The Impact of Domestic Savings, Financial Depth, and Financial Innovation on Economic Growth in Sub-Saharan African Countries

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Declaration

I, Rachel Grace Amalachuku Macauley, hereby declare that this thesis is my original work. Where other people's work is used, acknowledgements have been made. I declare that neither this work, nor a part of it has been previously submitted for the award of a degree in this or any other university.

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Date: ____22/07/2024_____

Abstract

This thesis empirically examines issues related to the impact of the financial sector on economic growth. Specifically, the three papers of this thesis presented in separate chapters are: 1) domestic savings and economic growth, 2) financial depth and economic growth, and 3) financial innovation and economic growth.

The first paper: **'Domestic savings and economic growth'** investigates the threshold effect of domestic savings on economic growth in the Sub Saharan African (SSA) countries. This paper examines at what point do excessive domestic savings have detrimental effects on economic growth and in which cases can domestic savings be classified as excessive domestic savings. The dynamic panel threshold model is employed to empirically examine the threshold effect of domestic savings on economic growth. Using data from 35 SSA countries between the period of 1980 and 2022, this study concludes that there is a threshold effect in the relationship between domestic savings and economic growth. This means that domestic savings promote economic growth if domestic savings are below the threshold. Conversely, domestic savings may have positive but insignificant effects on economic growth if they are above the threshold. However, the threshold effects on economic growth are dynamic, it should be revised as countries move from one income level to another, for instance low-income countries may move to a middle-income or upper-income category, which may increase the countries' domestic saving rates and may require higher thresholds.

Keywords: Domestic savings, economic growth, Sub-Saharan Africa (SSA), dynamic panel threshold model.

The second paper: **'Financial depth and economic growth'** examines the impact of financial depth on economic growth in Ebola-affected SSA countries, namely Liberia, Sierra Leone and Guinea. This paper examines the impact of financial depth on economic growth before-during-and-after a public health crisis. To get a clear picture on whether the Ebola period resulted in different dynamics in the relationship between financial depth and economic growth, this study examines two samples: the full sample (spanning from 1980 to 2022 comprises of the pre-and-post Ebola and COVID-19 eras) and the pre-Ebola era (1980 – 2014 which excludes the public health crisis period). The results show that the positive relationship between financial depth and economic growth in the pre-Ebola period is stronger than in the full sample. This difference means that financial depth significantly promoted economic

growth before the public health crisis, and that the Ebola crisis did not only claim lives but also impacted the financial depth–economic growth relationship. Therefore, the main finding of this study is that financial depth positively impacts economic growth; however, infectious diseases such as Ebola can disrupt the relationship. The Toda Yamamoto (1995) Granger causality results depict that a unidirectional causality from financial depth to economic growth is found in Guinea and Liberia while a bidirectional relationship exists between financial depth and economic growth in Sierra Leone.

Keywords: Financial depth, economic growth, Guinea, Liberia, Sierra Leone, Ebolavirus disease, Toda Yamamoto (1995) Granger causality, ordinary least square

The third paper: **'Financial innovation and economic growth'** considers the symmetric (same magnitude) and asymmetric (different magnitude) impacts of financial innovation on economic growth in SSA countries. The asymmetric impact, unlike the symmetric impact, decomposes financial innovation into positive and negative components to examine how economic growth reacts to these components of financial innovation. This study employs the linear autoregressive distributed lag (ARDL) model to test for the symmetric relationship between financial innovation and economic growth. The non-linear autoregressive distributed lag (NARDL) model tests for the asymmetric relationship between the two variables. Using data from 20 SSA countries between the period of 1990 and 2020, this study concludes that financial innovation has a symmetric impact on economic growth in SSA, the relationship is positive and statistically significant in the long-run. The result of the asymmetric impacts of the two variables shows that an increase in financial innovation has a positive and significant impact on economic growth in both the short-run and long-run. In the long-run, a decrease in financial innovation has a negative asymmetric relationship with economic growth.

Keywords: Financial innovation, economic growth, SSA, autoregressive distributed lag (ARDL) model and non-linear autoregressive distributed lag (NARDL) model.

Dedication

This thesis is dedicated to:
My Lord and Saviour Jesus Christ, for upholding me during my brokenness,
My mother: Blanche Macauley,
My husband: Lindsey Thomas,
My daughter: Grace Thomas and
My siblings: Stephen Macauley, Olivet and Magnus Williams.

I also dedicate this work to my deceased relatives:
My daughter: Esther Thomas (born 25/02/2018 and passed on 13/07/2018) and
My father: Victor Macauley (passed on 05/02/2022).
Both passed on in South Africa while I was pursuing my PhD degree.
I love you both in living and in death.

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List of acronyms

ADF	Augmented Dickey Fuller
ARDL	Autoregressive Distributed Lag
NARDL	Nonlinear Autoregressive Distributed Lag
GDP	Gross Domestic Product
SADC	Southern African Development Community
SSA	Sub-Saharan Africa
WDI	World Development Indicators
PMG	Pooled Mean Group
PP	Phillips Perron
SDG	Sustainable Development Goals
GMM	Generalized Method of Moments
IPS	Im-Pesaran-Shin
PCA	Principal Component Analysis
BRICS	Brazil, Russia, India, China and South Africa
STAR	Smooth Transition Autoregressive
OLS	Ordinary Least Square
MENA	Middle East and North Africa
ECOWAS	Economic Community of West African States
OIC	Organisation of Islamic Cooperation
OECD	Organisation for Economic Co-operation and Development
EU	European Union

Table of Contents

List of Tables

List of Figures

CHAPTER 1

INTRODUCTION

1.1 Introduction and background

This thesis focuses on three interrelated issues: aggregate domestic savings, financial depth, and financial innovation. Aggregate domestic savings are typically defined as a country's gross domestic product (GDP) less its total consumption expenditure. This definition comprises private and public savings. According to the World Bank Group (2024), financial depth is the total size of banks, other financial markets, and financial institutions in a nation relative to the nation's economic growth. Financial depth is not limited to the size of the commercial banks but includes non-bank financial institutions such as insurance companies, pension funds, and exchange bureaus. Financial innovation, on the other hand, is the creation of new financial instruments, products, or institutions and includes mundane financial improvements such as new financial reporting procedures, improvements in data processing, and credit scoring (Laeven, Levine & Michalopoulos, 2015:3).

Poverty remains a major challenge in Sub-Saharan Africa (SSA). About 80% of people living in extreme poverty reside in South Asia and in SSA (United Nations Development Programme, 2023). In recent years, new threats to the eradication of poverty in SSA have emerged including the Covid-19 pandemic, political conflicts and instability, and climate change. The population growth rate in SSA is alarming and the high fertility rate poses a threat to SSA's economic growth. Africa's population will increase to about 3.8 billion by the year 2100 (Sustainable Development Goals Center for Africa, 2017). Although SSA has a significant amount of rich natural resources, the region still struggles with basic infrastructure, health delivery, and infectious diseases.

To address these challenges, the United Nations (UN) set out 17 Sustainable Development Goals (SDGs) as a universal call to eradicate poverty by the year 2030. The UN SDGs feature inclusion, innovation, finance, and savings as strategies to achieve five of the 17 SDG goals by the year 2030. Financial innovation, financial depth, and domestic savings, specifically, support the first SDG of eradicating extreme poverty, the second of zero hungry, the third of good health, the eighth of economic growth, and the 10th of reducing inequalities. For example, one of the goal targets of SDG8 (economic growth) is to promote development-

oriented policies that support job creation, innovation, and access to financial services. Hence, financial innovation, domestic savings, and financial depth enhance the SDGs by promoting access to economic resources and financial and healthcare services by supporting research and development and by improving the standards of living.

The African Union's Agenda 2063 presents the continent's plan for inclusive growth and sustainable development by the year 2063. Agenda 2063 (African Union Commission, 2015) focuses on three broad aspects: the "Africa we want by 2063" vision, "what must be done to attain the vision" goals, targets, and strategies, and the "making it happen" position. Financial depth, domestic savings and financial innovation are identified as tools in achieving Africa's Agenda 2063. For example, though external mobilisation of resources (such as aid, foreign direct investment, and debt relief) is essential, the mobilisation of domestic resources through domestic savings, investment, productive government expenditure, innovation, and taxation are highlighted as key strategies in achieving Agenda 2063. In addition, the COVID-19 pandemic reawakened the need for digital finance, innovation, inclusion, depth, and savings. During the pandemic, internet banking and online purchases were highly utilised in SSA. However, the pandemic exposed the inequality and fragility among countries in SSA.

In light of this background, this thesis empirically examines issues related to the impact of the financial sector on economic growth. Specifically, the three papers of this thesis focus on 1) domestic savings and economic growth, 2) financial depth and economic growth, and 3) financial innovation and economic growth.

1. Domestic savings and economic growth

The relationship between domestic savings and economic growth can be viewed from both theoretical and empirical perspectives. There are two strands of the theoretical literature on the relationship between savings and economic growth. The first strand of literature is by Solow and Swan model (1956) and explains the role of savings on economic growth in a closed economy (that is, with no government or international trade). The Solow-Swan model (1956) indicates that savings affect the steady state growth level or equilibrium level—the state in which output growth rate is constant. An increase in the saving rate leads to an increase in capital accumulation, which brings about a temporary increase in the growth rate of output.

The second strand of literature indicates that in an open economy, countries that have high savings might still borrow from abroad to finance domestic investment due to capital

scarcity, that is limited financial resources and underdeveloped infrastructures. Similarly, Claus et al. (2001) record that in an open economy where there are inflows of international capital, domestic saving hinders neither investment nor growth. Firms can finance investment through either domestic savings or foreign savings in an open economy. The barriers to foreign capital such as business permit restrictions and tax regulation might impede economic growth but not necessarily domestic savings (Claus et al., 2001).

The empirical contributions to the relationship between savings and economic growth can be divided into various strands such as 'savings-led growth', 'growth-driven savings', 'the relevance of domestic savings in developing countries', and 'the negative impact of savings on economic growth'. The 'savings-led growth' model is the traditional perspective, which states that higher savings lead to higher economic growth through investment. Studies such as De Gregorio (1992), Jappelli and Pagano (1994), Alguacil, Cuadros and Orts (2004), Patra et al. (2017), Misztal (2011), Mehrara and Maysan (2013), Keho (2019), and Ribaj and Mexhuani's (2021) all agree with the traditional wisdom of the savings-led growth relationship. For instance, Bankole and Falai (2014) analyse data from SSA countries and find that saving leads to economic growth. The researchers therefore suggest that policymakers in SSA should promote domestic savings policies to enhance economic growth.

Advocates of the 'growth-driven savings' approach are of the view that savings are a reflection of economic growth, meaning an increase in economic growth leads to higher savings. Studies such as those by Sinha (1999), Sinha and Sinha (2008), Carroll and Weil (1994), Saltz (1999), Odhiambo (2007), Alomar (2013), and Mohanty (2018) support the 'growth-driven savings' view. These studies find that causality flows from economic growth to savings and not vice versa. A recent study by Van Wyle and Kapingura (2021) supports the findings that the direction of causality runs from economic growth to domestic savings in the case of South Africa. However, other scholars have found a bidirectional causal link between domestic savings and economic growth (Anorou & Ahmad, 2001, Mistzal, 2011, Najarzadeh, Reed & Tasan, 2014, Nesrine, 2020, Chakraborty, 2023).

In contrast, studies such as those by Mavrotas and Kelly (2001), Hundies (2014), and Sothan (2014) dispute all the above findings and conclude that no causal relationship exists between savings and economic growth. Romer (1990) and Aghion and Howitt (1992) emphasise that economic growth is driven by innovation, research, and development. Later, Aghion et al. (2016) elaborate why domestic savings matter for economic growth in developing

countries, explaining that in these environments, savings are essential for innovation, and thus, economic growth. This significance is because savings enable local entrepreneurs who are exposed to the domestic market to collaborate with foreign investors, who are more familiar with technological innovation. Domestic savings have been described as the main sources of investment, economic growth, inflation stability, and employment, especially in developing countries (Sahoo & Dash, 2013). On the negative impact of domestic savings on economic growth, studies report that excessive savings reduce consumption (Cashell, 2005) and slow down economic growth in the case of less developed financial markets (Lean & Song, 2009).

Although the above studies address the relationship between domestic savings and economic growth, the question that this study addresses is: at what point do excessive domestic savings have detrimental effects on economic growth and in which case can domestic savings be classified as excessive domestic savings? The savings–economic growth relationship has significant policy implications, because if higher savings boost economic growth, then policymakers will promote savings, which will in turn improve investments and thus economic growth. If the opposite occurs, policymakers will recommend and implement other growth determinants to boost economic growth. Some countries in Africa are high savers while other countries are moving towards high saving economies. According to the World Bank (2024) database, Gabon's gross domestic savings (% of GDP) for the year 2022 was 60%, whilst for the same year, Zambia's and the Republic of Congo's domestic savings rate were 50%, Tanzania and Seychelles accounted for 36%. Djibouti is the top saver in Africa with a domestic savings (% of GDP) of 84% as of 2022. In addition, there are high saving advanced economies such as Qatar (67.7%), Ireland (64.1%) and Singapore (60.1%), see World Bank (2024) data. High domestic savings rates do not imply high income countries. Therefore, it is vital for policymakers to have sound knowledge of the dynamic relationship between domestic savings and economic growth. Hence, further investigation of the savings–economic growth relationship in terms of threshold effects is required.

Motivated by the above background information, the research objective of this study is to investigate the threshold effect of domestic savings on economic growth in the SSA region. This thesis aims to fill the gap in the existing literature on domestic savings by contributing to the debate on the relationship between domestic savings and economic growth in four important ways. The first contribution this paper makes is to empirically examine the threshold effect in the relationship between domestic savings and economic growth. In this way, this paper examines at what point do excessive domestic savings have detrimental effects on

economic growth and in which cases can domestic savings be classified as excessive domestic savings?

The threshold analysis in the domestic savings and economic growth relationship is relevant because it not only provides a better understanding of how domestic savings impact on economic growth, but it also guides policymakers on the economic consequences of higher domestic savings. Furthermore, the global financial crisis of 2007–2008 and the ongoing Covid-19 pandemic have both caused policymakers to revisit the impact of domestic savings on economic growth. Policymakers tend to reexamine domestic savings during periods of financial crisis because the savings rate of developed countries tends to increase during financial uncertainties, as economic agents consume less and save more due to fear of unemployment (Juelsurd & Wold, 2019). The savings rate of some SSA countries slightly increased during the onset of the Covid-19 pandemic (2020–2021), as shown by the World Bank (2023) data, for instance, Benin's domestic savings (% of GDP) increased from 19.1% in 2018 to 28.9% in 2022. For the same years, Botswana's domestic savings increased from 27.4% to 30.4%. During the hit of the Covid-19 pandemic, some low saving countries experienced increase in their savings rate, for instance, Rwanda and Madagascar's domestic savings increased from 7.0% and 4.3% (in 2020) to 10.9% and 6.2% (in 2021) respectively.

The second way that this paper contributes to the literature is by examining the threshold effect of domestic savings on economic growth per individual country in SSA. The rationale for examining the sample per country is that countries in SSA are at different income levels (low-income, middle-income, and high-income). The overall domestic savings threshold effect may not reflect the threshold value for each country. As such, this study compares the overall threshold value for SSA to the threshold value per country. In addition, this study ranks the domestic threshold value per country and analyses the respective country's threshold values by the different income categories.

The third contribution this paper makes is in the methodological technique used to investigate the relationship between domestic savings and economic growth. Existing studies use techniques such as Granger causality, autoregressive distributed lag (ARDL), and ordinary least squares (OLS) to examine the relationship between domestic savings and economic growth (Ribaj & Mexhuani, 2021, Chakraborty, 2023). These techniques ignore the potential threshold effect of domestic savings on economic growth. Instead, this study uses the work of

Kremer, Bick and Nautz (2013), which is one of the latest dynamic panel threshold estimation techniques.

As will be further discussed in section 2.3.1., the advantages of using the dynamic panel threshold approach are that Kremer, Bick and Nautz's (2013) method is an extension and improvement of Hansen's (1999) original static panel threshold estimation. Hansen (1999) developed an appropriate threshold regression model for panel data. His model is suitable for static panels (excludes lagged variables) with individual specific fixed effects; that is, variables remain constant across time and for each individual. The model tests for a threshold by using the fixed effect transformation, wherein the presence of threshold is determined by OLS and the likelihood ratio test. A non-standard asymptotic distribution theory is developed which is used to estimate the confidence interval of parameters and to test the hypothesis. A bootstrap technique is used to determine the statistical significance of the threshold effect (Hansen, 1999).

The fourth contribution this study makes is that it focuses exclusively on SSA, a region in which all its countries are developing economies and where research on domestic saving and economic growth is essential for policymaking processes. The mobilisation of domestic resources through taxation, domestic savings, and domestic investment is a key policy issue in SSA. The goal of domestic resource mobilisation is to formulate effective policies and promote economic growth. As a result, new research on this topic focusing specifically on SSA is relevant.

Using data from 35 SSA countries between the period of 1980 and 2022, this study concludes that there is a threshold effect in the relationship between domestic savings and economic growth. This link means that domestic savings promote economic growth if the savings are below the threshold. Conversely, domestic savings may have positive but insignificant effects on economic growth if savings are above the threshold. In particular, domestic savings (% of GDP) below 31.15% (the estimated value) are associated with higher economic growth in SSA. Likewise, domestic savings (% of GDP) above the 31.15% threshold are associated with positive but insignificant economic growth in SSA. However, the threshold effects on economic growth are dynamic, it should be revised as countries move from one income level to another, for instance low-income countries may move to a middle-income or upper-income category, which may increase the countries' domestic saving rates and may require higher thresholds.

The policy implication of this study is that SSA's policymakers should be guided by the threshold level of domestic savings and may promote domestic saving activities to increase the size of domestic savings. Policymakers can utilise and control domestic savings amid high inflation through taxation. For instance, tax exemptions on some saving schemes such as pension saving funds can be used to encourage domestic savings. Governments can increase the size of domestic savings through government debt reduction and by reducing unproductive government expenditure. In addition, policymakers should create access to pension schemes as only 8.9% of the working-age population contributes to a pension fund in SSA (ILO 2021). However, higher domestic savings should be transmitted to productive activities such as investment for the expansion of economic growth. Chapter 2 of this paper presents more insights on this topic.

2. Financial depth and economic growth

Financial depth is important to the economy as it allows monetary policy to be more effective, because it gives the central bank a broader range of tools to manage monetary policy (Singh, 2011). Moreover, financial depth increases the potential of access to financial institutions. Thus, financial depth increases financial inclusion with all the benefit of the latter (financial inclusion). The advancement of a deeper financial system is supported by several global commitments such as the UN SDGs. The World Bank's Global Findex Database, one of the leading databases of financial inclusion, shows that in 2021, 76% of adults worldwide own an account at a bank or a regulated financial institution such as credit union, microfinance, or mobile money. Despite the increase in account ownership worldwide, there are still gaps in the financial sector, especially that financial depth in developing countries remains predominantly banks, operates underdeveloped stock markets and weak financial institutions. As such, a study on the extent of financial depth is essential.

