 (21627.9) [-0.69930]	6.04E-05 (0.00035) [0.17146]	214.6927 (21706.1) [0.00989]
D(RGDP(-2))	-0.038698 (0.02793) [-1.38555]	38.05914 (916.668) [0.04152]	67470.57 (43288.4) [1.55863]	0.000248 (0.00020) [1.22012]	-5757.472 (21608.4) [-0.26645]	-0.000110 (0.00035) [-0.31332]	1586.821 (21686.5) [0.07317]
D(ICT(-1))	-1.18E-08 (7.2E-07) [-0.01635]	-0.166520 (0.02365) [-7.04044]	0.093861 (1.11693) [0.08403]	6.57E-09 (5.3E-09) [1.25193]	0.079367 (0.55754) [0.14235]	-5.04E-09 (9.1E-09) [-0.55431]	0.269034 (0.55956) [0.48080]
D(ICT(-2))	-5.26E-08 (4.2E-07) [-0.12488]	-0.058547 (0.01383) [-4.23457]	-0.004987 (0.65291) [-0.00764]	1.72E-10 (3.1E-09) [0.05601]	-0.059505 (0.32591) [-0.18258]	3.29E-09 (5.3E-09) [0.61967]	-0.161719 (0.32709) [-0.49442]
D(FDI(-1))	-9.24E-09 (1.7E-08) [-0.53578]	-0.000103 (0.00057) [-0.18246]	-0.244515 (0.02672) [-9.15132]	1.29E-11 (1.3E-10) [0.10250]	0.010123 (0.01334) [0.75898]	2.25E-12 (2.2E-10) [0.01035]	0.003951 (0.01339) [0.29519]
D(FDI(-2))	3.15E-08 (1.7E-08) [1.81816]	-0.000177 (0.00057) [-0.31248]	-0.310952 (0.02682) [-11.5922]	1.58E-11 (1.3E-10) [0.12405]	-0.022952 (0.01339) [-1.71414]	-1.76E-10 (2.2E-10) [-0.80876]	0.000589 (0.01344) [0.04385]
D(PDC(-1))	-2.407667 (3.90971) [-0.61582]	-22058.67 (128319.) [-0.17190]	418577.8 (6059687) [0.06908]	0.056939 (0.02849) [1.99864]	-2082967. (3024833) [-0.68862]	-0.055315 (0.04928) [-1.12240]	-529983.1 (3035768) [-0.17458]
D(PDC(-2))	-1.604850 (3.98393) [-0.40283]	125905.5 (130755.) [0.96291]	7150765. (6174717) [1.15807]	-0.092686 (0.02903) [-3.19281]	-26267.62 (3082253) [-0.00852]	-0.051559 (0.05022) [-1.02671]	486258.1 (3093396) [0.15719]
D(DA(-1))	-5.77E-09 (3.4E-08) [-0.16731]	0.000305 (0.00113) [0.27003]	-0.070898 (0.05342) [-1.32719]	-4.26E-11 (2.5E-10) [-0.16908]	-0.299677 (0.02667) [-11.2384]	6.09E-10 (4.3E-10) [1.40268]	0.008309 (0.02676) [0.31046]
D(DA(-2))	2.54E-08 (3.3E-08) [0.77299]	3.12E-05 (0.00108) [0.02890]	0.029250 (0.05097) [0.57388]	2.02E-10 (2.4E-10) [0.84282]	-0.286911 (0.02544) [-11.2772]	1.88E-10 (4.1E-10) [0.45323]	0.064052 (0.02553) [2.50853]
D(PSE(-1))	-3.505848 (2.30241) [-1.52269]	-78939.60 (75566.5) [-1.04464]	-1670385. (3568522) [-0.46809]	0.021037 (0.01678) [1.25394]	-95819.59 (1781311) [-0.05379]	-0.146706 (0.02902) [-5.05494]	-286704.9 (1787750) [-0.16037]
D(PSE(-2))	-5.402243 (2.55846) [-2.11152]	60897.99 (83970.2) [0.72523]	-164517.5 (3965377) [-0.04149]	-0.009406 (0.01864) [-0.50453]	271425.4 (1979410) [0.13712]	-0.165862 (0.03225) [-5.14303]	1136409. (1986566) [0.57205]
D(REM(-1))	2.45E-08 (3.8E-08) [0.64517]	-0.000484 (0.00125) [-0.38787]	0.136110 (0.05895) [2.30902]	5.25E-11 (2.8E-10) [0.18960]	0.370832 (0.02942) [12.6027]	-3.77E-10 (4.8E-10) [-0.78545]	0.188203 (0.02953) [6.37302]
D(REM(-2))	2.46E-09 (2.1E-08) [0.11518]	7.34E-05 (0.00070) [0.10481]	0.039669 (0.03306) [1.19973]	6.95E-11 (1.6E-10) [0.44683]	-0.152410 (0.01651) [-9.23411]	3.45E-11 (2.7E-10) [0.12819]	-0.000493 (0.01656) [-0.02975]
C	54.21382 (14.4696) [3.74675]	-1022714. (474900.) [-2.15354]	18867394 (2.2E+07) [0.84130]	0.323244 (0.10544) [3.06579]	26018929 (1.1E+07) [2.32422]	1.218562 (0.18239) [6.68102]	26145921 (1.1E+07) [2.32715]
R-squared	0.028442	0.270577	0.135381	0.017487	0.250626	0.039919	0.043949
Adj. R-squared	0.017231	0.262160	0.125405	0.006151	0.241980	0.028841	0.032918
Sum sq. resids	3.28E+08	3.54E+17	7.89E+20	17430.74	1.97E+20	52161.52	1.98E+20
S.E. equation	502.5210	16493041	7.79E+08	3.661729	3.89E+08	6.334370	3.90E+08
F-statistic	2.537111	32.14867	13.57022	1.542542	28.98549	3.603502	3.984014
Log likelihood	-10044.32	-23729.15	-28802.19	-3567.357	-27887.83	-4288.597	-27892.58
Akaike AIC	15.28924	36.08686	43.79665	5.445832	42.40704	6.541941	42.41426
Schwarz SC	15.35224	36.14987	43.85965	5.508839	42.47005	6.604949	42.47727
Mean dependent	53.03759	-888955.3	21623596	0.350286	23092624	0.942103	34512864
S.D. dependent	506.9074	19200819	8.33E+08	3.673043	4.47E+08	6.427740	3.97E+08