Existing studies on the relationship between financial depth and economic growth mainly focus on the level of financial depth in a nation and its role on economic growth (Setiawan, 2015, Polenis, Stengos & Tzaremes, 2020, Shapoval, 2021). The results of these studies, as explained in Section 3.2. below, reveal that the main barrier to the low levels of financial depth in developing countries is due to poor institutional quality and lack of competition in the financial institutions. In addition, the results show that financial depth serves as a resource base for financial innovation, which in turn creates economic growth opportunities. Furthermore, the positive impact of financial depth on economic growth has

been well established in the literature; see for example Chukwu and Agu (2009), Mangwiro, Maradze and Nyoni (2020), and Khatri (2022).

However, the direction of causality between financial depth and economic growth remains inconclusive. Studies such as Chukwu and Agu (2009), Peia and Rosbazch (2014) and Ghildiyal, Pokhriyal and Mohan's (2015) support the existence of a unidirectional causality between financial depth and economic growth. That is, an increase in financial depth leads to a rise in economic growth with no feedback effect. Literature such as Stolbov (2017) illustrates that no causal relationship exits for major economies such as the US, Japan, Germany and France (Stolbov, 2017). However, Recent literature from emerging economies in Africa illustrates that financial depth yields a bidirectional causality with economic growth (Manasseh et al., 2024). That is, an increase in financial depth leads to a rise in economic growth, and an improvement in economic growth fosters financial depth. While the above studies address the relationship between financial depth and economic growth, the questions this study addresses are 1) Is financial depth beneficial to economic growth in low-income countries? and 2) Can infectious diseases such as the Ebola-pandemic influence the relationship between financial depth and economic growth?

According to the research surveyed, there is no existing study that analyses the pre-during-and-post-infectious disease's effects on the financial depth and economic growth relationship. Research related to public health crisis is important because it allows an investigation on the relationship between financial depth and economic growth over a period in which there is an expectation of higher financial market dislocation and limited provision of financial services.

Supported by the above background information, the research objective of this study is to investigate the impact of financial depth on economic growth in Ebola-affected SSA countries. This thesis aims to fill the gap in the existing literature on financial depth by contributing to the debate on the relationship between financial depth and economic growth in four important ways. Thus, the first contribution this paper makes is to empirically examine the impact of financial depth on economic growth—considering whether there is a difference in the impact of financial depth on economic growth before and 'pre-during-and-post' a public health crisis. The analysis of public health crisis in the financial depth and economic growth relationship is relevant because it can affect the economy beyond the crisis period.

The Covid-19 pandemic and the 2022 Monkeypox outbreak have stoked a keen interest in policymakers to the impact of infectious diseases on the financial sector. The 2014–2016 West African Ebola epidemic claimed 11,323 lives globally and 11,308 lives in the three highly affected West African countries (World Health Organization, 2023). Similar to the Covid-19 pandemic, the Ebola epidemic imposed traveling restrictions, lockdowns, curfews, isolation, social distancing, and quarantine on individuals in the affected countries. By examining the impact of financial depth on economic growth in the three Ebola-hit countries, namely Guinea, Sierra Leone, and Liberia, this paper serves as a relevant case study to examine the effect of health crises in the financial depth and growth nexus.

The second way that this paper contributes to the literature is by computing the financial depth index on the three highly Ebola-hit countries. Financial depth is board; no single indicator can provide a detailed measure on the level of financial depth. Using a single measure of financial depth makes it difficult for researchers and policymakers to form firm conclusions of the degree of financial depth across countries. Therefore, a financial depth index captures different aspect of financial depth and provides a detailed measure of financial depth. Furthermore, a financial depth index serves as a tool to rank financial depth across countries and to evaluate the progress made on financial depth within a country over a certain period of years. As described in Section 3.3. below, this study calculates a financial depth index that is then used to examine the impact of financial depth on economic growth and to determine the direction of causality between financial depth and economic growth in the Ebola-hit countries.

The third contribution this paper makes is the examination of the causal link between financial depth and economic growth for the countries examined. Literature addressing the causal relationship between financial depth and economic growth in SSA is generally scanty, and even lesser in the Ebola-hit countries. Some of these existing studies on this topic are panel studies, which group countries at different levels of financial depth and economic growth. This thesis addresses the causality between financial depth and economic growth from a country-specific angle. The Granger causality test originated by Granger (1969) tests whether one series significantly predicts another series, that is, whether lagged values of the predictor variable carry statistically significant information about the predicted variable, after controlling for lagged values of the predicted variable. Additionally, a variable is considered to Granger-cause another variable, if the former can help to forecast the latter and thus the mean squared error is lower with the additional information set. The test reveals the direction of causality, which

serves as a guide to policymakers in the implementation of financial depth and economic growth enhancing policies.

The fourth contribution is that the study focuses exclusively on low-income countries, specifically Guinea, Sierra Leone, and Liberia—the three worst-affected Ebola-hit countries. These three countries have similarities in that they are highly naturally resourced yet poor developing countries, have experienced civil wars, are prone to diseases outbreaks, and were highly affected by the Ebola-epidemic much more than the Covid-19 pandemic. These countries are mostly marginalised and hardly researched on. Since their economies are some of the poorest in the world, it is vital for policymakers to focus on advancing financial depth in these countries. Therefore, research on this topic focusing on these countries is relevant.

Using the ordinary least square estimation technique and the Toda Yamamoto (1995) Granger causality test and focusing on three-Ebola hit SSA countries between the period 1980 and 2022, this study finds that financial depth has a positive and statistically significant relationship with economic growth. To get a clear picture on whether the Ebola period resulted in different dynamics in the relationship between financial depth and economic growth, this study examines two samples: the full sample (spanning1980–2022) and the pre-Ebola era (1980–2014). The full sample consists of the pre-Ebola, Ebola, post-Ebola, and to some extent the Covid-19 pandemic eras. For all the eras (full sample and pre-Ebola) and for all the countries (Guinea, Liberia and Sierra Leone), the impact of financial depth on economic growth exhibits a positive sign and a statistically significant level.

However, the results show that the positive financial depth–economic growth relationship in the pre-Ebola period is stronger than in the full sample, which comprises of the pre-Ebola, Ebola and post-Ebola eras. This difference means that financial depth significantly promoted economic growth before the Ebola crisis, and that the Ebola crisis did not only claim lives but also impacted the financial depth–economic growth relationship. Therefore, the main finding of this study is that financial depth positively impacts economic growth; however, infectious diseases such as Ebola can disrupt the relationship.

Furthermore, the Granger causality results depict that a unidirectional causality from financial depth to economic growth is found in Guinea and Liberia. Hence, financial depth Granger causes economic growth in Guinea and Liberia, but economic growth does not Granger cause financial depth. Sierra Leone's Granger causality result shows that a

bidirectional relationship is found between financial depth and economic growth. Financial depth Granger causes economic growth, with a feedback effect in Sierra Leone. The policy implication based on the Granger causality result suggests that the three countries should implement more financial depth enhancing policies aim at increasing the access and usage of the financial sector, fostering competition among banks, and developing the stock market. Chapter 3 of this paper presents more insights on this topic.

3. Financial innovation and economic growth

Theoretical contributions to the financial innovation and economic growth relationship can be divided into two broad categories, namely 'innovation-growth' and 'innovation-fragility'. The 'Innovation-growth' view suggests that financial innovation such as electronic payments technologies, information exchange (credit reports and credit scoring), and securities (such as bonds and shares) improves the quality of banking services such as deposits, and offers diverse banking products, which in turn expand economic growth (Allen & Gale, 1991, Berger, 2003, Dynan, Elmendorf & Sichel, 2006). The 'innovation-fragility' perspective suggests that financial innovation creates financial fragility, that is, small financial shocks with detrimental effects (Allen & Carletti, 2006, Wagner, 2007, Gennaioli, Shleifer & Vishny, 2012). Financial innovation stimulates fire sales when both investors and intermediaries try to sell out cash flow securities with neglected risks, thereby creating financial fragility as evidenced in the 2007–2008 global financial crisis. Due to the lack of consensus on the relationship between financial innovation and economic growth, this paper empirically investigates the impact of financial innovation on economic growth.

Existing studies have examined the impact of financial innovation along various dimensions. Some studies, such as Attanasio, Guiso and Jappelli's (2002), focus on financial innovation and money demand while others explore financial innovation and welfare, for example Allen (2012). Additionally, Laeven, Levine and Michalopoulos (2015) and Xu, Qamruzzaman and Adow (2021), and Naeem et al. (2023) analyse financial innovation and economic growth. These studies highlight the high development rate of financial innovation in both developed and developing economies. Previous research uses diverse indicators to account for financial innovation: research and development spending, mobile money, banking sector credit to private sector to gross domestic product (GDP), and the ratio of broad money to narrow money (Bara, Mugano & Le Roux, 2016, Bernier & Plouffe, 2019, Laeven, Levine & Michalopoulos, 2015, Xu, Qamruzzaman & Adow, 2021, Calderon & Liu, 2003, Ahmad et

al., 2023). While these proxies do account for financial innovation, the movement (either positive or negative) of financial innovation on economic growth remains unanswered.

The questions this study addresses are 1) Does financial innovation have a symmetric (same magnitude) and asymmetric (different magnitude) impact on economic growth? 2) Are there short-run and long-run impacts of financial innovation on economic growth? The asymmetric disaggregates financial innovation into positive and negative changes to investigate how these changes in financial innovation improve or hamper economic growth. The symmetric does not decompose financial innovation into positive and negative changes but investigates the aggregate financial innovation impacts on economic growth. According to the research surveyed, there is no existing study that examines the symmetric and asymmetric impact of financial innovation on economic growth.

In macroeconomics, long run denotes the time over which firms can enter or leave an industry, the time wherein capital stock can be replaced and the period over which all prices, wage contracts, tax rates and expectations can fully adjust (Samuelson & Nordhaus, 2004). The opposite is true in the short run. In other words, short run is a period in which one of the factors of production remains unchanged (for example, capital) while long run is a time horizon in which all the factors of production are flexible (for example, when a firm purchases additional capital). The concept of short and long run is relevant to economic growth (and not just to firms) because it reveals how the economy absorbs and reacts to time horizon and volatility in financial innovation. Therefore, an investigation on the short run and long run impact of the financial innovation and economic growth relationship is relevant.

Motivated by the above background information, the research objective of this study is to investigate the impact of financial innovation on economic growth in SSA. This thesis aims to fill the gap in the existing literature on financial innovation by contributing to the debate on the relationship between financial innovation and economic growth in four important ways. The first contribution of the paper in this regard is to empirically examine the symmetric and asymmetric impacts of financial innovation on economic growth. The purpose is to ascertain if there is a presence of linear and nonlinear impacts in the financial innovation and economic growth relationship. The symmetric analysis of financial innovation on economic growth determines whether financial innovation positively or negatively impacts growth. The symmetric estimation examines if there is a presence of linear impact in the financial innovation and economic growth relationship. The asymmetric impact, unlike the symmetric

impact, decomposes financial innovation into positive (increase) and negative (decrease) components to examine how economic growth reacts to these components of financial innovation. The asymmetric estimation examines if there is a presence of nonlinear impact in the financial innovation and economic growth relationship.

The second contribution of this study is the investigation of the time-varying (short-run and long-run) relationship between financial innovation and economic growth. This is relevant because it presents whether the impact of financial innovation on economic growth experiences a temporal gain (short run) or long-term benefits or decline (long run). The third contribution of this study is to examine the asymmetric impacts of financial innovation on economic growth per country. The reason for estimating per country is to reveal how increase and decrease changes in financial innovation impact economic growth for the individual countries used in the sample. Lastly, this study focuses exclusively on SSA, a region that is exposed to relatively new financial innovative processes, operators, and products. SSA accounts for the highest cohort of mobile money (a type of financial innovation) users worldwide, with Kenya in East Africa taking the lead (Demirguc-Kunt et al., 2015, Anderson-Manjang & Naghavi, 2021). As such, a thesis on this topic focusing exclusively on SSA is relevant.

This study employs two panel econometric techniques, namely autoregressive distributed lag (ARDL) and nonlinear autoregressive distributed lag (NARDL). As will be described in section 4.3.3. ahead, the linear ARDL model tests for the symmetric relationship between financial innovation and economic growth. The nonlinear ARDL tests for the asymmetric relationship, that is the impact of the positive and negative changes of financial innovation on economic growth.

Using data from 20 SSA countries between the period 1990 and 2020, this study concludes that financial innovation has a symmetric impact on economic growth in SSA—the relationship is positive and statistically significant in the long run. The result of the asymmetric impact of the two variables shows that an increase in financial innovation has a positive and significant impact on economic growth in both the short-run and long-run. In the long-run, a decrease in financial innovation has a negative asymmetric relationship with economic growth. The policy implication of this study is that SSA should invest more in developing and promoting financial innovative products, processes, and institutions to enhance economic growth. Other forms of localised financial innovation targeting the underprivileged or disadvantaged groups of the respective populations should be implemented. Governments

should implement and reinforce policies that will advance financial innovation and promote economic growth. Chapter 4 of this study below presents more insights on this topic.

1.2 Overview of the thesis

The remainder of this paper is organised as follows: Chapter 2, which examines the threshold effect of domestic savings on economic growth. Chapter 3, which investigates the impact of financial depth on economic growth. Chapter 4, which examines the impact of financial innovation on economic growth. And finally, Chapter 5, which concludes this thesis.

CHAPTER 2

THRESHOLD EFFECT OF DOMESTIC SAVINGS ON ECONOMIC GROWTH: EVIDENCE FROM SUB-SAHARAN AFRICAN COUNTRIES

2.1. Introduction and background

Aggregate domestic savings is typically defined as gross domestic product (GDP) less total consumption expenditure of a country and this definition comprises of private and public savings. As discussed in Chapter 1, The relationship between domestic savings and economic growth can be viewed from both theoretical and empirical perspectives. There are two strands of the theoretical literature on the relationship between savings and economic growth. The first strand of literature is by Solow and Swan model (1956) and explains the role of savings on economic growth in a closed economy (that is, with no government or international trade). The Solow-Swan model (1956) indicates that savings affect the steady state growth level or equilibrium level—the state in which output growth rate is constant. An increase in the saving rate leads to an increase in capital accumulation, which brings about a temporary increase in the growth rate of output.

The second strand of literature indicates that in an open economy, countries that have high savings might still borrow from abroad to finance domestic investment due to capital scarcity, that is limited financial resources and underdeveloped infrastructures. Similarly, Claus et al. (2001) record that in an open economy where there are inflows of international capital, domestic saving hinders neither investment nor growth. Firms can finance investment through either domestic savings or foreign savings in an open economy. The barriers to foreign capital such as business permit restrictions and tax regulation might impede economic growth but not necessarily domestic savings (Claus et al., 2001).

The empirical contributions to the relationship between savings and economic growth can be divided into various strands such as ‘savings-led growth’, ‘growth-driven savings’, ‘the relevance of domestic savings in developing countries’, and ‘the negative impact of savings on economic growth’. The ‘savings-led growth’ model is the traditional perspective, which states that higher savings lead to higher economic growth through investment. Studies such as De Gregorio (1992), Jappelli and Pagano (1994), Alguacil, Cuadros and Orts (2004), Patra et al. (2017), Misztal (2011), Mehrara and Maysan (2013), Keho (2019), and Ribaj and Mexhuani’s

(2021) all agree with the traditional wisdom of the savings-led growth relationship. For instance, Bankole and Falai (2014) analyse data from SSA countries and find that saving leads to economic growth. The researchers therefore suggest that policymakers in SSA should promote domestic savings policies to enhance economic growth.

Advocates of the 'growth-driven savings' approach are of the view that savings are a reflection of economic growth, meaning an increase in economic growth leads to higher savings. Studies such as those by Sinha (1999), Sinha and Sinha (2008), Carroll and Weil (1994), Saltz (1999), Odhiambo (2007), Alomar (2013), and Mohanty (2018) support the 'growth-driven savings' view. These studies find that causality flows from economic growth to savings and not vice versa. A recent study by Van Wyle and Kapingura (2021) supports the findings that the direction of causality runs from economic growth to domestic savings in the case of South Africa. However, other scholars have found a bidirectional causal link between domestic savings and economic growth (Anorou & Ahmad, 2001, Mistzal, 2011, Najarzadeh, Reed & Tasan, 2014, Nesrine, 2020, Chakraborty, 2023).

In contrast, studies such as those by Mavrotas and Kelly (2001), Hundies (2014), and Sothan (2014) dispute all the above findings and conclude that no causal relationship exists between savings and economic growth. Romer (1990) and Aghion and Howitt (1992) emphasise that economic growth is driven by innovation, research, and development. Later, Aghion et al. (2016) elaborate why domestic savings matter for economic growth in developing countries, explaining that in these environments, savings are essential for innovation, and thus, economic growth. This significance is because savings enable local entrepreneurs who are exposed to the domestic market to collaborate with foreign investors, who are more familiar with technological innovation. Domestic savings have been described as the main sources of investment, economic growth, inflation stability, and employment, especially in developing countries (Sahoo & Dash, 2013). On the negative impact of domestic savings on economic growth, studies report that excessive savings reduce consumption (Cashell, 2005) and slow down economic growth in the case of less developed financial markets (Lean & Song, 2009).

Although the above studies address the relationship between domestic savings and economic growth, the question that this study addresses is: at what point do excessive domestic savings have detrimental effects on economic growth and in which case can domestic savings be classified as excessive domestic savings? The savings–economic growth relationship has significant policy implications, because if higher savings boost economic growth, then

policymakers will promote savings, which will in turn improve investments and thus economic growth. If the opposite occurs, policymakers will recommend and implement other growth determinants to boost economic growth. Some countries in Africa are high savers while other countries are moving towards high saving economies. According to the World Bank (2024) database, Gabon's gross domestic savings (% of GDP) for the year 2022 was 60%, whilst for the same year, Zambia's and the Republic of Congo's domestic savings rate were 50%, Tanzania and Seychelles accounted for 36%. Djibouti is the top saver in Africa with a domestic savings (% of GDP) of 84% as of 2022. In addition, there are high saving advanced economies such as Qatar (67.7%), Ireland (64.1%) and Singapore (60.1%), see World Bank (2024) data. High domestic savings rates do not imply high income countries. Therefore, it is vital for policymakers to have sound knowledge of the dynamic relationship between domestic savings and economic growth. Hence, further investigation of the savings–economic growth relationship in terms of threshold effects is required.

Motivated by the above background information, the research objective of this study is to investigate the threshold effect of domestic savings on economic growth in the SSA region. This thesis aims to fill the gap in the existing literature on domestic savings by contributing to the debate on the relationship between domestic savings and economic growth in four important ways. The first contribution this paper makes is to empirically examine the threshold effect in the relationship between domestic savings and economic growth. In this way, this paper examines at what point do excessive domestic savings have detrimental effects on economic growth and in which cases can domestic savings be classified as excessive domestic savings?

The threshold analysis in the domestic savings and economic growth relationship is relevant because it not only provides a better understanding of how domestic savings impact on economic growth, but it also guides policymakers on the economic consequences of higher domestic savings. Furthermore, the global financial crisis of 2007–2008 and the ongoing Covid-19 pandemic have both caused policymakers to revisit the impact of domestic savings on economic growth. Policymakers tend to reexamine domestic savings during periods of financial crisis because the savings rate of developed countries tends to increase during financial uncertainties, as economic agents consume less and save more due to fear of unemployment (Juelsurd & Wold, 2019). The savings rate of some SSA slightly increased during the onset of the Covid-19 pandemic (2020–2021), as shown by the World Bank (2023) data, for instance, Benin's domestic savings (% of GDP) increased from 19.1% in 2018 to

28.9% in 2022. For the same years, Botswana's domestic savings increased from 27.4% to 30.4%. During the hit of the Covid-19 pandemic, some low saving countries experienced increase in their savings rate, for instance, Rwanda and Madagascar's domestic savings increased from 7.0% and 4.3% (in 2020) to 10.9% and 6.2% (in 2021) respectively.

The second way that this paper contributes to the literature is by examining the threshold effect of domestic savings on economic growth per individual country in SSA. The rationale for examining the sample per country is that countries in SSA are at different income levels (low-income, middle-income, and high-income). The overall domestic savings threshold effect may not reflect the threshold value for each country. As such, this study compares the overall threshold value for SSA to the threshold value per country. In addition, this study ranks the domestic threshold value per country and analyses the respective country's threshold values by the different income categories.

The third contribution this paper makes is in the methodological technique used to investigate the relationship between domestic savings and economic growth. Existing studies use techniques such as Granger causality, autoregressive distributed lag (ARDL), and ordinary least squares (OLS) to examine the relationship between domestic savings and economic growth (Ribaj & Mexhuani, 2021, Chakraborty, 2023). These techniques ignore the potential threshold effect of domestic savings on economic growth. Instead, this study uses the work of Kremer, Bick and Nautz (2013), which is one of the latest dynamic panel threshold estimation techniques.

As will be further discussed in section 2.3.1., the advantages of using the dynamic panel threshold approach are that Kremer, Bick and Nautz's (2013) method is an extension and improvement of Hansen's (1999) original static panel threshold estimation. Hansen (1999) developed an appropriate threshold regression model for panel data. His model is suitable for static panels (excludes lagged variables) with individual specific fixed effects; that is, variables remain constant across time and for each individual. The model tests for a threshold by using the fixed effect transformation, wherein the presence of threshold is determined by OLS and the likelihood ratio test. A non-standard asymptotic distribution theory is developed which is used to estimate the confidence interval of parameters and to test the hypothesis. A bootstrap technique is used to determine the statistical significance of the threshold effect (Hansen, 1999).

The fourth contribution this study makes is that it focuses exclusively on SSA, a region in which all its countries are developing economies and where research on domestic saving and economic growth is essential for policymaking processes. The mobilisation of domestic resources through taxation, domestic savings, and domestic investment is a key policy issue in SSA. The goal of domestic resource mobilisation is to formulate effective policies and promote economic growth. As a result, new research on this topic focusing specifically on SSA is relevant.

Using data from 35 SSA countries between the period of 1980 and 2022, this study concludes that there is a threshold effect in the relationship between domestic savings and economic growth. This link means that domestic savings promote economic growth if the savings are below the threshold. Conversely, domestic savings may have positive but insignificant effects on economic growth if savings are above the threshold. In particular, domestic savings (% of GDP) below 31.15% (the estimated value) are associated with higher economic growth in SSA. Likewise, domestic savings (% of GDP) above the 31.15% threshold are associated with positive but insignificant economic growth in SSA. However, the threshold effects on economic growth are dynamic, it should be revised as countries move from one income level to another, for instance low-income countries may move to a middle-income or upper-income category, which may increase the countries' domestic saving rates and may require higher thresholds.

The policy implication of this study is that SSA's policymakers should be guided by the threshold level of domestic savings and may promote domestic saving activities to increase the size of domestic savings. Policymakers can utilise and control domestic savings amid high inflation through taxation. For instance, tax exemptions on some saving schemes such as pension saving funds can be used to encourage domestic savings. Governments can increase the size of domestic savings through government debt reduction and by reducing unproductive government expenditure. In addition, policymakers should create access to pension schemes as only 8.9% of the working-age population contributes to a pension fund in SSA (ILO 2021). However, higher domestic savings should be transmitted to productive activities such as investment for the expansion of economic growth.

The remainder of this chapter is organised as follows: Section 2.2, which presents the theoretical and empirical literature review of domestic savings on economic growth. Section 2.3, which describes the data, model specification and methodology used in this paper. Section

2.4, which reports the result of the threshold effect of domestic savings on economic growth. And finally, Section 2.5, which concludes this chapter.

2.2. Theoretical and empirical literature review—Domestic savings and economic growth

2.2.1. Theoretical literature

The theoretical link between savings and economic growth can be understood from the Solow-Swan (1956) model, the Engel and Kletzer (1989) model and the buffer-stock theory of savings developed by Carroll, Hall and Zeldes (1992).

The 1956 Solow-Swan growth model explains the role of savings on long-run economic growth within the neoclassical economic context. The Solow Swan model (1956) indicates that savings do indeed affect the steady-state growth level or equilibrium level; that is, the state in which output growth rate is constant. An increase in the saving rate leads to an increase in capital accumulation, which brings about a temporary increase in the growth rate of output. The main assumption of the Solow-Swan model is that there is a closed economy in operation (no government or international trade). Even though the model does not account for an open economy, it is still relevant as it identifies the role of savings in economic growth. The Solow-Swan model is one of the foundational models of the savings and economic growth link.

Furthermore, since the SSA countries have an open economy, this study considers the model proposed by Engel and Kletzer (1989) that explains the correlation between savings and investment, hence economic growth in an open economy. The model suggests that countries with high savings might still borrow from abroad to finance domestic investment due to capital scarcity (limited financial resources and underdeveloped infrastructures). Similarly, Claus et al. (2001) record that in an open economy where there are inflows of international capital, domestic saving does not hinder investment and growth. Firms can finance investment through either domestic savings or foreign savings in an open economy. The barriers to foreign capital such as tax regulations might impede economic growth and not necessarily domestic savings (Claus et al., 2001).

The buffer-stock theory of savings developed by Carroll, Hall and Zeldes (1992) is another model that explains the savings–economic growth relationship in an open economy.

The buffer-stock theory assumes that consumers hold assets as precautionary savings in the sense that the consumer saves to maintain a smooth consumption pattern in case there is unpredictable fluctuation in their income. In this model, consumers are both impatient and prudent when facing income uncertainty. Consumers are impatient in that if their income were certain, they would prefer to borrow to finance current consumption and repay the borrowed income with future income.

The consumer's prudent behaviour forces them to save their assets for precautionary motives. According to Carroll, Hall and Zeldes (1992), unemployment plays a role in the model: high unemployment expectation leads to high future income uncertainty, which in turn leads to a reduction in current consumption and an increase in buffer-stock and savings. Therefore, the buffer-stock theory of savings postulates that savings expand economic growth because an increase in unemployment expectation pushes consumers to save more, which subsequently leads to economic growth.

2.2.2. Empirical literature

Prior research as indicated below generally debates the causal relationship between domestic savings and economic growth. The debate remains centred on either 'savings-led growth' or 'growth-driven savings'—that is whether higher domestic savings cause economic growth or whether domestic savings are a reflection of economic growth. Table 2.1 provides a summary of the empirical literature on the relationship between domestic savings and economic growth.

The traditional perspective regarding the 'savings-led growth' association is that higher savings lead to higher economic growth through investment. Studies such as De Gregorio (1992), Jappelli and Pagano (1994), Alguacil, Cuadros and Orts (2004), Patra et al. (2017), Misztal (2011), Mehrara and Maysan (2013), Keho (2019), and Ribaj and Mexhuani's (2021) agree with the wisdom of the savings-led growth relationship. For instance, Bankole and Falai (2014) analyse data from SSA countries and find that saving leads to economic growth. The researchers therefore suggest that policymakers in SSA should promote domestic savings policies to enhance economic growth. Savings stimulate investment, production, and employment, which in turn significantly impacts economic growth in a developing country like Kosovo (Ribaj & Mexhuani, 2021).

Furthermore, domestic savings are described as the main sources of investment, economic growth, inflation stability, and employment, especially in South Asian countries such

as India, Pakistan, Bangladesh, Sri Lanka, and Nepal (Sahoo & Dash, 2013). In addition, Aghion et al. (2016) elaborate on why domestic savings matter for economic growth in poor countries. In poor countries, domestic savings matter for innovation and hence economic growth. This is because savings enable local entrepreneurs who are exposed to the domestic market to collaborate with foreign investors, who are more familiar with technological innovation. Similarly, although domestic savings and investment are positively correlated, low domestic savings are likely to constrain investment even if the economy is exposed to international capital flow (David et al., 2020).

However, studies such as those by Sinha (1999), Sinha and Sinha (2008), Carroll and Weil (1994), Saltz (1999), Odhiambo (2007), Alomar (2013), and Mohanty (2018) find that causality flows from economic growth to savings and not vice versa. These studies support the 'growth-driven savings' idea. Van Wyle and Kapingura's (2021) recent study supports the findings that the direction of causality runs from economic growth to domestic savings in the case of South Africa. Ellis and Worku (2015) establish that a causal relationship exists between economic growth and domestic savings in East African countries (Ethiopia and Uganda, specifically). However, the relationship is unidirectional, running from economic growth to domestic savings. Furthermore, studies such as those by Anorou and Ahmad (2001), Mistzal (2011), Najarzadeh, Reed and Tasan (2014), and Nesrine (2020) find the presence of bidirectional causality between domestic savings and economic growth. Studies by Mavrotas and Kelly (2001), Hundies (2014), and Sothan (2014) dispute the above findings and conclude that no causal relationship between savings and economic growth exists.

Although a series of previous studies are of the view that savings positively impact economic growth (see Irandoust & Ericsson, 2005, Hemmi, Tabata & Futagami, 2007; Aghion et al., 2016, Nesrine, 2020), the opposite can also be true. On the negative impact of domestic savings on economic growth, Cashell (2005) finds that higher savings reduce consumption and slow down economic growth in the short-run, but in the long-run, higher domestic savings will tend to foster domestic investment, which in turn will improve net exports and economic growth. Lean and Song (2009) state that excessive savings reduce economic growth in the case of less developed financial markets.

In developing countries, the conversion of savings into investment is harder due to the low financial development, less variety of financial instruments and small financial size. Therefore, in developing economies, savings are mainly used to provide loans to consumers

(Lean & Song, 2009). Recent studies focusing on South Africa show that the effect of domestic savings on economic growth is not only negative but insignificant (Van Wyk & Kapingura, 2021). A Similar conclusion was found by Joshi, Pradhan and Bist (2019) and Panthi (2021) in the case of Nepal in South Asia. Another recent study by Awino and Kioko (2022) shows that the contribution of the official development assistance aid improves economic growth and augments domestic savings.

Table 2.1. Selected empirical literature on the savings–growth relationship.

Author(s) and Year	Countries	Period	Method	Finding/Direction of Causality
Carroll and Weil (1994)	64 countries	1958–1987	Granger causality test	At the aggregate level, growth Granger causes saving but saving does not Granger cause growth.
Jappelli and Pagano (1994)	22 OECD countries	1960–1987	OLS	Liquidity constraints on households lead to an increase in savings rate, which in turn increases the growth rate.
Sinha (1999)	Pakistan	1960–1995	Granger causality	Existence of a positive long-run relationship between saving (private and total saving) and economic growth. A one-way causal relationship between economic growth and savings (private and total savings) exists. Total saving Granger causes economic growth, but private saving does not Granger cause economic growth.
Attanasio, Guiso and Jappelli (2002)	123 countries	1961–1994	Granger causality test, OLS, and GMM	Lagged saving rates are related to investment with a positive sign. Investment rates negatively Granger cause growth rates while growth rates positively Granger cause investment.
Anoruo and Ahmad (2001)	Democratic Republic of Congo (DRC), Cote d'Ivoire, Ghana, South Africa, Zambia, Nigeria, and Kenya	1960–1997	Cointegration test and vector error correction model	Economic growth Granger causes domestic savings in Ghana, Kenya, Nigeria, and Zambia. A bidirectional relationship exists between domestic savings and economic growth in Cote d'Ivoire and South Africa. A unidirectional causality runs from domestic savings to economic growth in the DRC.
Mavrotas and Kelly (2001)	India and Sri Lanka	1960–1967	Toda and Yamamoto	No causality is found between saving and economic growth in India, but a bidirectional causality between private saving and economic growth is found in Sri Lanka.

Krieckhaus (2002)	32 countries	1960–1980	Multiple regressions	Public savings influence economic growth in the cross-section countries. The same result is obtained when using Brazil as a case study.
Mohan (2006)	25 countries	1960–2001	Granger causality test	Causality runs from economic growth to savings and the level of income is insignificant in determining the direction of causality.
Sinha and Sinha (2008)	India	1950–2001	Multivariate Granger causality tests	Higher household, public, and corporate savings follow from higher economic growth and not vice versa.
Aghion et al. (2016)	118 countries	1960–2000	OLS	The result shows a positive association between lagged savings and the productivity growth in developing economies and not in developed economies.
Misztal (2011)	29 countries	1980–2010	Co-integration tests and Granger causality tests	Unidirectional causation runs from savings to economic growth for developed, developing, and transition countries.
Opschoor (2015)	84 countries	1970–2010	Granger causality, pooled mean group, and GMM	The direction of causality between savings and economic growth is ambiguous and depends on the level of income. Public savings (unlike private savings) positively and significantly affect economic growth.
Mohanty (2018)	Ethiopia	1976–2017	ARDL and Toda Yamamoto	Economic growth precedes and Granger causes savings; that is, economic growth leads to higher savings.
Keho (2019)	Cote d'Ivoire	1970–2016	Bound testing approach and Granger causality test	Domestic savings are positively and significantly related to economic growth. Savings Granger causes economic growth.
Ribaj and Mexhuani (2021)	Kosovo	2010–2017	Augmented Dicker Fuller and Granger causality tests	Domestic savings are positive and significant determinants of economic growth.
Chakrabory (2023)	BRICS countries	1992–2018	Granger causality and Dumitrescu-Hurlin panel tests	Bidirectional causality between savings and economic growth is found in BRICS countries.

2.3. Model specification, methodology, and the data—Domestic savings and economic growth

2.3.1. Model specification and methodology

The empirical model is based on the theoretical literature discussed above and the research conducted by Aghion et al. (2016) as the authors explain that domestic savings matter for economic growth since domestic savings allow local investors to co-finance businesses, thus mitigating agency problems and encouraging foreign investors to invest. Aghion et al. (2016) also propose the following linear equation to investigate the relationship between savings and growth:

$$GDP_{it} = \propto_0 + \beta GDS_{it} + \gamma X_{it} + \varepsilon_{it} \quad (1)$$

Where GDP_{it} is real GDP per capita growth rate, GDS_{it} is the saving rate, X_{it} is the control variables, ε_{it} is the error term, i = 1,…,N represents countries and t = 1…N represents time.

Using the dynamic panel threshold regression technique developed by Kremer, Bick, and Nautz (2013), Equation 1 is expressed in a dynamic panel threshold regression form as follows:

$$GDP_{it} = \mu_i + \beta_1 GDS_{it} I(GDS_{it} \leq \lambda) + \delta_{it} I(GDS_{it} \leq \lambda) + \beta_2 GDS_{it} I(GDS_{it} > \lambda) + \gamma X_{it} + \theta_t + \varepsilon_{it} \quad (2)$$

Where μ_i – country-specific fixed effect, θ_t – time effect and GDS_{it} – the level of domestic savings, which is the threshold variable. This variable splits the sample into regimes. λ – unknown threshold parameter, I(.) – indicator function, 1 – if the argument in the parenthesis is valid and 0 – otherwise. This allows the effect of domestic savings on economic growth to differ depending on whether domestic savings are below or above some unknown level of λ. X_{it} – m-dimensional vector of explanatory variables, including the lagged value of GDP and other endogenous variables. X_{it} takes the form of X_{1it} (exogenous variables uncorrelated with the error term and also includes the control variables) and X_{2it} (endogenous variables correlated with the error term and also includes the initial income that is, GDP_{it-1}). δ_{it}- allows for differences in regime intercepts. $\beta_1 \; and \; \beta_2$ – show the impact of domestic savings on economic growth for low/high levels of domestic savings regime. In addition to Equation 2, the model requires a suitable set of k ≥ m instrumental variables Z_{it} including X_{1it}. Also, GDS – gross domestic savings, GDP – real gross domestic product per capita growth rate, ε - error term, t – time and i – country.

According to Kremer, Bick and Nautz (2013), the estimation procedures are as follow: first, the individual effects, μ_i, are eliminated by using a fixed-effect transformation. Kremer, Bick and Nautz (2013), use the forward orthogonal deviations transformation proposed by

Arellano and Bover (1995) to eliminate the fixed effects. Second, to determine the threshold parameter (λ), the following steps are applied:

a) following Caner and Hansen (2004), a reduced form regression for the endogenous variables, X_{2it}, as a function of the instruments, Z_{it}, by the least square approach is estimated, obtaining the predicted value($\hat{X}_{2it}$);
b) the predicted value ($\hat{X}_{2it}$) is substituted into Equation 2 and the threshold parameter (λ) is then estimated by the least square method. The resulting sum of squared residuals is denoted as by $S(\lambda)$. This step is repeated for a strict subset of the support of the threshold variable, domestic savings; and
c) the estimator of the threshold value λ is selected as the one associated with the smallest sum of squared residuals that is, $\hat{\lambda} = argmin\, S_n(\lambda)$.

Third, according to Hansen (1999) and Caner and Hansen (2004), the critical values for determining the 95% confidence interval of the threshold value are expressed as:

$\Gamma = \{\lambda: LR(\lambda) \leq C(\alpha)\}$, where $C(\alpha)$ – 95% percentile of the asymptotic distribution of the likelihood ratio statistic $LR(\lambda)$. Lastly, the slope coefficient is estimated by the GMM method for the previously used instruments and the previously estimated threshold $\hat{\lambda}$.