Determinant resid covariance (dof adj.)	4.23E+74
Determinant resid covariance	3.89E+74
Log likelihood	-126081.8
Akaike information criterion	191.7946
Schwarz criterion	192.2632
Number of coefficients	119

A5: Variance Decomposition

Variance Decomposition of RGDP:

Period	S.E.	RGDP	ICT	FDI	PDC	DA	PSE	REM
1	502.5210	100.0000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
2	761.8709	99.87724	0.000130	0.007954	0.015419	0.000138	0.086024	0.013094
3	948.0203	99.46301	0.000648	0.043425	0.044188	0.013280	0.411931	0.023519
4	1101.170	99.28593	0.000990	0.063436	0.054539	0.019388	0.532224	0.043489
5	1235.703	99.24843	0.001353	0.058855	0.055067	0.020248	0.563127	0.052918
6	1357.017	99.21554	0.001654	0.058022	0.055816	0.022737	0.588881	0.057346
7	1468.274	99.18217	0.001896	0.060347	0.057373	0.024542	0.611861	0.061810
8	1571.705	99.16058	0.002123	0.060725	0.058389	0.025250	0.627923	0.065013
9	1668.753	99.14520	0.002341	0.060626	0.058989	0.026013	0.639657	0.067174
10	1760.444	99.13186	0.002545	0.061011	0.059539	0.026718	0.649273	0.069055

Variance Decomposition of ICT:

Period	S.E.	RGDP	ICT	FDI	PDC	DA	PSE	REM
1	16493041	3.33E-05	99.99997	0.000000	0.000000	0.000000	0.000000	0.000000
2	20295400	7.01E-05	99.91280	0.001826	0.005491	0.000206	0.070096	0.009514
3	22732828	9.85E-05	99.90351	0.003788	0.023826	0.001551	0.056081	0.011141
4	24670091	0.000352	99.89283	0.012512	0.026725	0.004683	0.047813	0.015088
5	26148349	0.000939	99.87660	0.025960	0.024281	0.006548	0.047049	0.018626
6	27299630	0.001565	99.85710	0.041843	0.022385	0.009381	0.046659	0.021065
7	28213270	0.002203	99.83038	0.062173	0.020959	0.013368	0.046801	0.024119
8	28944665	0.002927	99.79640	0.087418	0.020132	0.017518	0.048222	0.027381
9	29534320	0.003753	99.75621	0.116710	0.020050	0.022236	0.050512	0.030534
10	30012639	0.004666	99.70970	0.149987	0.020745	0.027687	0.053366	0.033849