The advantages of using the dynamic panel threshold approach are that Kremer, Bick and Nautz (2013), method is an extension and improvement of Hansen's (1999) original static panel threshold estimation. Hansen (1999) developed an appropriate threshold regression model for panel data. The threshold model specifies that the observations in a sample can fall into classes based on the value of an observed variable. Hansen's (1999) model is suitable for static panels (excludes lagged variables) with individual specific fixed effects, that is variables remain constant across time and for each individual. The model tests for a threshold by using the fixed effect transformation, wherein the presence of threshold is determined by ordinary least square (OLS) and the likelihood ratio test. A non-standard asymptotic distribution theory is developed, which is used to estimate the confidence interval of parameters and to test the hypothesis. A bootstrap technique is used to determine the statistical significance of the threshold effect (Hansen, 1999).

The technique by Kremer, Bick and Nautz (2013), improves Hansen's (1999) approach in the following ways: First, Hansen (1999) eliminates the individual effects or the country-specific effect of a static model through a fixed-effects transformation. Kremer, Bick and Nautz (2013), argue that in a dynamic model, fixed-effects transformation leads to inconsistent estimates because the lagged dependent variable correlates with the mean of the individual effects and all the transformed individual errors. As such, Kremer, Bick and Nautz (2013), address this issue by using the forward orthogonal deviations transformation method to eliminate the individual effects. With this method, the lagged dependent variable does not correlate with the error terms and thus there is no serial correlation of the transformed error term.

Second, Hansen's assumption (1999) that all regressors are exogenous (variables uncorrelated with error terms) is critical because regressors can be exogenous in growth regressions with panel data. Therefore, Kremer, Bick and Nautz (2013), improve the model by allowing endogenous regressors in the estimation of the threshold effects in a panel data setting. Kremer, Bick and Nautz's (2013) technique combines the Hansen (1999) approach and the cross-sectional instrumental variable (IV) threshold model by Caner and Hansen (2004), wherein the GMM type estimators are used to allow for endogeneity. Third, Hansen's (1999) model is only applicable to a balanced panel data whilst Kremer, Bick and Nautz's (2013) model is suitable for balanced and unbalanced datasets.

Kremer, Bick and Nautz (2013), apply the dynamic panel threshold model to empirically examine the impact of inflation on economic growth in industrialised and non-industrialised economies. Based on a total of 124 countries (23 industrialised and 101 non-industrialised countries), the empirical results confirm the presence of inflation threshold in the relationship between inflation and economic growth. For non-industrialised countries, the estimated inflation threshold rate is 17.2% whilst for industrialised economies, the estimated inflation threshold rate is 2.5%. Inflation threshold rates exceeding the 2.5%-point leads to a decline in economic growth for industrialised countries. However, there is no significant difference in the relationship between inflation and economic growth when the inflation threshold rates exceed 17.2% for non-industrialised countries.

2.3.2. Data

The panel data consists of annual data for 35 SSA countries between 1980 and 2022. The data is obtained from the World Bank's World Development Indicators (2024). The choice of the

number of countries and the period is based on the availability of data. The list of countries and a description of the variables used in this study are detailed in Appendices A2.1 and A2. 2. The dependent variable is real GDP per capita growth rate, which measures economic growth (also see Cave, Chaudhuri & Kumbhakar, 2020). Furthermore, other literature such as Anoruo and Ahmad (2001) uses real GDP per capita growth rate as a dependent variable in investigating the relationship between domestic savings and economic growth in a study of six African countries.

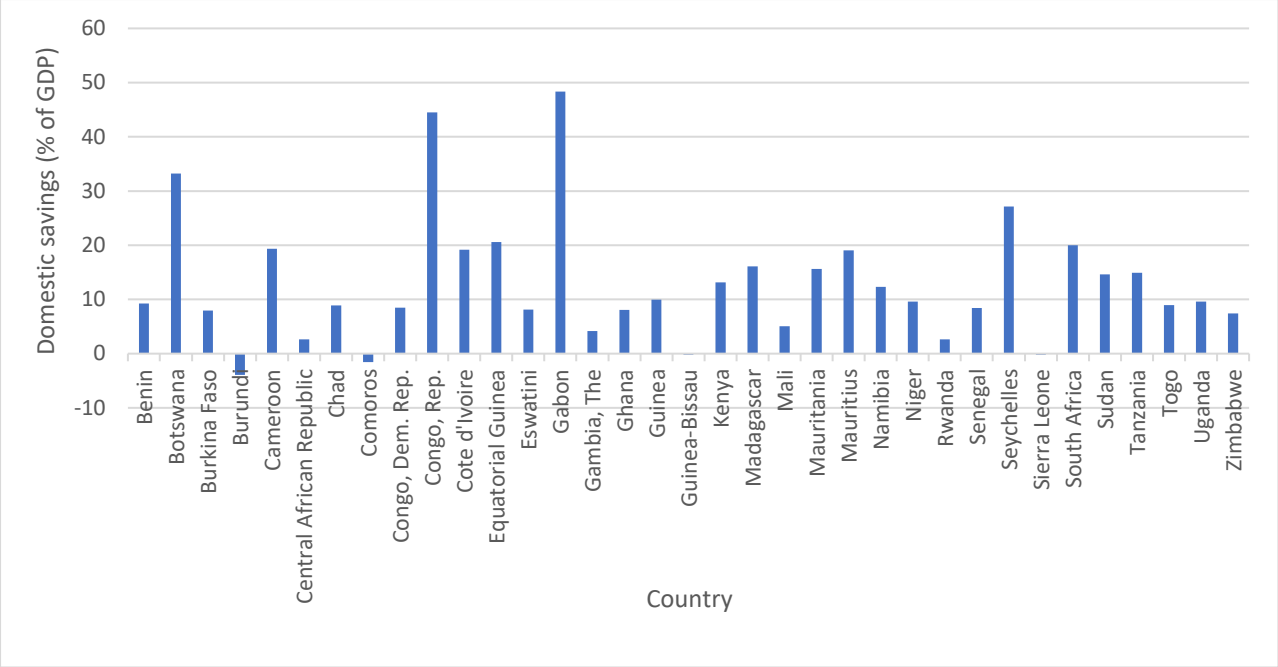
The main independent variable of interest in this study is domestic savings since it is the threshold variable. This study includes the following control variables: domestic credit to private sector to proxy for financial development, trade openness to proxy for the extent of openness in the economy, inflation to proxy for macroeconomic stability, government expenditure to measure the size of the government, capital formation to measure investment, foreign direct investment (FDI), and the initial real GDP per capita growth rate (lagged dependent variable).

2.3.2.1. Variables

Domestic savings

Domestic savings capture the difference between gross domestic products and total consumption expenditure. The causal relationship between domestic savings and economic growth can be bidirectional or unidirectional, as discussed in Section 2.2. of this paper above. Figure 2.1. in Appendix A2.4 shows the trend of domestic savings (% of GDP) for each SSA country. The figure shows that SSA experiences high and low levels of domestic savings over the years. In addition, Figure 2.2. below displays the average of domestic savings per country over the period 1980 through to 2022. According to Figure 2.2., in SSA, Gabon, ranks the highest, followed by Congo Democratic Republic, Botswana, and Seychelles. Sierra Leone, Guinea-Bissau, Comoros, and Burundi are ranked the least in terms of domestic savings in SSA.

Figure 2.2. Average domestic savings—35 SSA countries (1980 to 2022)



Source: Author's compilation, (average domestic savings rate from 1980 to 2022). Data from the World Bank's World Development Indicators database. Unit of measure: domestic savings (% of GDP).

Control variables:

Financial development

This study employs the widely used measure of financial development: domestic credit to private sector. Domestic credit to private sector is defined by the World Bank dataset (2024) as financial resources provided to the private sector by financial corporations. These corporations include monetary authorities and deposit money banks, as well as other financial corporations such as finance and leasing companies, money lenders, insurance corporations, pension funds, and foreign exchange companies. Domestic credit to private sector excludes public and government lending.

King and Levine's (1993) seminal work finds that increased financial development significantly leads to economic growth, physical capital accumulation, and improvement in economic efficiency. This positive relationship between financial development and economic growth is supported by a range of scholars including Calderon and Liu (2003) and Hermes and Lensink (2003). Another strand of the literature suggests that higher financial development may reduce economic growth because the financial sector, like the other sectors in the economy, is competing over scarce resources (Cecchetti & Kharroubi, 2012). Moreover, a

boom in the financial sector can be detrimental to economic growth, as was seen during the global financial crisis of 2007–2008.

Inflation

Inflation is measured by the consumer price index and accounts for macroeconomic stability. Studies conducted by Mahawiya (2015) and Barcola and Kebalo (2018) reveal that inflation has a threshold effect on economic growth, meaning that the former is beneficial to the latter up to a certain point, after which inflation can be detrimental to economic growth. In a study comparing countries in the Southern African Development Communities (SADC) and the Economic Community of West Africa States (ECOWAS), Mahawiya (2015) estimates that a 17.9% inflation threshold for ECOWAS countries and a 14.5% inflation threshold for SADC countries are required for financial development. In West Africa, Barcola and Kebalo (2018) conclude that the inflation threshold is between 8.01% and 15.46%. Inflation positively impacts economic growth when it is within that range, otherwise it bears a hindering effect.

Government expenditure

Government expenditure is an indication of the size of the government and fiscal stability. It does not necessarily imply a causal relationship with economic growth according to Wagner's (1958) law, which states that as the economy grows, there is a corresponding and inevitable increase in public sector spending relative to the overall economy. Depending on the productivity of government projects, government expenditure may have either a positive or negative impact on economic growth. Government expenditure that is focused on developmental activities such as education and infrastructure promote economic growth, while non-developmental activities may impede economic growth.

Gross fixed capital formation

Gross fixed capital formation is an indication of investment. Capital formation captures the value of fixed assets in the economy. In SSA, capital formation and economic growth have a bidirectional relationship. This means that as economic growth expands, so too does capital formation. Therefore, higher capital formation leads to higher economic growth (Uneze, 2013).

Trade openness

Trade openness is the sum of export and import as per GDP. It is expected to positively impact economic growth. Theoretical literature such as that of Thirlwall (2000) asserts that trade openness enables local entrepreneurs to gain access to international markets. It also promotes competition in an economy (Rajan & Zingales, 2003).

Foreign direct investment

Foreign direct investment (FDI) is measured by FDI's net inflows as per GDP. The impact of FDI on the receiving country's economic growth largely depends on the sector in which the investment is assigned (Melnyk, Kubatko & Pysarenko, 2014). A study by Alfaro (2003) reveals that FDI flows positively impact economic growth through the manufacturing sector, but through the primary/raw material sector, the relationship turns negative.

Table 2.2. presents the descriptive statistics of the variables used in the study, while Table A2.3. in the Appendix shows the correlation coefficient matrix of the threshold effect of domestic savings on economic growth.

Table 2.2. a) Descriptive statistics—Actual data

Variable (actual data)	N	Mean	Std.Dev.	Min	Max
Real GDP per capita growth rate	1526	1.027	6.826	-41.587	140.48
Domestic savings	1443	13.454	14.833	-48.508	83.287
Foreign direct investment	1515	2.697	6.901	-28.624	161.824
Domestic credit to private sector	1401	17.606	20.063	0.002	142.422
Inflation	1347	137.325	1197.796	0	38796.56
Government expenditure	1423	14.925	6.558	0	51.975
Capital formation	1431	20.137	9.519	-2.424	93.547
Trade	1448	64.427	33.843	2.699	235.82

N = number of observations, Std.Dev = Standard deviation, Min = Minimum, Max = Maximum.
Source: World Bank (2024) database

Table 2.2. b) Descriptive statistics—Log-transformed data

Variable (log-transformed data)	N	Mean	Std. Dev.	Min	Max
Log real GDP per capita growth rate	966	0.871	1.054	-5.023	4.945
Log domestic savings	1217	2.464	0.983	-5.843	4.422
Log FDI	1348	0.159	1.676	-8.927	5.087
Log domestic credit to private sector	1401	2.386	1.294	-6.429	4.959
Log inflation	1347	3.672	3.044	-26.218	10.566
Log government expenditure	1418	2.618	0.425	0.716	3.951
Log capital formation	1429	2.896	0.494	-1.228	4.538
Log trade	1448	4.042	0.503	0.993	5.463

N = number of observations, Std.Dev = Standard deviation, Min = Minimum, Max = Maximum.

Source: World Bank (2024) database

2.4. Results and analysis—Domestic savings and economic growth

2.4.1. Results of the domestic savings threshold for economic growth

Table 2.3. reports the empirical results of estimating the domestic savings threshold for economic growth for 35 SSA countries between the period 1980 to 2022. The estimated domestic savings threshold value is 31.15%, and the corresponding 95% confidence interval is [28.90 - 32.01]. The regime-dependent coefficients of domestic savings depict how they affect economic growth. We analyse the statistical significance and signs of the two regime-dependent domestic savings coefficients, $\hat{\beta}_1$ and $\hat{\beta}_2$. The impact of domestic savings on growth is positive and statistically significant if the domestic savings are lower than the threshold $(\hat{\beta}_1 = 0.02)$. This means that domestic savings accelerate economic growth if the savings are less than the threshold. In contrast, the impact of domestic savings on growth is statistically insignificant though positive, if the domestic savings are above the threshold $(\hat{\beta}_2 = 0.001)$. The finding shows that there is no significant relationship between domestic saving and economic growth when savings are above the threshold value. Instead, the coefficients of domestic savings indicate that their impact on economic growth is positive, greater and significant when domestic savings are below the threshold.

Based on Table 2.3, the central finding of this study that domestic savings positively impact economic growth in SSA corresponds with studies by Anoruo and Ahmad (2001), Keho (2019), and Van Wyk and Kapingura (2021). The finding is consistent with theory documented by Solow-Swan (1956). Savings foster investment, welfare, and reduced unemployment all of which positively contribute to economic growth. However, the positive relationship between domestic savings and economic growth is larger and significant when domestic savings are above the threshold. According to the research surveyed, there are scanty existing studies on the threshold effect of domestic savings on economic growth, however, this study is relevant because some countries in Africa are high saving economies and others are moving towards high saving rates, for example, according to the World Bank (2024) database, Gabon's gross domestic savings (% of GDP) for the year 2022 was 60%, whilst for the same year, Zambia's and the Republic of Congo's domestic savings rate were 50%, Tanzania and Seychelles accounted for 36%. Djibouti is the top saver in Africa with a domestic savings (% of GDP) of 84% as of 2022. In addition, there are high saving advanced economies such as

Qatar (67.7%), Ireland (64.1%) and Singapore (60.1%), see World Bank (2024) data. As such, a thesis on this topic (threshold effect of domestic savings and economic growth) is relevant. High domestic savings rates do not imply high income countries.

McKinnon (1973) and Shaw (1973) stated that as the level of financial development increases, the efficiency of financial institutions raises, which in turn increases savings, hence financial development play a role in savings, so this study compares its results to those in the literature on the threshold effect of financial development on economic growth. Similar to this study's findings, Ibrahim and Alagidede (2018) examine the threshold effect of financial development and economic growth for 29 SSA countries over the period 1980–2014, Ibrahim and Alagidede (2018) obtain a threshold value between 27% and 29%, wherein after this threshold, financial development becomes detrimental to economic growth. This study finds similar high threshold value of 31.15%, wherein domestic savings are beneficial to economic growth up to a certain level, after which they insignificantly contribute to economic growth. However, the threshold effects on economic growth are dynamic, it should be revised as countries move from one income level to another, for instance low-income countries may move to a middle-income or upper-income category, which may increase the countries' domestic saving rates and may require higher thresholds.

Although the data shows that some economies in Africa are high savers, majority of countries in Africa are low savers which could be explained by the unaccounted informal saving scheme that is predominant in this region. The relatively low domestic saving rates for some SSA countries could be explained by the rise of local investment in SSA and hence a fall in domestic savings. Countries in SSA have experienced a surge in technology and innovation, have local content policies, and organise local trade fairs to boost domestic investment. Another explanation for the relatively low domestic savings rate for some SSA economies is the inadequate mobilisation of domestic resources due to limited use of and access to the financial sector, poor institutional structures, and income inequality.

Table 2.3. Results of dynamic panel threshold estimations

Variable	
Threshold estimates	
$\hat{\lambda}$	31.147
95% confidence interval	[28.899 – 32.009]
Regime-dependent variables	
(Impact of domestic savings)	
$\hat{\beta}_1$ (coefficient below $\hat{\lambda}$)	0.0157**
	(0.0065)
$\hat{\beta}_2$ (coefficient above $\hat{\lambda}$)	0.0055
	(0.0064)
Regime-explanatory variables	
Initial real GDP per capita growth rate	-0.0015***
	(0.0398)
FDI	0.0057
	(0.0096)
Inflation	-0.0015**
	(0.0012)
Trade	0.0082***
	(0.0029)
Government expenditure	-0.0312**
	(0.0177)
Constant	0.7607**
	(0.3577)
Observations	590
Number of countries	35

Notes: The standard errors are in parentheses. Dependent variable: real GDP per capita growth rate (economic growth). ***significance at 1% level, **significance at 5% level, *significance at 10% level.

2.4.2. Country-specific results

This study acknowledges the fact that countries in SSA are at different income levels and that the overall threshold estimate for the entire SSA region may not depict the actual threshold level for an individual country. For this reason, this study splits the sample into low-income and middle- or high-income countries and estimates the domestic threshold effect for each SSA country in the sample. Out of the 35 countries in the sample, one country is a high-income economy, six countries are considered upper-middle-income, 13 are lower-middle-income, and 15 are low-income, as classified by the World Bank. The World Bank (2024) classifies countries as low-income when they exhibit a gross national income (GNI) per capita of USD 1,135 and below. Lower-middle-income economies accounts for a GNI per capital between USD 1,136 and USD 4,465. Countries with a GNI per capita between USD 4,466 and USD 13,845 are classified as upper-middle-income. Those countries with a GNI per capita of USD 13,846 and above are categorised as high-income economies.

The dynamic panel threshold technique by Kremer, Bick and Nautz (2013), is not compatible with timeseries data, hence this study uses the Smooth Transition Autoregressive (STAR) model to examine the threshold effect of domestic savings on economic growth per country. The STAR model is a commonly used nonlinear timeseries for estimating thresholds. In the STAR model, regime switching occurs in a smooth transition when an observed economic variable crosses the unobserved thresholds (Terasvirta, 1994).

The individual country results of the domestic saving threshold effects on economic growth are reported in Table 2.4. The threshold values range from 38.0 for Seychelles to 1.1 for Comoros. Low-income countries appear to have a low threshold level, while upper-middle-income countries tend to have a higher threshold (although there are exceptions). It can be concluded that income level is one of the determinants of domestic savings. Seychelles, the only high-income country in SSA, exhibits high domestic savings threshold of 38.0%. Similarly, all the upper-middle-income countries (Botswana, South Africa, Equatorial Guinea, and Gabon) account for high domestic savings thresholds with the exception of Mauritius and Namibia, which only exhibits a domestic threshold level of 13.0% and 6.1% respectively. Their income level may justify their relatively high domestic savings threshold values. Gabon, for instance, is an oil exporting nation, and its oil exports play a significant role in its high domestic savings and the country's income level. Although Mauritius and Namibia are upper-income-countries, they are not high savings countries, hence their consumption patterns might have driven the low domestic savings rate. Thus, the consumption level could also be one of the determinants of domestic savings.

For the lower-middle-income group, the domestic threshold levels of Comoros, Benin, Guinea, Mauritania, Ghana, and eSwatini rank far below when compared to other countries within the same lower-middle income category. As highlighted in Figure 2.2. of Section 2.3., low-income countries exhibit low domestic savings; therefore, it can be concluded that they also exhibit a low domestic saving threshold effect on economic growth. Countries such as Togo, Gambia, The and Burundi are all low-income countries, and they all exhibit a low domestic saving threshold level below 10%. Most of the low-income countries have informal savings culture, which contribute to the low savings rate. Generally, this study shows that domestic savings is a function of its country’s income level, meaning low-income countries exhibit low domestic savings and low savings threshold value. In contrast, Guinea-Bissau and Cameroon are low- and lower-middle-income countries with high savings thresholds. Hence, income level is not the only determinant of the savings behaviour in SSA. However, the threshold effects on

economic growth are dynamic, it should be revised as countries move from one income level to another, for instance low-income countries may move to a middle-income or upper-income category, which may increase the countries' domestic saving rates and may require higher thresholds.

Comparing the domestic savings threshold effect per country to the overall domestic savings threshold effect (31.15%) for SSA, the low-income level countries and the lower-middle-income countries, except for Guinea-Bissau, exhibit a threshold below the overall threshold effect for SSA. Seychelles, a high-income country in SSA exhibit a threshold level above the overall threshold values. All the upper-middle-income countries) except Botswana exhibit a threshold level above the below threshold value.

Table 2.4. Results of domestic savings threshold effects—Country-specific

Countries	Threshold	Income category	Region
Seychelles	38.0	High-income	East Africa
Mauritius	13.0	Upper-middle-income	East Africa
Botswana	36.7	Upper-middle-income	Southern Africa
Gabon	30.0	Upper-middle-income	Central Africa
Namibia	6.1	Upper-middle-income	Southern Africa
South Africa	21.8	Upper-middle-income	Southern Africa
Equatorial Guinea	21.2	Upper-middle-income	Central Africa
Eswatini	2.0	Lower-middle-income	Southern Africa
Cameroon	20.4	Lower-middle-income	Central Africa
Tanzania	18.0	Lower-middle-income	East Africa
Cote d'Ivoire	10.6	Lower-middle-income	West Africa
Senegal	17.5	Lower-middle-income	West Africa
Mauritania	3.7	Lower-middle-income	Central Africa
Congo Republic	30.0	Lower middle-income	Central Africa
Ghana	4.1	Lower-middle-income	West Africa
Kenya	15.9	Lower-middle-income	East Africa
Benin	1.4	Lower-middle-income	West Africa
Zimbabwe	10.1	Lower-middle-income	Southern Africa
Guinea	1.9	Lower-middle-income	West Africa
Comoros	1.1	Lower-middle-income	East Africa
Uganda	7.3	Low-income	East Africa
Sudan	9.7	Low-income	Central Africa
Madagascar	7.4	Low-income	East Africa
Burkina Faso	7.7	Low-income	West Africa
Burundi	3.3	Low-income	East Africa
Chad	9.2	Low-income	Central Africa
Central African Republic	1.2	Low-income	Central Africa
Congo, Democratic Republic	5.2	Low-income	Central Africa
Gambia, The	2.1	Low-income	West Africa
Guinea-Bissau	32.4	Low-income	West Africa
Mali	6.5	Low-income	West Africa
Niger	4.8	Low-income	West Africa
Rwanda	8.0	Low-income	East Africa
Sierra Leone	13.5	Low-income	West Africa
Togo	2.7	Low-income	West Africa

2.4.3. Robustness test

This study conducts robustness checks to test the sensitivity of the main result. These tests are additional control variables and increased instrumental variables. Table 2.5. presents the results of the robustness checks. Column 1 of Table 2.5. reports the first robustness check, which involves adding more control variables into the baseline specification. The additional control variables are growth determinant variables, and they include capital formation and domestic credit to the private sector. The results of column 1 of Table 2.5. are similar to that of Table 2.3. wherein the domestic savings threshold value remains the same at 31.15%. Furthermore, the two regime-dependent domestic savings coefficients, $\hat{\beta}_1$ and $\hat{\beta}_2$, correspond to the results reported in Table 2.3. above. $\hat{\beta}_1$ remains positive and significant below the threshold level, while $\hat{\beta}_2$ is positive and insignificant above the threshold level.

According to Roodman (2009), empirical results may depend on the number of instruments used. Thus, this study further examines the baseline regression by increasing the number of instruments. In addition to the single instrument (initial income/lag of real GDP per capita income) used in the specification, two more instrumental variables were added to examine the specification. The result reported in column 2 of Table 2.5. based on more instrumental variables is similar to the result of Table 2.3. based on a single instrumental variable. The domestic savings threshold value of 31.15%. remains the same. Therefore, the number of instruments used in this study has no significant effect on the result. Based on the robustness checks results presented in Table 2.5., this study concludes that the main result reported in Table 2.3. is indeed robust. Hence, a nonlinear relationship exists between domestic savings and economic growth.

Table 2.5. Results of dynamic panel threshold estimations—Additional control variables and increased instrumental variables

Variable	Additional explanatory variable (1)	More instrumental variables (2)
Threshold estimates		
$\hat{\lambda}$	31.147	31.147
95% confidence interval	[28.595 – 32.293]	[28.899 – 32.009]
Regime-dependent variables (Impact of domestic savings)		
$\hat{\beta}_1$ (coefficient below $\hat{\lambda}$)	0.0198***	0.0184***
	(0.0072)	(0.0065)
$\hat{\beta}_2$ (coefficient above $\hat{\lambda}$)	0.0076	0.0030
	(0.0069)	(0.0061)
Regime-explanatory variables		
Initial real GDP per capita growth rate	-0.0139*	-0.0034*
	(0.4118)	(0.0340)
FDI	0.0114	0.0083
	(0.0108)	(0.0096)
Inflation	-0.0051**	-0.0016*
	(0.0016)	(0.0012)
Trade	0.0097***	0.0078***
	(0.0033)	(0.0030)
Government expenditure	-0.0437**	-0.0417*
	(0.0195)	(0.0174)
Capital formation	-0.0108**	-
	(0.0087)	
Domestic credit to private sector	0.0024	-
	(0.0055)	
Constant	0.8457**	0.9305***
	(0.3753)	(0.3502)
Observations	554	590
Number of countries	35	35

Notes: The standard errors are in parentheses. Dependent variable: real GDP per capita growth rate (economic growth). ***significance at 1% level, **significance at 5% level, *significance at 10% level.

2.5. Conclusion

This study investigates the threshold effect of domestic savings on economic growth in 35 SSA countries from the period 1980 to 2022. The main contribution of this study is the indication of a threshold effect in the relationship between domestic savings and economic growth. This study provides a threshold level for each country used in the sample. Another contribution that this paper makes is applying the dynamic threshold model by Kremer, Bick and Nautz (2013), to estimate the domestic savings and economic growth relationship. Focusing exclusively on SSA offers another key contribution to the current literature.

By using the Kremer, Bick and Nautz (2013), dynamic threshold model, the overall finding of this study is that there is a threshold effect in the relationship between domestic savings and economic growth in SSA. The empirical result shows that the impact of domestic savings on growth is positive and statistically significant if domestic savings are lower than the

threshold. This means that domestic savings promote economic growth if they fall below the threshold. In contrast, the impact of domestic savings on growth is positive but statistically insignificant if domestic savings are above the threshold. Hence, more domestic savings may have positive but insignificant effects on economic growth when they are above the threshold value. As a result, higher domestic savings will not lead to greater economic growth. However, the threshold effects on economic growth are dynamic, it should be revised as countries move from an income level to another, for instance low-income countries may move to a middle-income or upper-income category, which will require higher thresholds.

The policy implication of this study is that SSA's policymakers should be guided by the threshold level of domestic savings and may promote domestic saving activities to increase the size of domestic savings. Policymakers can utilise and control domestic savings amid high inflation through taxation. For instance, tax exemptions on some saving schemes such as pension saving funds can be used to encourage domestic savings. Governments can increase the size of domestic savings through government debt reduction and by reducing unproductive government expenditure. In addition, policymakers should create access to pension schemes as only 8.9% of the working-age population contributes to a pension fund in SSA (ILO 2021). However, higher domestic savings should be transmitted to productive activities such as investment for the expansion of economic growth.

Regarding the limitations of the study, this study only employs aggregate domestic savings data, however, domestic savings are broadly disaggregated into household savings and government savings. Household savings or personal savings are defined as any current income not consumed at a given time. Pension and insurance contributions form part of household savings. Government savings are the savings obtained from tax and non-tax revenues. A disaggregated domestic threshold effect on economic growth (though beyond the scope of this paper) can provide guided information on the nonlinear relationship between domestic savings and economic growth by sector. This topic can be considered for further research.

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Appendix A

Appendix A2.1. List of SAA countries used in this study

1. Benin
2. Botswana
3. Burkina Faso
4. Burundi
5. Cameroon
6. Central African Republic
7. Chad
8. Comoros
9. Congo, Dem. Rep.
10. Congo, Rep.
11. Cote d'Ivoire
12. Equatorial Guinea
13. eSwatini
14. Gabon
15. Gambia, The
16. Ghana
17. Guinea
18. Guinea-Bissau
19. Kenya
20. Madagascar
21. Mali
22. Mauritania
23. Mauritius
24. Namibia
25. Niger
26. Rwanda
27. Senegal
28. Seychelles
29. Sierra Leone
30. South Africa
31. Sudan
32. Tanzania
33. Togo
34. Uganda
35. Zimbabwe

Appendix A2.2. Variable list, descriptions, and sources

Variable list	Description	Source
Domestic credit to private sector (% of GDP)	Domestic credit to private sector refers to financial resources provided to the private sector by financial corporations.	WDI, 2024
Inflation	Consumer price index (2010 = 100)	WDI, 2024
Real GDP per capita growth rate	Annual percentage growth rate of GDP per capita based on constant local currency. GDP per capita is gross domestic product divided by midyear population. GDP at purchaser's prices is the sum of gross value added by all resident producers in the economy plus any product taxes and minus any subsidies not included in the value of the products. It is calculated without making deductions for depreciation of fabricated assets or for depletion and degradation of natural resources.	WDI, 2024
General government final consumption expenditure (% of GDP)	All current government expenditures for purchases of goods and services (including compensation of employees).	WDI, 2024
Gross fixed capital formation (% of GDP)	All land improvements, machinery, and equipment purchases, and the construction of roads, railways, etc.	WDI, 2024
Trade (% of GDP)	Sum of exports and imports of goods and services measured as a share of GDP.	WDI, 2024
FDI, net inflows (% of GDP)	Sum of equity capital, reinvestment of earnings, long- and short-term capitals, divided by GDP.	WDI, 2024

Gross domestic savings	Gross domestic products are calculated as GDP less final consumption expenditure (total consumption).	WDI, 2024

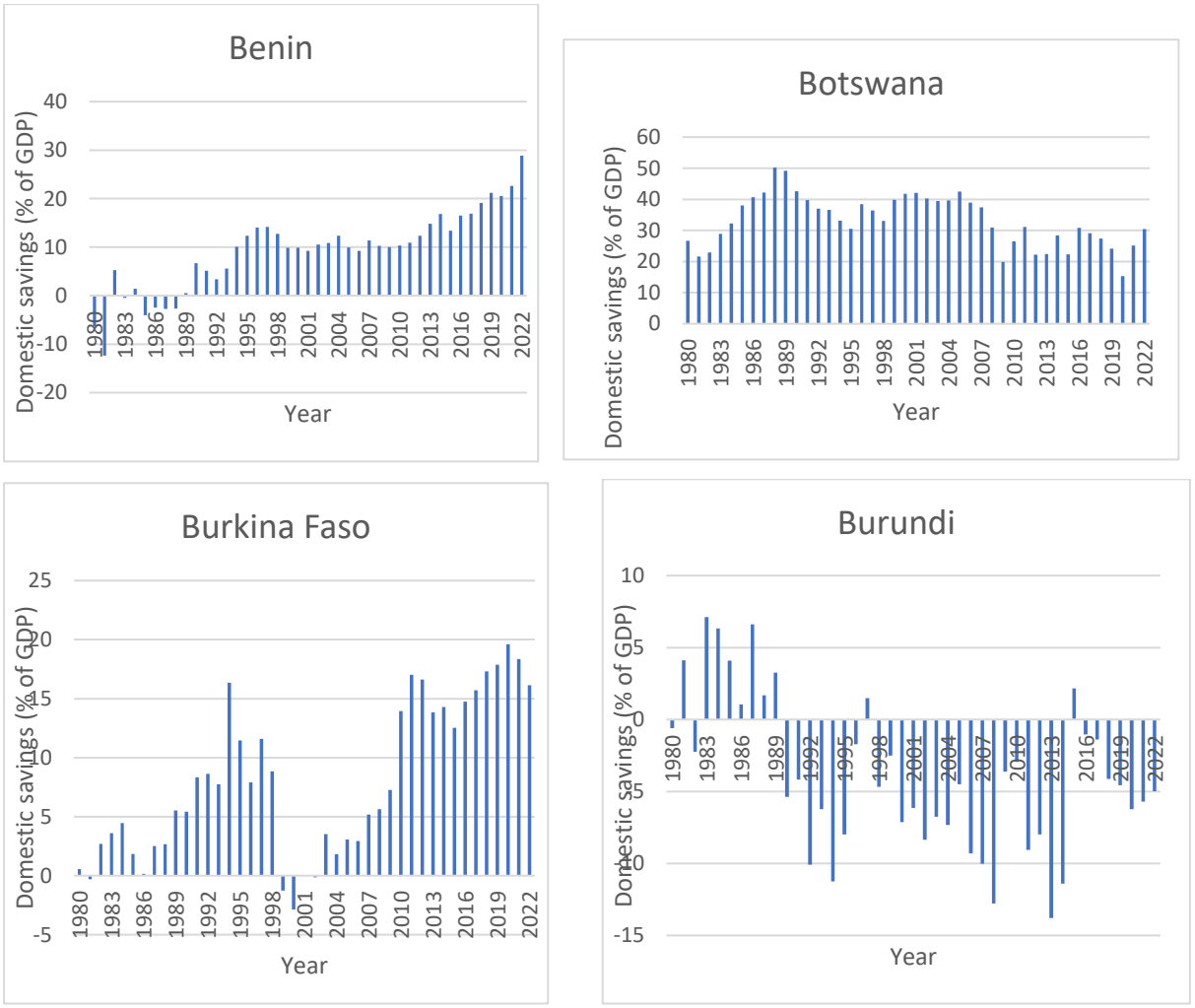
WDI = World Bank Development Indicators

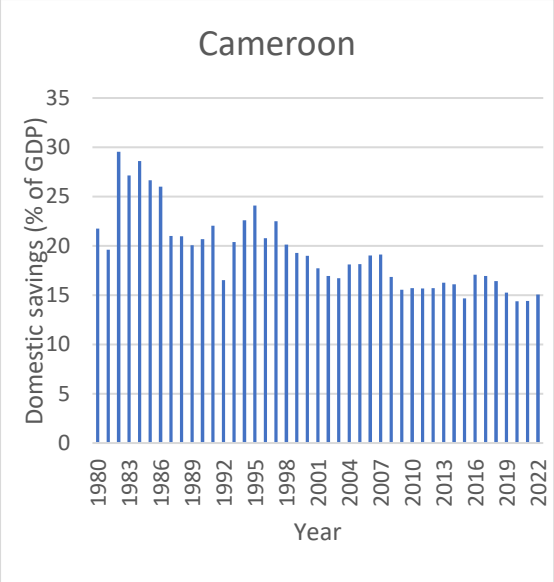
Appendix A2.3. Correlation coefficient for threshold effects of domestic savings on economic growth

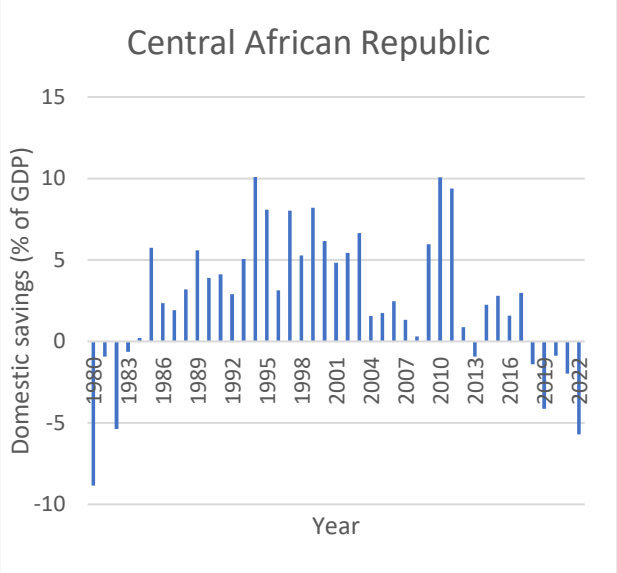
Variables	RGrowth	DoS	FDI	DoC	Inf	GoE	CaF	Trade
RGrowth	1.000							
DoS	0.027	1.000						
FDI	0.109	0.143	1.000					
DoC	-0.007	0.065	-0.073	1.000				
Inf	-0.034	-0.036	-0.008	-0.027	1.000			
GoE	-0.053	0.110	0.039	0.229	-0.002	1.000		
CaF	0.080	0.554	0.394	0.012	-0.089	0.191	1.000	
Trade	0.111	0.398	0.346	0.135	-0.076	0.378	0.446	1.000

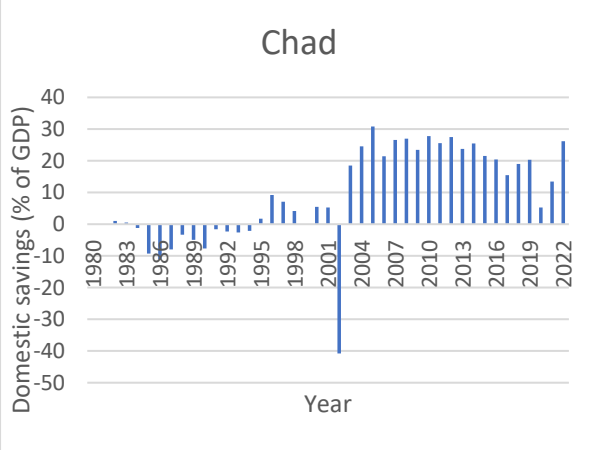
RGrowth = Real GDP per capita growth rate, DoS = Domestic savings, FDI = foreign direct investment; DoC = Domestic credit to the private sector. Inf = Inflation; GoE = Government expenditure; CaF = Capital formation, Trade = trade openness.