Variance Decomposition of FDI:

Period	S.E.	RGDP	ICT	FDI	PDC	DA	PSE	REM
1	7.79E+08	0.354818	0.000302	99.64488	0.000000	0.000000	0.000000	0.000000
2	9.79E+08	0.231951	0.000625	99.50506	0.000159	0.004473	0.013514	0.244220
3	1.06E+09	0.414862	0.000604	99.01560	0.061049	0.043130	0.021227	0.443526
4	1.18E+09	0.389623	0.000572	98.87901	0.077192	0.093594	0.022238	0.537774
5	1.30E+09	0.344511	0.000604	98.86754	0.070095	0.088784	0.026722	0.601745
6	1.39E+09	0.342214	0.000623	98.81384	0.072520	0.089280	0.029744	0.651781
7	1.48E+09	0.340286	0.000637	98.76010	0.077420	0.099247	0.030682	0.691624
8	1.57E+09	0.330630	0.000675	98.73294	0.078241	0.102665	0.031865	0.722986
9	1.65E+09	0.324778	0.000715	98.71214	0.078836	0.103628	0.033106	0.746799
10	1.73E+09	0.321584	0.000751	98.69056	0.080126	0.106226	0.033907	0.766842

Variance Decomposition of PDC:

Period	S.E.	RGDP	ICT	FDI	PDC	DA	PSE	REM
1	3.661729	0.156703	0.027217	0.341121	99.47496	0.000000	0.000000	0.000000
2	5.330674	0.076684	0.023862	0.357209	99.47865	5.25E-05	0.062294	0.001248
3	6.397707	0.099948	0.021267	0.374994	99.42873	0.020261	0.049771	0.005027
4	7.290277	0.119430	0.018000	0.386203	99.38859	0.032311	0.038646	0.016819
5	8.097908	0.123035	0.016003	0.393706	99.38064	0.032582	0.032364	0.021670
6	8.834714	0.124600	0.014639	0.399419	99.37494	0.034469	0.028596	0.023337
7	9.513543	0.126346	0.013624	0.403573	99.36840	0.036847	0.025690	0.025517
8	10.14668	0.127756	0.012841	0.406223	99.36463	0.037887	0.023425	0.027241
9	10.74269	0.128807	0.012203	0.408382	99.36188	0.038719	0.021682	0.028327
10	11.30737	0.129641	0.011674	0.410354	99.35922	0.039561	0.020283	0.029273

Variance Decomposition of DA:

Period	S.E.	RGDP	ICT	FDI	PDC	DA	PSE	REM
1	3.89E+08	0.013631	0.032090	0.008041	0.079715	99.86652	0.000000	0.000000
2	5.28E+08	0.008563	0.047430	0.181281	0.154297	93.36263	0.003005	6.242792
3	5.77E+08	0.012912	0.053269	0.160915	0.180445	93.16853	0.002577	6.421348
4	6.42E+08	0.012494	0.065246	0.130202	0.174001	94.05281	0.005050	5.560194
5	7.08E+08	0.013212	0.073368	0.130392	0.179980	94.09804	0.004260	5.500752
6	7.59E+08	0.013698	0.080258	0.115182	0.188189	94.11697	0.003711	5.481988
7	8.09E+08	0.013553	0.088154	0.101724	0.189705	94.28603	0.003484	5.317350
8	8.58E+08	0.013755	0.095546	0.094327	0.191700	94.36812	0.003239	5.233314
9	9.02E+08	0.013962	0.102429	0.087780	0.194599	94.41149	0.002962	5.186778
10	9.45E+08	0.013980	0.109227	0.081316	0.196345	94.46788	0.002767	5.128481

Variance Decomposition of PSE:

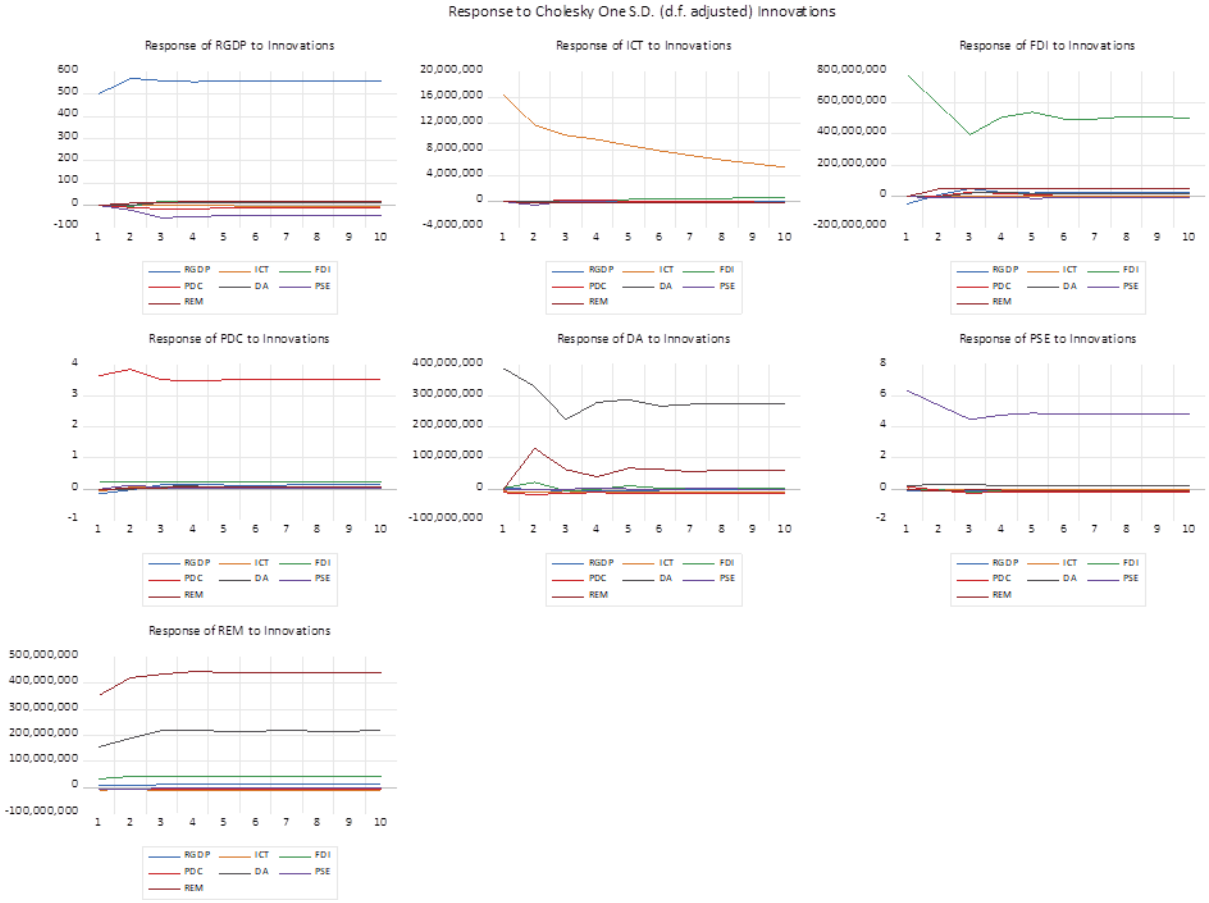
Period	S.E.	RGDP	ICT	FDI	PDC	DA	PSE	REM
1	6.334370	0.020892	0.002113	0.001023	0.065825	0.096812	99.81334	0.000000
2	8.334066	0.014367	0.006723	0.002556	0.044679	0.228083	99.67775	0.025843
3	9.473845	0.017812	0.005365	0.034806	0.113511	0.292018	99.51409	0.022395
4	10.60969	0.026331	0.004281	0.042432	0.123467	0.272660	99.50869	0.022135
5	11.68733	0.032239	0.003676	0.040046	0.118226	0.265123	99.51280	0.027886
6	12.64962	0.034862	0.003221	0.041496	0.118530	0.271081	99.50167	0.029138
7	13.53833	0.036711	0.002882	0.044019	0.120009	0.270950	99.49612	0.029305
8	14.37651	0.038464	0.002653	0.044762	0.120508	0.269521	99.49382	0.030270
9	15.16877	0.039854	0.002494	0.045137	0.120850	0.269763	99.49093	0.030975
10	15.92089	0.040911	0.002379	0.045781	0.121221	0.269807	99.48854	0.031357