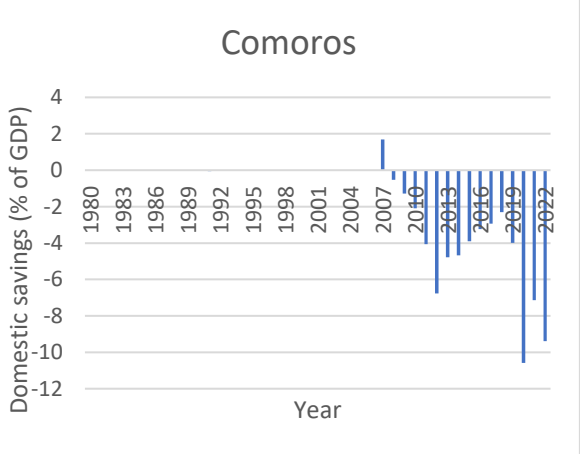
Appendix A2.4. Figure 2.1. Trend of domestic savings in SSA (per country)

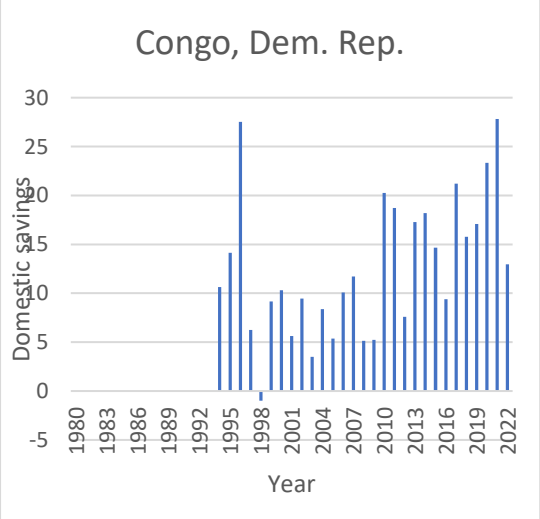


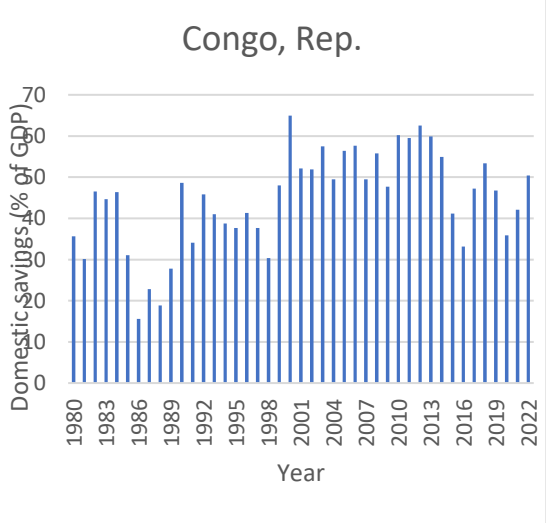

Cameroon
Domestic savings (% of GDP)
35
30
25
20
15
10
5
0
1980
1983
1986
1989
1992
1995
1998
2001
2004
2007
2010
2013
2016
2019
2022
Year

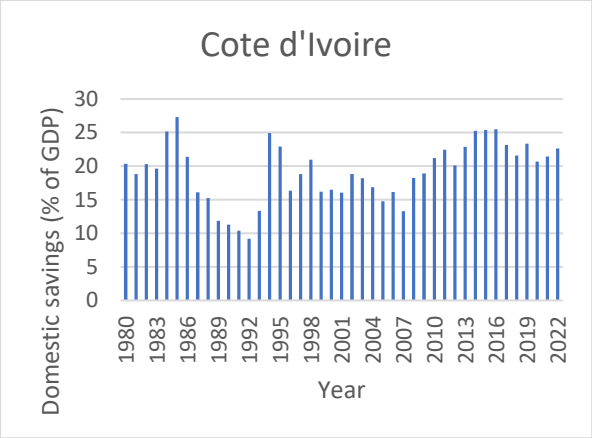

Central African Republic
Domestic savings (% of GDP)
15
10
5
0
-5
-10
1980
1983
1986
1989
1992
1995
1998
2001
2004
2007
2010
2013
2016
2019
2022
Year

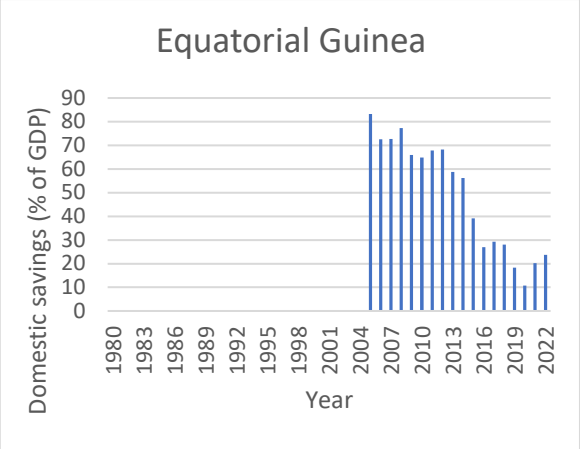

Chad
Domestic savings (% of GDP)
40
30
20
10
0
-10
-20
-30
-40
-50
1980
1983
1986
1989
1992
1995
1998
2001
2004
2007
2010
2013
2016
2019
2022
Year

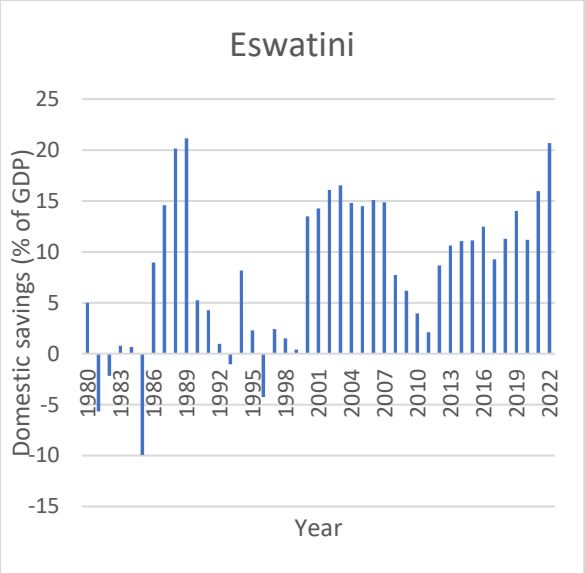

Comoros
Domestic savings (% of GDP)
4
2
0
-2
-4
-6
-8
-10
-12
1980
1983
1986
1989
1992
1995
1998
2001
2004
2007
2010
2013
2016
2019
2022
Year

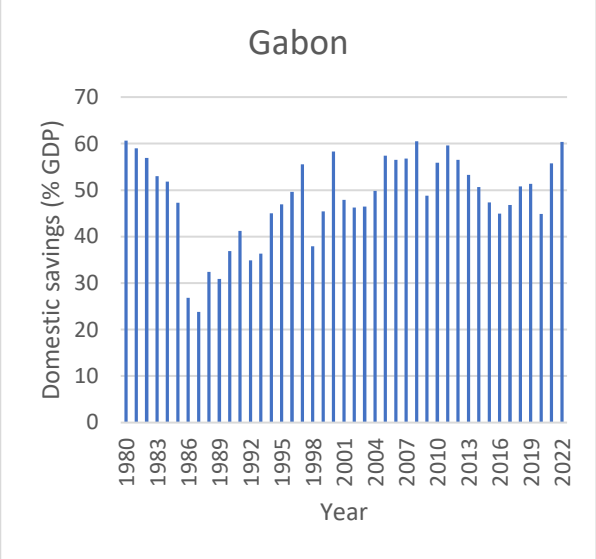

Congo, Dem. Rep.
Domestic savings
30
25
20
15
10
5
0
-5
1980
1983
1986
1989
1992
1995
1998
2001
2004
2007
2010
2013
2016
2019
2022
Year

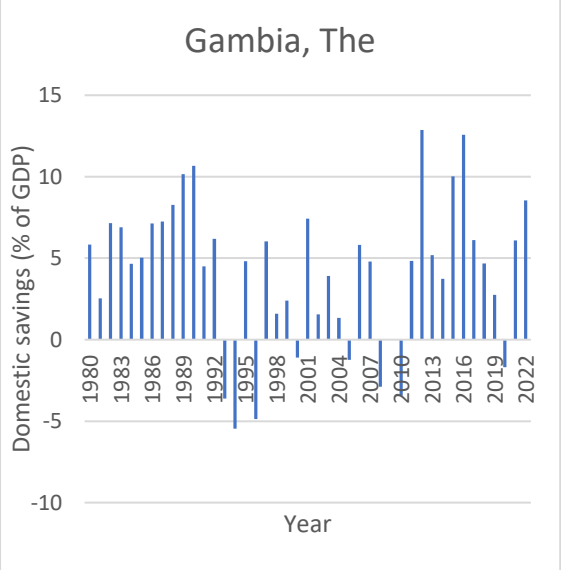

Congo, Rep.
Domestic savings (% of GDP)
70
60
50
40
30
20
10
0
1980
1983
1986
1989
1992
1995
1998
2001
2004
2007
2010
2013
2016
2019
2022
Year

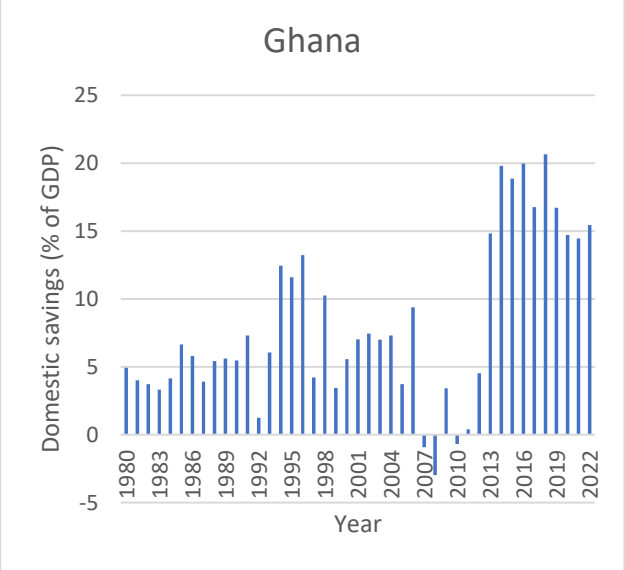

Cote d'Ivoire
Domestic savings (% of GDP)
30
25
20
15
10
5
0
1980 1983 1986 1989 1992 1995 1998 2001 2004 2007 2010 2013 2016 2019 2022
Year


Equatorial Guinea
Domestic savings (% of GDP)
90
80
70
60
50
40
30
20
10
0
1980 1983 1986 1989 1992 1995 1998 2001 2004 2007 2010 2013 2016 2019 2022
Year


Eswatini
Domestic savings (% of GDP)
25
20
15
10
5
0
-5
-10
-15
1980 1983 1986 1989 1992 1995 1998 2001 2004 2007 2010 2013 2016 2019 2022
Year


Gabon
Domestic savings (% GDP)
70
60
50
40
30
20
10
0
1980 1983 1986 1989 1992 1995 1998 2001 2004 2007 2010 2013 2016 2019 2022
Year


Gambia, The
Domestic savings (% of GDP)
15
10
5
0
-5
-10
1980 1983 1986 1989 1992 1995 1998 2001 2004 2007 2010 2013 2016 2019 2022
Year


Ghana
Domestic savings (% of GDP)
25
20
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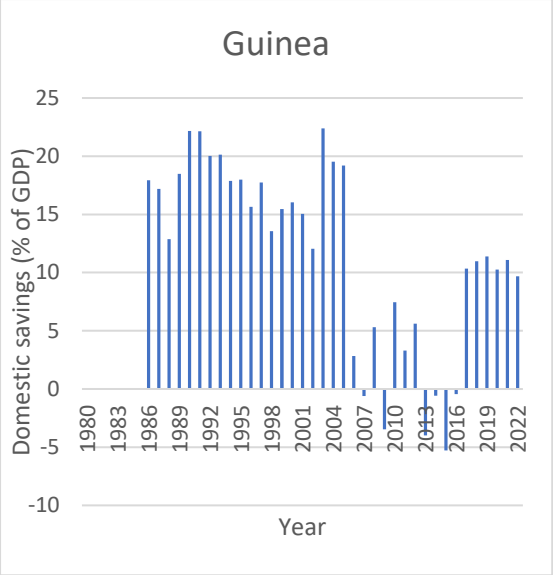
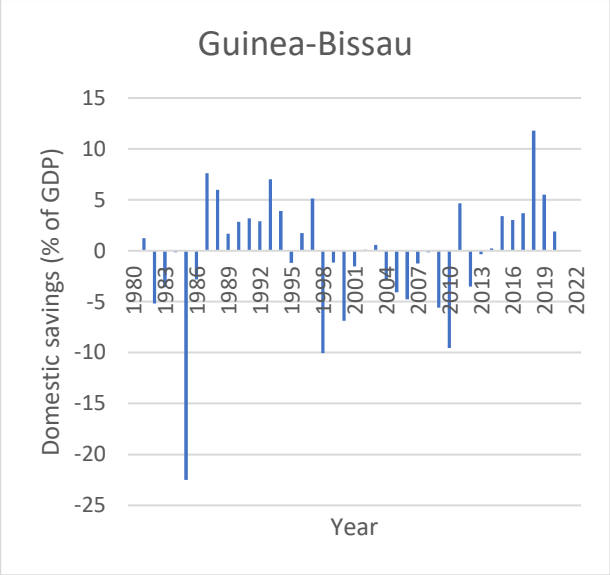
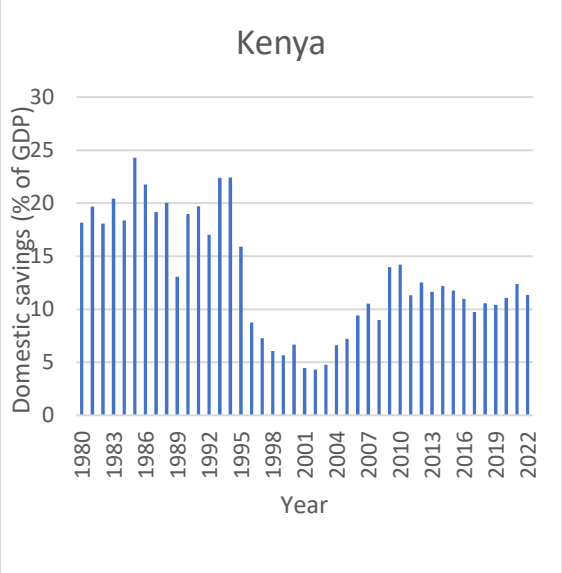
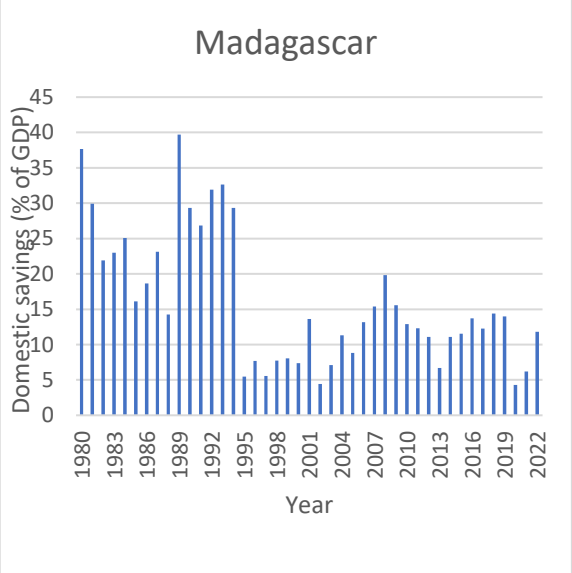
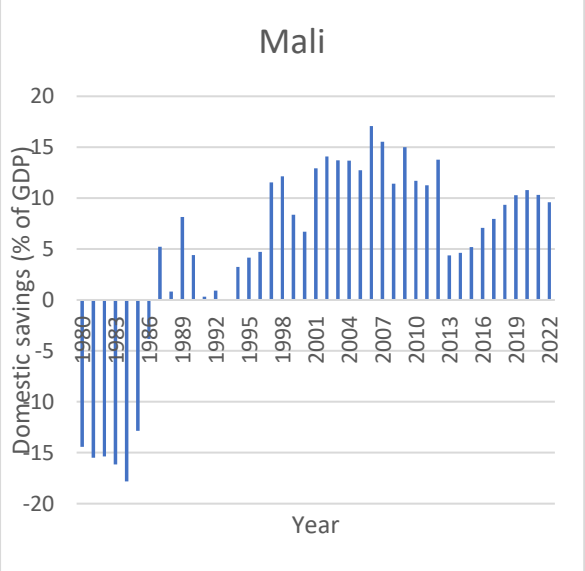
5
0
-5
1980 1983 1986 1989 1992 1995 1998 2001 2004 2007 2010 2013 2016 2019 2022
Year

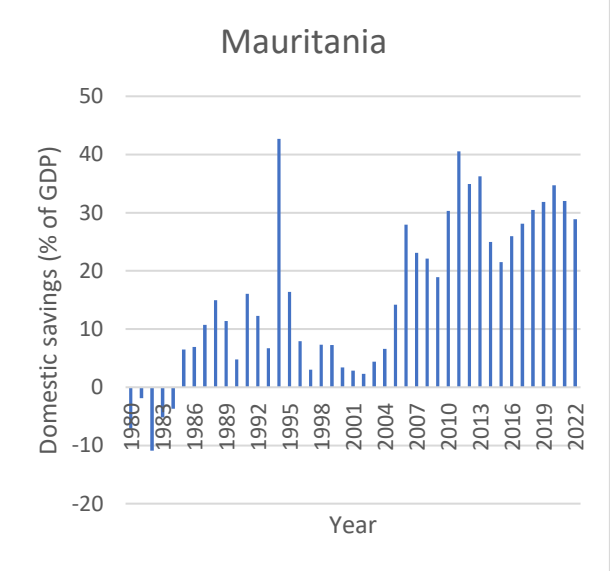

Guinea
Domestic savings (% of GDP)
Year

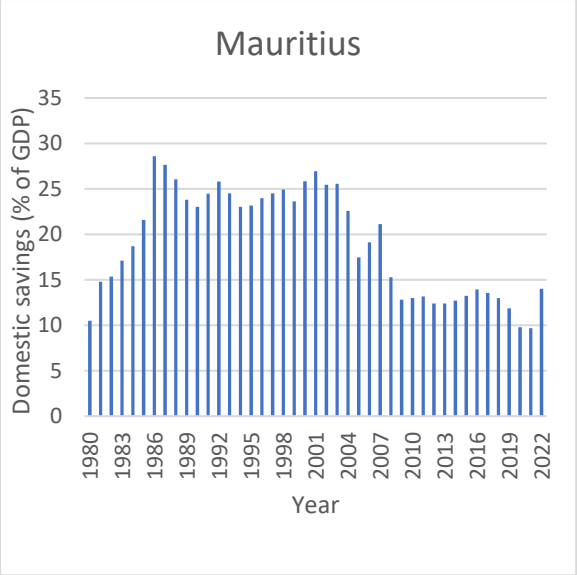

Guinea-Bissau
Domestic savings (% of GDP)
Year


Kenya
Domestic savings (% of GDP)
Year


Madagascar
Domestic savings (% of GDP)
Year


Mali
Domestic savings (% of GDP)
Year


Mauritania
Domestic savings (% of GDP)
Year


Mauritius
Domestic savings (% of GDP)
35
30
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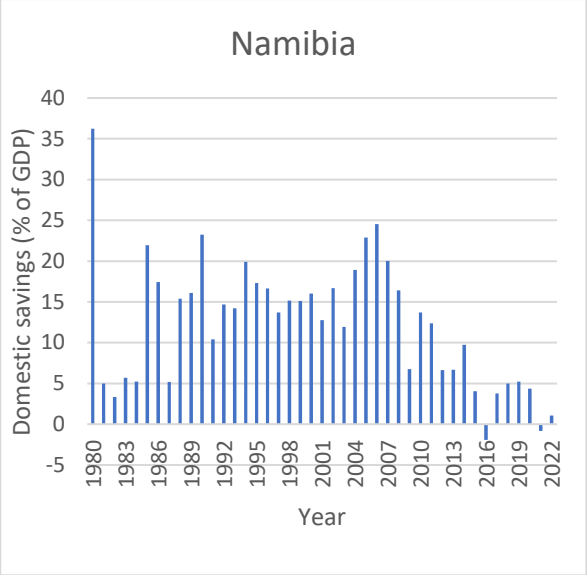
Namibia
Domestic savings (% of GDP)
40
35
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25
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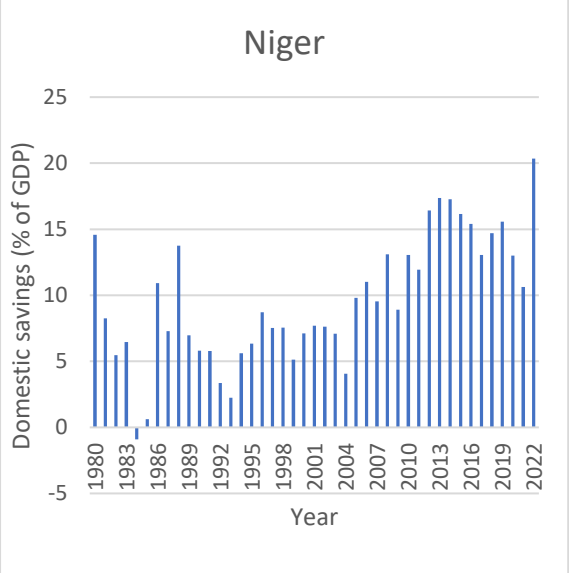
Niger
Domestic savings (% of GDP)
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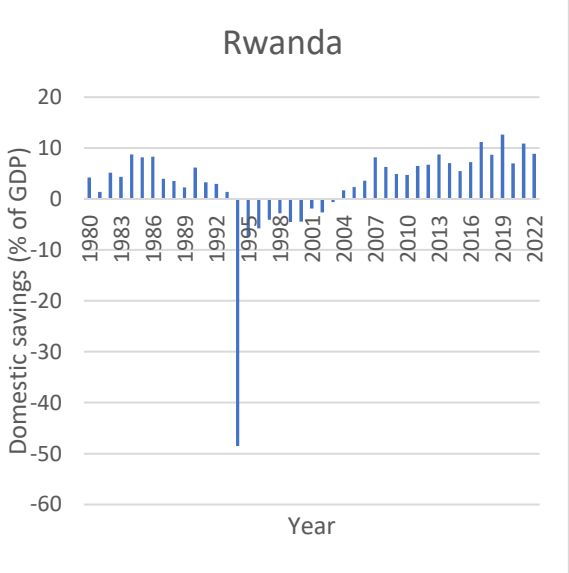
Rwanda
Domestic savings (% of GDP)
20
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-10
-20
-30
-40
-50
-60
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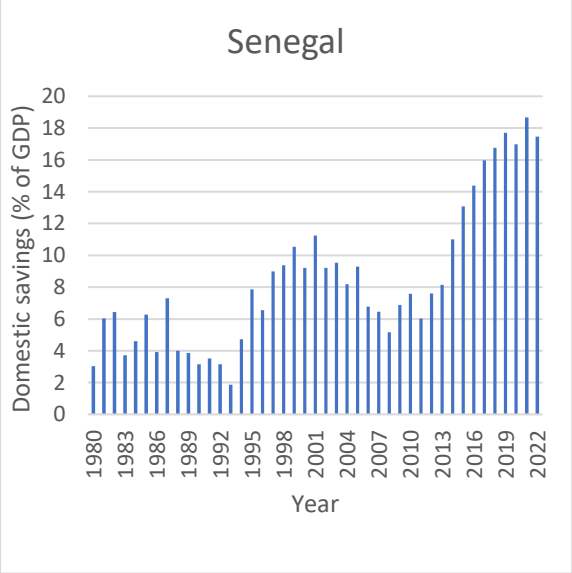
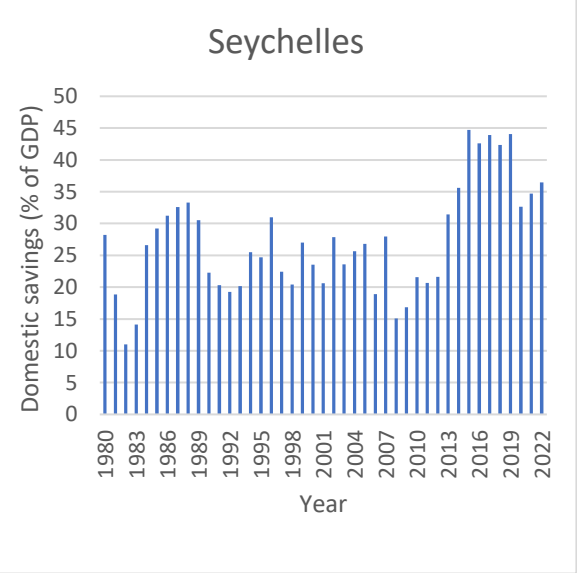
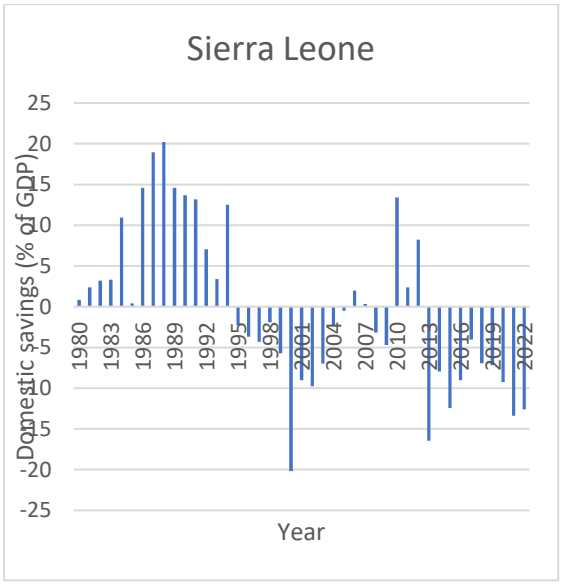
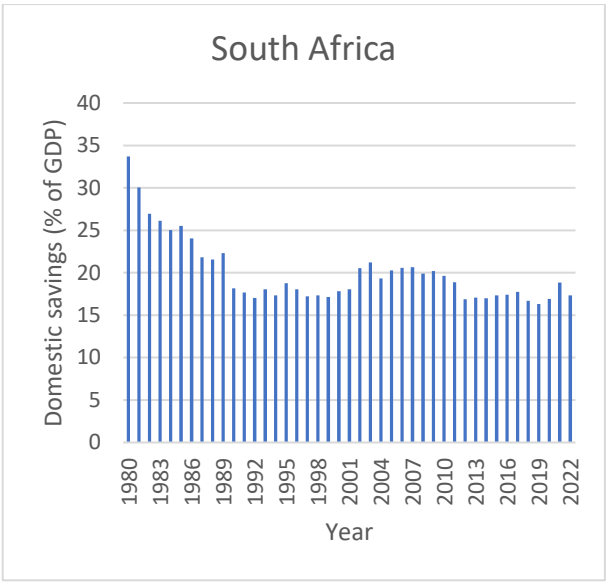
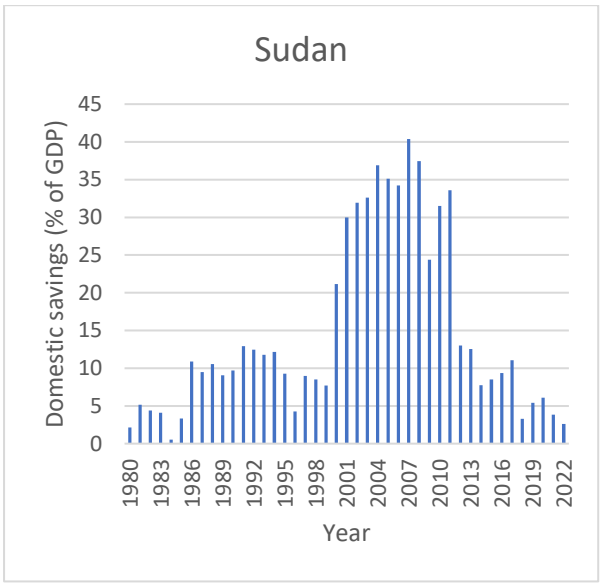
2016
2019
2022
Year

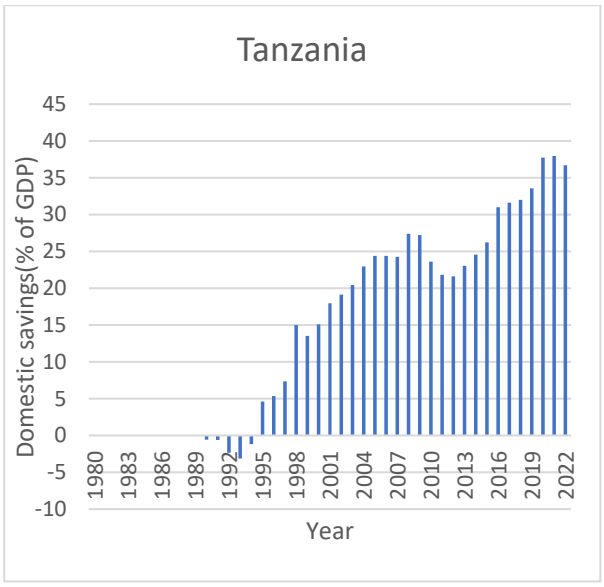

Senegal
Domestic savings (% of GDP)
20
18
16
14
12
10
8
6
4
2
0
1980
1983
1986
1989
1992
1995
1998
2001
2004
2007
2010
2013
2016
2019
2022
Year

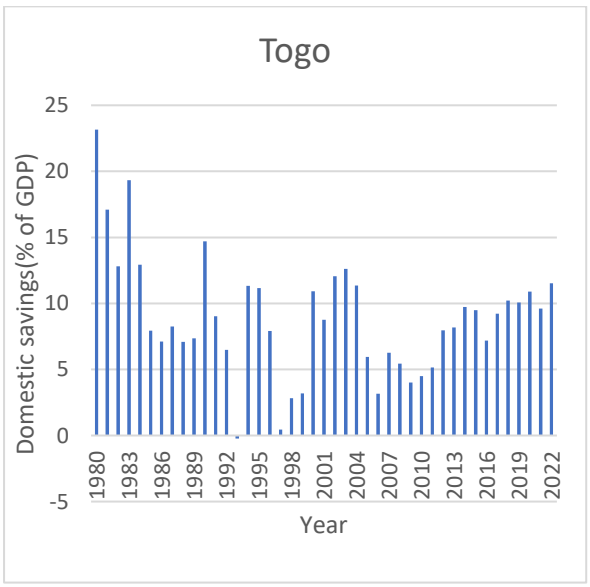

Seychelles
Domestic savings (% of GDP)
50
45
40
35
30
25
20
15
10
5
0
1980
1983
1986
1989
1992
1995
1998
2001
2004
2007
2010
2013
2016
2019
2022
Year

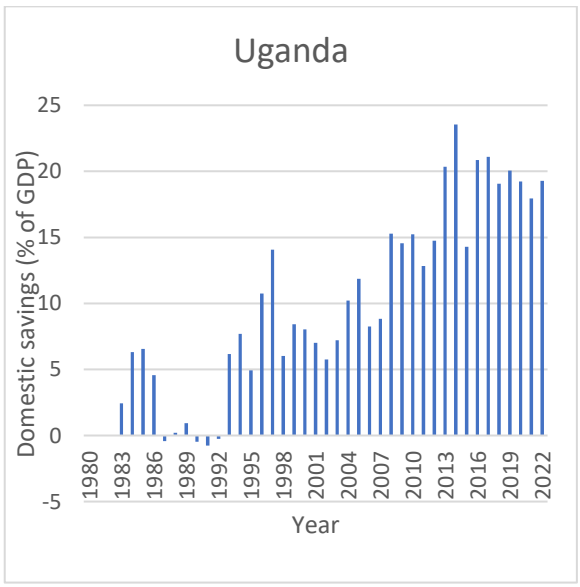

Sierra Leone
Domestic savings (% of GDP)
Year

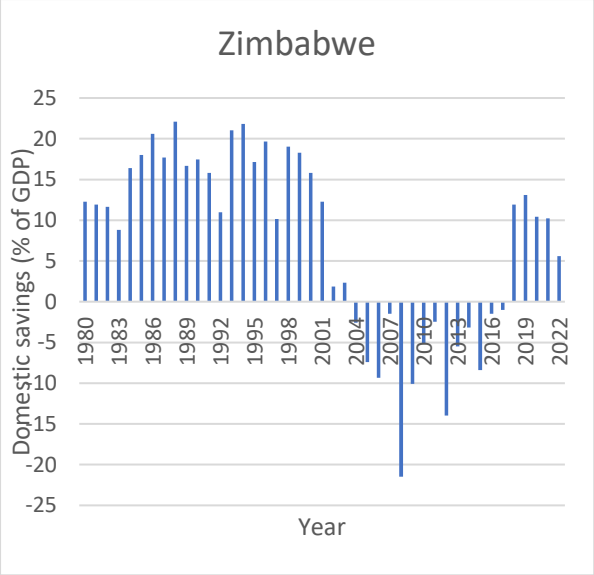

South Africa
Domestic savings (% of GDP)
Year


Sudan
Domestic savings (% of GDP)
Year


Tanzania
Domestic savings(% of GDP)
Year


Togo
Domestic savings(% of GDP)
Year


Uganda
Domestic savings (% of GDP)
Year



Source: Author's compilation, data from the World Bank's World Development Indicators database.

CHAPTER 3

THE IMPACT OF FINANCIAL DEPTH ON ECONOMIC GROWTH: EVIDENCE FROM EBOLA-AFFECTED SSA COUNTRIES

3.1 Introduction and background

Financial depth is the total size of banks, other financial markets, and financial institutions in a nation relative to the nation's economic growth, this definition is according to the World Bank Group. As discussed in Chapter 1, Financial depth is not limited to the size of the commercial banks but includes non-bank financial institutions such as insurance companies, pension funds, and exchange bureaus. Financial depth is important to the economy as it allows monetary policy to be more effective, because it gives the central bank a broader range of tools to manage monetary policy (Singh, 2011). Moreover, financial depth increases the potential of access to financial institutions. Thus, financial depth increases financial inclusion with all the benefit of the latter (financial inclusion). The advancement of a deeper financial system is supported by several global commitments such as the UN SDGs. The World Bank's Global Findex Database, one of the leading databases of financial inclusion, shows that in 2021, 76% of adults worldwide own an account at a bank or a regulated financial institution such as credit union, microfinance, or mobile money. Despite the increase in account ownership worldwide, there are still gaps in the financial sector, especially that financial depth in developing countries remains predominantly banks, operates underdeveloped stock markets and weak financial institutions. As such, a study on the extent of financial depth is essential.

Existing studies on the relationship between financial depth and economic growth mainly focus on the level of financial depth in a nation and its role on economic growth (Setiawan, 2015, Polenis, Stengos & Tzaremes, 2020, Shapoval, 2021). The results of these studies, as explained in Section 3.2. below, reveal that the main barrier to the low levels of financial depth in developing countries is due to poor institutional quality and lack of competition in the financial institutions. In addition, the results show that financial depth serves as a resource base for financial innovation, which in turn creates economic growth opportunities. Furthermore, the positive impact of financial depth on economic growth has been well established in the literature; see for example Chukwu and Agu (2009), Mangwiro, Maradze and Nyoni (2020), and Khatri (2022).

However, the direction of causality between financial depth and economic growth remains inconclusive. Studies such as Chukwu and Agu (2009), Peia and Rosbazch (2014) and Ghildiyal, Pokhriyal and Mohan's (2015) support the existence of a unidirectional causality between financial depth and economic growth. That is, an increase in financial depth leads to a rise in economic growth with no feedback effect. Literature such as Stolbov (2017) illustrates that no causal relationship exits for major economies such as the US, Japan, Germany and France (Stolbov, 2017). However, Recent literature from emerging economies in Africa illustrates that financial depth yields a bidirectional causality with economic growth (Manasseh et al., 2024). That is, an increase in financial depth leads to a rise in economic growth, and an improvement in economic growth fosters financial depth. While the above studies address the relationship between financial depth and economic growth, the questions this study addresses are 1) Is financial depth beneficial to economic growth in low-income countries? and 2) Can infectious diseases such as the Ebola-pandemic influence the relationship between financial depth and economic growth?

According to the research surveyed, there is no existing study that analyses the pre-during-and-post-infectious disease's effects on the financial depth and economic growth relationship. Research related to public health crisis is important because it allows an investigation on the relationship between financial depth and economic growth over a period in which there is an expectation of higher financial market dislocation and limited provision of financial services.

Supported by the above background information, the research objective of this study is to investigate the impact of financial depth on economic growth in Ebola-affected SSA countries. This thesis aims to fill the gap in the existing literature on financial depth by contributing to the debate on the relationship between financial depth and economic growth in four important ways. Thus, the first contribution this paper makes is to empirically examine the impact of financial depth on economic growth—considering whether there is a difference in the impact of financial depth on economic growth before and 'pre-during-and-post' a public health crisis. The analysis of public health crisis in the financial depth and economic growth relationship is relevant because it can affect the economy beyond the crisis period.