Variance Decomposition of REM:

Period	S.E.	RGDP	ICT	FDI	PDC	DA	PSE	REM
1	3.90E+08	0.036917	0.071205	0.704834	0.023447	16.10139	0.024122	83.03809
2	6.07E+08	0.037104	0.044652	0.766780	0.032442	16.36425	0.031964	82.72280
3	7.81E+08	0.039634	0.046955	0.777728	0.031835	17.82962	0.020274	81.25396
4	9.27E+08	0.040610	0.048003	0.778087	0.031121	18.32464	0.014740	80.76280
5	1.05E+09	0.041031	0.047756	0.770357	0.031164	18.44526	0.012168	80.65227
6	1.16E+09	0.041284	0.047608	0.767721	0.031101	18.60344	0.010427	80.49841
7	1.26E+09	0.041358	0.047310	0.768591	0.031080	18.71646	0.009190	80.38601
8	1.36E+09	0.041451	0.046918	0.767462	0.031071	18.77937	0.008311	80.32541
9	1.45E+09	0.041549	0.046535	0.766124	0.031026	18.83415	0.007630	80.27299
10	1.53E+09	0.041600	0.046147	0.765759	0.030996	18.87995	0.007089	80.22845

Cholesky Ordering: RGDP ICT FDI PDC DA PSE REM

A6: Impulse Response



A7: Fixed Effects and Random Effects

Dependent Variable: RGDP
Method: Panel Least Squares
Date: 08/05/21 Time: 23:54
Sample: 1989 2019
Periods included: 31
Cross-sections included: 47
Total panel (balanced) observations: 1457

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	746.3595	206.2933	3.617953	0.0003
ICT	-1.87E-07	6.53E-07	-0.285664	0.7752
FDI	1.84E-07	4.61E-08	3.983516	0.0001
PDC	52.35356	5.030298	10.40765	0.0000
DA	9.68E-09	8.15E-08	0.118761	0.9055
PSE	-0.938424	3.144898	-0.298396	0.7654
REM	4.27E-08	2.78E-08	1.538008	0.1243

Effects Specification

Cross-section fixed (dummy variables)

Root MSE	1429.025	R-squared	0.708501
Mean dependent var	1608.040	Adjusted R-squared	0.697705
S.D. dependent var	2647.710	S.E. of regression	1455.747
Akaike info criterion	17.44012	Sum squared resid	2.98E+09
Schwarz criterion	17.63234	Log likelihood	-12652.13
Hannan-Quinn criter.	17.51184	F-statistic	65.62471
Durbin-Watson stat	0.157031	Prob(F-statistic)	0.000000

Dependent Variable: RGDP
Method: Panel EGLS (Cross-section random effects)
Date: 08/05/21 Time: 23:56
Sample: 1989 2019
Periods included: 31
Cross-sections included: 47
Total panel (balanced) observations: 1457
Swamy and Arora estimator of component variances

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	667.9630	338.3708	1.974056	0.0486
ICT	-2.72E-07	6.48E-07	-0.419490	0.6749
FDI	1.85E-07	4.60E-08	4.017706	0.0001
PDC	53.08418	4.906167	10.81989	0.0000
DA	-3.24E-08	8.04E-08	-0.403675	0.6865
PSE	0.413777	3.105048	0.133259	0.8940
REM	4.47E-08	2.75E-08	1.622628	0.1049

Effects Specification

	S.D.	Rho
Cross-section random	1855.283	0.6189
Idiosyncratic random	1455.747	0.3811

Weighted Statistics

Root MSE	1455.657	R-squared	0.105536
Mean dependent var	224.3994	Adjusted R-squared	0.101835
S.D. dependent var	1539.667	S.E. of regression	1459.167
Sum squared resid	3.09E+09	F-statistic	28.51377
Durbin-Watson stat	0.152154	Prob(F-statistic)	0.000000

Unweighted Statistics

R-squared	0.149634	Mean dependent var	1608.040
Sum squared resid	8.68E+09	Durbin-Watson stat	0.054119

A8: HAUSMAN TESTS

Correlated Random Effects - Hausman Test
Equation: Untitled
Test cross-section random effects

Test Summary	Chi-Sq. Statistic	Chi-Sq. d.f.	Prob.
Cross-section random	12.819583	6	0.0460

Cross-section random effects test comparisons:

Variable	Fixed	Random	Var(Diff.)	Prob.
ICT	-0.000000	-0.000000	0.000000	0.3000
FDI	0.000000	0.000000	0.000000	0.7617
PDC	52.353557	53.084183	1.233425	0.5106
DA	0.000000	-0.000000	0.000000	0.0018
PSE	-0.938424	0.413777	0.249065	0.0067
REM	0.000000	0.000000	0.000000	0.5620

Cross-section random effects test equation:
Dependent Variable: RGDP
Method: Panel Least Squares
Date: 08/05/21 Time: 23:59
Sample: 1989 2019
Periods included: 31
Cross-sections included: 47
Total panel (balanced) observations: 1457

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	746.3595	206.2933	3.617953	0.0003
ICT	-1.87E-07	6.53E-07	-0.285664	0.7752
FDI	1.84E-07	4.61E-08	3.983516	0.0001
PDC	52.35356	5.030298	10.40765	0.0000
DA	9.68E-09	8.15E-08	0.118761	0.9055
PSE	-0.938424	3.144898	-0.298396	0.7654
REM	4.27E-08	2.78E-08	1.538008	0.1243

Effects Specification

Cross-section fixed (dummy variables)

Root MSE	1429.025	R-squared	0.708501
Mean dependent var	1608.040	Adjusted R-squared	0.697705
S.D. dependent var	2647.710	S.E. of regression	1455.747
Akaike info criterion	17.44012	Sum squared resid	2.98E+09
Schwarz criterion	17.63234	Log likelihood	-12652.13
Hannan-Quinn criter.	17.51184	F-statistic	65.62471
Durbin-Watson stat	0.157031	Prob(F-statistic)	0.000000

A9: HETEROSCEDASTICITY TESTS

Panel Period Heteroskedasticity LR Test
Equation: UNTITLED
Specification: LNRGDP ICT FDI PDC DA PSE REM
Null hypothesis: Residuals are homoskedastic

	Value	df	Probability
Likelihood ratio	32.71253	47	0.9436

LR test summary:

	Value	df
Restricted LogL	-2725.851	1451
Unrestricted LogL	-2709.495	1451

A10: Serial Correlation

```
  FGLS regression
   Wald chi2(6)       =    457.08
   Prob > chi2        =    0.0000


Coefficients:  generalized least squares
  Panels:         homoscedastic
  no autocorrelation
       ln_rgdp        Coef.   Std. Err.       z    P>|z|     [95% Conf.
       Interval]
       ln_ict     .1086762    .008173    13.30   0.000     .0926574     .124695
       ln_fdi     .0030123   .0097881     0.31   0.758     -.016172    .0221967
       ln_pdc    -.0158172   .0084899    -1.86   0.062    -.0324571    .0008227
       ln_rem    -.0338025   .0094082    -3.59   0.000    -.0522423   -.0153628
         pse     -.0039494   .0079863    -0.49   0.621    -.0196022    .0117034
      ln_da       .0673308   .0147914     4.55   0.000     .0383402    .0963213
        _cons    -1.179789   .0487326   -24.21   0.000    -1.275303   -1.084275
```

A11: PANEL VECTOR AUTO-REGRESSION ESTIMATION ANALYSIS

Vector Autoregression Estimates
Date: 08/08/21 Time: 21:09
Sample (adjusted): 1991 2019
Included observations: 1363 after adjustments
Standard errors in ( ) & t-statistics in [ ]

	RGDP	ICT	FDI	PDC	DA	PSE	REM
RGDP(-1)	1.120354	-46.42691	111435.6	0.000301	-16073.43	0.000232	3652.350
	(0.02713)	(969.995)	(40873.2)	(0.00020)	(22942.6)	(0.00034)	(21061.9)
	[41.2932]	[-0.04786]	[2.72638]	[1.51201]	[-0.70059]	[0.67569]	[0.17341]
RGDP(-2)	-0.129273	56.68751	-92797.74	-0.000179	1677.004	-0.000239	-5955.383
	(0.02782)	(994.451)	(41903.7)	(0.00020)	(23521.1)	(0.00035)	(21592.9)
	[-4.64749]	[0.05700]	[-2.21455]	[-0.87801]	[0.07130]	[-0.67850]	[-0.27580]
ICT(-1)	-2.98E-08	1.010973	-0.195885	3.11E-09	-0.172393	-1.68E-09	0.023281
	(4.1E-07)	(0.01453)	(0.61238)	(3.0E-09)	(0.34374)	(5.1E-09)	(0.31556)
	[-0.07334]	[69.5641]	[-0.31987]	[1.04236]	[-0.50152]	[-0.32716]	[0.07378]
ICT(-2)	-6.42E-09	-0.108306	-0.023933	-2.36E-09	0.106024	1.08E-09	-0.017608
	(4.1E-07)	(0.01453)	(0.61230)	(3.0E-09)	(0.34369)	(5.1E-09)	(0.31552)
	[-0.01579]	[-7.45342]	[-0.03909]	[-0.79249]	[0.30848]	[0.21055]	[-0.05581]
FDI(-1)	-4.20E-09	-6.91E-06	0.646941	-2.85E-11	0.049164	-1.05E-11	0.018376
	(1.8E-08)	(0.00065)	(0.02740)	(1.3E-10)	(0.01538)	(2.3E-10)	(0.01412)
	[-0.23088]	[-0.01062]	[23.6070]	[-0.21352]	[3.19611]	[-0.04558]	[1.30128]
FDI(-2)	3.22E-08	-7.91E-05	-0.028295	-9.18E-11	-0.005898	-9.08E-11	0.003918
	(1.9E-08)	(0.00068)	(0.02866)	(1.4E-10)	(0.01609)	(2.4E-10)	(0.01477)
	[1.69241]	[-0.11635]	[-0.98731]	[-0.65828]	[-0.36664]	[-0.37754]	[0.26528]
PDC(-1)	-2.739278	-4192.732	654203.1	1.033132	-1869698.	-0.039631	-423116.6
	(3.83706)	(137180.)	(5780424)	(0.02812)	(3244625)	(0.04850)	(2978649)
	[-0.71390]	[-0.03056]	[0.11318]	[36.7398]	[-0.57624]	[-0.81721]	[-0.14205]
PDC(-2)	3.654096	6678.099	3276567.	-0.056888	1618185.	0.066200	-49596.67
	(3.88266)	(138810.)	(5849127)	(0.02845)	(3283188)	(0.04907)	(3014051)
	[0.94113]	[0.04811]	[0.56018]	[-1.99928]	[0.49287]	[1.34905]	[-0.01646]
DA(-1)	-1.24E-08	0.000540	0.027515	2.65E-11	0.733903	6.68E-10	0.047737
	(3.3E-08)	(0.00118)	(0.04973)	(2.4E-10)	(0.02791)	(4.2E-10)	(0.02562)
	[-0.37459]	[0.45745]	[0.55332]	[0.10975]	[26.2936]	[1.60051]	[1.86298]
DA(-2)	-1.49E-08	-0.000323	0.199558	1.46E-10	0.104465	-3.02E-10	-0.036813
	(3.4E-08)	(0.00121)	(0.05084)	(2.5E-10)	(0.02854)	(4.3E-10)	(0.02620)
	[-0.44055]	[-0.26742]	[3.92528]	[0.58873]	[3.66071]	[-0.70873]	[-1.40522]
PSE(-1)	-2.211021	-92836.45	-2576475.	0.032952	-498913.7	0.832503	170193.0
	(2.26385)	(80935.9)	(3410434)	(0.01659)	(1914320)	(0.02861)	(1757395)
	[-0.97666]	[-1.14704]	[-0.75547]	[1.98618]	[-0.26062]	[29.0963]	[0.09684]
PSE(-2)	3.738271	86926.67	3111462.	-0.017294	608109.3	0.106012	-51788.37
	(2.27075)	(81182.3)	(3420820)	(0.01664)	(1920149)	(0.02870)	(1762746)
	[1.64627]	[1.07076]	[0.90957]	[-1.03923]	[0.31670]	[3.69390]	[-0.02938]
REM(-1)	9.07E-09	-0.000109	0.090990	3.02E-11	0.108653	-1.83E-10	1.059031
	(2.1E-08)	(0.00076)	(0.03211)	(1.6E-10)	(0.01802)	(2.7E-10)	(0.01655)
	[0.42533]	[-0.14272]	[2.83351]	[0.19357]	[6.02792]	[-0.67766]	[64.0001]
REM(-2)	-1.45E-08	0.000113	-0.030890	-3.01E-11	-0.112929	1.13E-10	-0.037051
	(2.1E-08)	(0.00076)	(0.03194)	(1.6E-10)	(0.01793)	(2.7E-10)	(0.01646)
	[-0.68406]	[0.14912]	[-0.96700]	[-0.19352]	[-6.29819]	[0.42199]	[-2.25087]
C	-47.96777	339714.0	-1.04E+08	-0.631908	1.21E+08	4.583548	10567811
	(51.1791)	(1829722)	(7.7E+07)	(0.37507)	(4.3E+07)	(0.64683)	(4.0E+07)
	[-0.93725]	[0.18566]	[-1.34547]	[-1.68477]	[2.80176]	[7.08614]	[0.26599]
R-squared	0.967120	0.945475	0.587610	0.945929	0.720372	0.893010	0.967802
Adj. R-squared	0.966779	0.944908	0.583327	0.945368	0.717468	0.891899	0.967468
Sum sq. resids	3.30E+08	4.22E+17	7.49E+20	17717.35	2.36E+20	52693.57	1.99E+20
S.E. equation	494.6911	17685888	7.45E+08	3.625387	4.18E+08	6.252214	3.84E+08
F-statistic	2832.143	1669.601	137.1963	1684.444	248.0489	803.6651	2894.154
Log likelihood	-10382.43	-24672.59	-29771.49	-3681.963	-28984.39	-4424.763	-28867.81
Akaike AIC	15.25669	36.22538	43.70725	5.424743	42.55230	6.514693	42.38124
Schwarz SC	15.31411	36.28280	43.76467	5.482162	42.60972	6.572111	42.43866
Mean dependent	1660.613	7159329.	4.29E+08	16.00349	6.02E+08	68.11978	4.37E+08
S.D. dependent	2714.106	75350086	1.15E+09	15.51061	7.87E+08	19.01598	2.13E+09

Determinant resid covariance (dof adj.)	4.64E+74
Determinant resid covariance	4.29E+74
Log likelihood	-130652.4
Akaike information criterion	191.8671
Schwarz criterion	192.2690
Number of coefficients	105

A12: Generalised Method of Moments

One-step results:

```
------------------------------------------------------------------------------
       RGDP |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
       RGDP |
        L1. |  -.1001904   .0168777    -5.94   0.000      -.13327   -.0671107
            |
         DA |  -1.04e-06   7.64e-08   -13.58   0.000    -1.19e-06   -8.88e-07
        ICT |  -1.05e-06   7.75e-07    -1.36   0.175    -2.57e-06    4.67e-07
        FDI |   3.41e-07   6.78e-08     5.02   0.000     2.08e-07    4.74e-07
        REM |   3.94e-08   2.86e-08     1.38   0.168    -1.66e-08    9.54e-08
        PSE |   25.79618   3.131877     8.24   0.000     19.65782    31.93455
        PDC |   52.30378    3.63628    14.38   0.000      45.1768    59.43075
      _cons |  -349.1827   207.5493    -1.68   0.092    -755.9718    57.60641
------------------------------------------------------------------------------
Instruments for differenced equation
        GMM-type: L(2/.).RGDP
        Standard: D.DA D.ICT D.FDI D.REM D.PSE D.PDC
Instruments for level equation
        GMM-type: LD.RGDP
        GMM-type: LD.RGDP
```

Two-step results:

```
------------------------------------------------------------------------------
             |               WC-Robust
      lnRGDP |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
```

RGDP |						
L1. |	.8204205	2.083334	0.39	0.694	-3.262839	4.90368
DA |	.0627944	.5780719	0.11	0.913	-1.070206	1.195795
ICT |	.014251	.4284014	0.03	0.973	-.8254004	.8539024
FDI |	.0197158	.1012902	0.19	0.846	-.1788093	.218241
REM |	.0126712	.2122473	0.06	0.952	-.4033259	.4286682
PSE |	.0143555	2.599126	0.01	0.996	-5.079838	5.108549
PDC |	-.0511204	.6981071	-0.07	0.942	-1.419385	1.317144
_cons |	-.5495525	6.90933	-0.08	0.937	-14.09159	12.99249

A13: Post-Estimation Tests GMM

Arellano-Bond test for zero autocorrelation in first-differenced errors

Order	z	Prob > z
1	-3.288	0.0010

H0: no autocorrelation