The Covid-19 pandemic and the 2022 Monkeypox outbreak have stoked a keen interest in policymakers to the impact of infectious diseases on the financial sector. The 2014–2016 West African Ebola epidemic claimed 11,323 lives globally and 11,308 lives in the three highly

affected West African countries (World Health Organization, 2023). Similar to the Covid-19 pandemic, the Ebola epidemic imposed traveling restrictions, lockdowns, curfews, isolation, social distancing, and quarantine on individuals in the affected countries. By examining the impact of financial depth on economic growth in the three Ebola-hit countries, namely Guinea, Sierra Leone, and Liberia, this paper serves as a relevant case study to examine the effect of health crises in the financial depth and growth nexus.

The second way that this paper contributes to the literature is by computing the financial depth index on the three highly Ebola-hit countries. Financial depth is board; no single indicator can provide a detailed measure on the level of financial depth. Using a single measure of financial depth makes it difficult for researchers and policymakers to form firm conclusions of the degree of financial depth across countries. Therefore, a financial depth index captures different aspect of financial depth and provides a detailed measure of financial depth. Furthermore, a financial depth index serves as a tool to rank financial depth across countries and to evaluate the progress made on financial depth within a country over a certain period of years. As described in Section 3.3. below, this study calculates a financial depth index that is then used to examine the impact of financial depth on economic growth and to determine the direction of causality between financial depth and economic growth in the Ebola-hit countries.

The third contribution this paper makes is the examination of the causal link between financial depth and economic growth for the countries examined. Literature addressing the causal relationship between financial depth and economic growth in SSA is generally scanty, and even lesser in the Ebola-hit countries. Some of these existing studies on this topic are panel studies, which group countries at different levels of financial depth and economic growth. This thesis addresses the causality between financial depth and economic growth from a country-specific angle. The Granger causality test originated by Granger (1969) tests whether one series significantly predicts another series, that is, whether lagged values of the predictor variable carry statistically significant information about the predicted variable, after controlling for lagged values of the predicted variable. Additionally, a variable is considered to Granger-cause another variable, if the former can help to forecast the latter and thus the mean squared error is lower with the additional information set. The test reveals the direction of causality, which serves as a guide to policymakers in the implementation of financial depth and economic growth enhancing policies.

The fourth contribution is that the study focuses exclusively on low-income countries, specifically Guinea, Sierra Leone, and Liberia—the three worst-affected Ebola-hit countries. These three countries have similarities in that they are highly naturally resourced yet poor developing countries, have experienced civil wars, are prone to diseases outbreaks, and were highly affected by the Ebola-epidemic much more than the Covid-19 pandemic. These countries are mostly marginalised and hardly researched on. Since their economies are some of the poorest in the world, it is vital for policymakers to focus on advancing financial depth in these countries. Therefore, research on this topic focusing on these countries is relevant.

Using the ordinary least square estimation technique and the Toda Yamamoto (1995) Granger causality test and focusing on three-Ebola hit SSA countries between the period 1980 and 2022, this study finds that financial depth has a positive and statistically significant relationship with economic growth. To get a clear picture on whether the Ebola period resulted in different dynamics in the relationship between financial depth and economic growth, this study examines two samples: the full sample (spanning1980–2022) and the pre-Ebola era (1980–2014). The full sample consists of the pre-Ebola, Ebola, post-Ebola, and to some extent the Covid-19 pandemic eras. For all the eras (full sample and pre-Ebola) and for all the countries (Guinea, Liberia and Sierra Leone), the impact of financial depth on economic growth exhibits a positive sign and a statistically significant level.

However, the results show that the positive financial depth–economic growth relationship in the pre-Ebola period is stronger than in the full sample, which comprises of the pre-Ebola, Ebola and post-Ebola eras. This difference means that financial depth significantly promoted economic growth before the Ebola crisis, and that the Ebola crisis did not only claim lives but also impacted the financial depth–economic growth relationship. Therefore, the main finding of this study is that financial depth positively impacts economic growth; however, infectious diseases such as Ebola can disrupt the relationship.

Furthermore, the Granger causality results depict that a unidirectional causality from financial depth to economic growth is found in Guinea and Liberia. Hence, financial depth Granger causes economic growth in Guinea and Liberia, but economic growth does not Granger cause financial depth. Sierra Leone's Granger causality result shows that a bidirectional relationship is found between financial depth and economic growth. Financial depth Granger causes economic growth, with a feedback effect in Sierra Leone. The policy implication based on the Granger causality result suggests that the three countries should

implement more financial depth enhancing policies aim at increasing the access and usage of the financial sector, fostering competition among banks, and developing the stock market.

The remainder of this chapter is organised as follows: Section 3.2, which presents the theoretical and empirical literature review of financial depth on economic growth. Section 3.3, which describes the data, model specification and methodology used in this paper. Section 3.4, which reports the result of the impact of financial depth on economic growth. And finally, Section 3.5, which concludes this chapter.

3.2 Theoretical and empirical literature review—Financial depth and economic growth

3.2.1 Theoretical literature

The theoretical link between financial depth and economic growth can be understood from Schumpeter (1911)'s theory of innovation, the Mckinnon (1973)'s theory of money and capital and Shaw (1973)'s theory of financial deepening, and the endogenous growth model. Schumpeter (1911), a leading scholar of the finance and economic growth relationship, argues that innovation or technological change is a key player in producing goods and services and hence economic growth. He highlights several forms of innovation that affect the production of goods and services, including the use of a new technology, raw material, product, and market. As such, the rapid growth of financial depth is often linked to the advancements of innovations (Rousseau, 1998).

According to Schumpeter (1911), the technological change or innovation can only be achieved through two mechanisms—administrative power and banking loans in the case of an open economy. Schumpeter's idea then is that the banking sector/financier serves as an intermediary between the innovators and the owners of capital (Stolbov, 2013). Bank loans are drivers in channelling innovation, which in turn brings about economic growth. Therefore, based on Schumpeter's idea, financial depth (which includes access to bank loans) spurs economic growth.

The theoretical landscape between financial depth and economic growth is also supported from the Mckinnon (1973) and Shaw (1973)'s theories. The authors claim that the price level and its rate of change is determined by the interaction of demand and supply of money. The government controls the supply of nominal balances. The demand for real balances depends on the income and the deposit rate (which is the difference between the average

interest received for holding money and the expected rate of inflation) (Mckinnon (1973), Shaw (1973). The scholars point out that in developing economies, the level of income positively depends on the amount of real balances and as the level of income rises, real deposit rate increases, and savings and investment rates rise. Therefore, it can be deduced from the theories of Mckinnon – Shaw (1973) that economic growth positively depends on financial depth and as economic growth rises, financial depth increases in response to higher economic growth.

Another theoretical mechanism through which financial depth impacts economic growth can be drawn from the endogenous growth model proposed by Lucas (1988) and Romer (1986). According to the endogenous growth model, the financial sector impacts economic growth through capital accumulation and by technological advancement. This means that the accumulated capital can be used to fund innovation, thus contributing to technological improvement, which subsequently fosters economic growth (Marwa & Zhanje, 2015). Researchers such as Rousseau (1998) show that financial depth promotes economic growth through innovation, whilst Klein and Olivei (2008) explain that financial depth leads to greater economic growth through the capital account channel. Financial depth expands financial services, which provides an opportunity for capital accumulation. Viewed from the endogenous growth model perspective, financial depth is beneficial to economic growth since it utilises innovation and promotes capital accumulation.

3.2.2 Empirical literature

Existing studies generally tend to conclude that financial depth spurs economic growth (Chukwu & Agu, 2009, Ghildiyal, Pokhriyal & Mohan, 2015, Mangwiro, Maradze & Nyoni, 2020) and a recent study by Khatri (2022) draws a similar conclusion. However, there is no consensus on the direction of causality between financial depth and economic growth. In addition, the level of financial depth and the role of financial depth on economic growth remains inconclusive. Table 3.1. provides a summary of the recent findings in the empirical literature on the relationship between financial depth and economic growth. This study adds to the debate by examining the impact of financial depth on economic growth in the three highly Ebola-affected countries.

Regarding the direction of causality between financial depth and economic growth, there has been a debate in the finance-growth literature about the supply leading hypothesis (financial depth leads to economic growth) and the demand following hypothesis (financial

depth follows economic growth). Financial depth is argued to exhibit a unidirectional causality with economic growth. That is, higher financial depth leads to an improvement in economic growth. Studies such as Chukwu and Agu (2009), Peia and Rosbazch (2014) and Ghildiyal, Pokhriyal and Mohan's (2015) support the existence of a unidirectional causality between financial depth and economic growth. Stolbov (2017) examines the causality between credit depth and economic growth in OECD countries. Out of 24 OECD countries examined, half of the countries in the sample exhibits evidence of the presence (or absence) and direction of causality. A unidirectional causality relationship running from credit depth to economic growth is found for four countries. No causality exits for major economies such as the US, Japan, Germany and France (Stolbov, 2017). Recent literature from emerging economies in Africa illustrates that financial depth yields a bidirectional causality with economic growth (Manasseh et al., 2024).

On the level of financial depth in developing countries, Setiawan (2015) examine the level of financial depth in Indonesia (a developing country). The author finds that the main barrier to the low rates of financial depth in developing countries is due to poor institutional quality and lack of competition in the financial institutions. In turn, Polenis, Stengos and Tzaremes (2020) re-investigate the financial depth and economic growth relationship for 40 developing and developed countries over the period 1970 to 2014. Their results reveal that the impact of financial depth on economic growth is very weak and that poor financial intermediaries such as commercial banks, investment banks, mutual funds and pension funds contribute to the weak impact of the financial depth-economic growth nexus.

One of the roles of financial depth is that it serves as a transmission mechanism through which financial innovation impacts economic growth. Shapoval (2021) focuses on 22 countries in the OECD region and demonstrates that financial depth serves as a resource base for financial innovation, which in turn creates economic growth opportunities. However, a negative effect of the impact of financial depth on economic growth suggests that a huge number of financial resources is geared towards unproductive activities such as debt service, which does not significantly contribute to economic growth (Isiaka et al., 2021). Similar to Isiaka et al., (2021), an earlier study by Ardi and Damar (2006) found a strong negative relationship between financial depth and economic growth using Turkey as a case study. The authors explain that funds from the banking sector were used for rent-distribution purposes by the government, thereby led to a slowdown in economic growth in Turkey.

Table 3.1. Selected recent empirical literature on the financial depth–growth relationship

Authors and Year	Countries	Period	Method	Findings
Mangwiro, Maradze and Nyoni (2020)	Zimbabwe	1980–2014	Ordinary Least Square (OLS)	A positive relationship is found between financial depth and economic growth.
Okafor et al. (2021)	Nigeria	1986–2016	Johannsen cointegration, and Granger causality test	Bank-based financial depth positively and significantly impacts economic growth.
An, Zou and Kargbo (2021)	SSA	1985 – 2015	Dynamic and static panel models	Financial depth promotes economic growth in the upper-income and the overall sample of SSA countries. For low-and middle-income SSA countries, it hinders economic growth.
Misati, Osoro and Odongo (2021)	Kenya	2009–2020	ARDL and Granger causality tests	A positive relationship and unidirectional causality are found between financial depth and economic growth.
Khatri (2022)	Nepal	1980–2019	ARDL	The positive and significant long-run and short-run impacts of financial depth on economic growth support the supply-leading (finance-led-growth) hypothesis.
Afzal (2023)	Poland	1995-2019	ARDL and Granger causality tests	A bidirectional causality exists between financial depth and economic growth only in the short-run and not in the long-run.
Sen (2023)	46 countries (23 upper-middle and 23-lower-middle-income countries)	1996–2020	System GMM	The impact of financial depth on economic growth depends on political ideologies. The impact financial depth on economic growth is positive and statistically insignificant when right-wing government (focuses on low inflation) is in power. The opposite is true for the left-wing government (aims at low unemployment).

3.3 Model specification, methodology, and the data—Financial depth and economic growth

3.3.1. Model specification and methodology

Based on the theoretical literature discussed above and following the research conducted by Klein and Olivei (2008), this study investigates the impact of financial depth on economic growth. Klein and Olivei (2008), suggest that financial depth is a key driver of economic growth specifically to countries with capital liberalization / open capital accounts. The authors propose the following equation to investigate the financial depth–economic growth relationship:

$$GDP_{it} = \alpha_0 + \alpha_1 FD_{it} + \alpha_2 Z_{it} + \varepsilon_{it} \quad (1)$$

Where GDP_{it} is GDP per capita growth rate. FD_{it} is financial depth. Z_{it} represents the control variables and ε_{it} represents the error term.

This study postulates equation 1 by augmenting it with a financial depth index for Ebola-affected countries, categorised as the pre-Ebola era (1980 to 2014) and the full sample (comprises of pre-during-and-post-Ebola eras - 1980 to 2022).

Equation 1 can be expressed in an ordinary least square form featuring the two samples as:

$$GDP_{it} = \beta_0 + \beta_1\left(FD_{full}\right)_{it} + \beta_3 X_{it} + \mu_{it} \qquad (2)$$

$$GDP_{it} = \beta_0 + \beta_2\left(FD_{pre}\right)_{it} + \beta_3 X_{it} + \mu_{it} \qquad (3)$$

Where β_0 represents the constant term and $\mu_{i,t}$ represents the error term. $\left(FI_{full}\right)_{it} and \left(FI_{pre}\right)_{it}$ are the financial depth index for the full sample (1980–2022) and the pre-Ebola phase (1980–2014). The real GDP per capita growth rate (RGDPPC) is the dependent variable. Financial depth (FD) is the independent variable. X represents the control variables, which consist of inflation, financial development, and human capital.

In the ordinary least square model, the aim is to obtain estimates for β. The sign and level of significance of the coefficients $\beta_1 and \beta_2$ are important because they capture the impact of financial depth on economic growth for the two categories (full sample and pre-Ebola). The ordinary least square technique is an appropriate method for this study given it is a time series study. The total number of countries (N=3) and total time spanning from 1980 to 2022 (T=43).

To examine the causal relationship between financial depth and economic growth, this study redefines equation (1) by employing the Toda and Yamamoto (1995) version of Granger causality (1969) test. The Toda and Yamamoto (1995) Granger causality test is an appropriate method for this study as it is suitable for a time series dataset and variables that are integrated in different orders, for example, I(0) and I(1). The Toda and Yamamoto (1995) version of Granger causality requires the maximal order of integration, $d_{max.}$ If the unit root test result depicts that the variables are stationary at level I(0) and integrated at order one I(1), the maximal order of integration, d_{max} will be one. To determine the optimal lag length k, the lag selection procedure is applied. The optimal lag length (k) should be greater than or equal to the

maximal order of integration (d_{max}), that is, $k \geq d_{max}$. To determine the direction of causality, it is required to estimate the $(k + d_{max})^{th}$ order of the vector auto regression (VAR) and the Block Exogeneity Wald test.

The Toda Yamamoto (1995) Granger causality empirical equation is specified as:

$$GDP_t = \propto_0 + \{\sum_{i=1}^{n} \propto_{1i} GDP_{t-i} + \sum_{i=k+1}^{\text{dmax}} \propto_{2i} GDP_{t-i}\} + \{\sum_{i=1}^{n} \beta_{1i} FD_{t-i} + \sum_{i=k+1}^{\text{dmax}} \beta_{2i} FD_{t-i}\} + \mu_t$$

(4)

$$FD_t = \propto_0 + \{\sum_{i=1}^{n} \propto_{1i} FD_{t-i} + \sum_{i=k+1}^{\text{dmax}} \propto_{2i} FD_{t-i}\} + \{\sum_{i=1}^{n} \beta_{1i} GDP_{t-i} + \sum_{i=k+1}^{\text{dmax}} \beta_{2i} GDP_{t-i}\} + \mu_t$$

(5)

This study utilises the following diagnostic tests: the unit root test, autocorrelation, and heterogeneity test.

Unit root tests

To obtain the order of integration for each of the variables under investigation, Fisher-type unit root tests are conducted. Both unit root tests can be used for an unbalanced time series data. The Fisher-type of unit root test performs the Augmented Dickey Fuller (ADF) and the Phillips-Perron (PP) unit root tests. The null hypothesis is given as 'unit root' against the alternative hypothesis, which is 'no unit root'. The alternative hypothesis means that the variable was generated by a stationary process. To account for serial correlation, the PP unit root tests implement the Newy-West standard errors while the ADF employs additional lags of the first-differenced variable.

Autocorrelation

This study applies the Durbin-Watson autocorrelation test. This test determines the presence or absence of autocorrelation in the data series. The null hypothesis is given as 'no autocorrelation' against the alternative hypothesis, which is 'autocorrelation'. The Durbin-Watson statistics ranges from the numbers zero to four. A value close to number two means there is no autocorrelation. Values approaching zero and those approaching four indicate positive and negative autocorrelation respectively.

Heteroscedasticity

The test for heteroscedasticity determines whether heteroscedasticity is present among the variables under investigation. This study utilises the Breusch-Pagan Lagrange / Cook Weisberg heteroscedasticity test, which assesses whether the variance of the errors from an estimation depends on the values of the explanatory variables. It allows for unbalanced time series data and the result is reported as chi-squared (x^2).

The null hypothesis of the Breusch-Pagan Lagrange / Cook Weisberg, heteroscedasticity test is 'homoscedasticity', while the alternative hypothesis states 'heteroscedasticity'. Rejecting the null hypothesis indicates the presence of heterogeneity among the variables. This means that the regression result is inefficient and that the test statistics (t-test, f-test) are invalid.

3.3.2. Data

This study employs annual data for three SSA countries, namely Guinea, Liberia, and Sierra Leone. This study covers the period between the year 1980 and 2022. The data is obtained from the World Bank's World Development Indicators and the Global financial development. The choice of the number of countries and the period is based on the pre-during-and-post-eras. The description of the variables used in this study are detailed in Appendix B3.1. As mentioned in Section 2.3.2., the dependent variable is real GDP per capita growth rate, which measures economic growth (also see Cave, Chaudhuri & Kumbhakar, 2020). Furthermore, other literature, such as Odhiambo's (2008), uses real GDP per capita growth rate as a dependent variable in investigating the relationship between financial depth and economic growth in Kenya.

The main independent variable of interest in this study is financial depth, which is in an index form. This study includes the following control variables: domestic credit to private sector to proxy for financial development, life expectancy to proxy for the extent of human capital in the economy, and inflation to proxy for macroeconomic stability.

3.3.2.1. Variables*:*

Financial depth

Financial depth is broad, and no single indicator can provide a detailed measure of the level of financial depth. Hence, a financial depth index captures different aspects of it and provides a detailed measure of financial depth. This study computes the financial depth index, which forms part of the growing financial depth literature. Since there is no consensus on the indicators of financial depth, existing studies approach the subject from the standpoint of the sizes of banks, stock market, bond market, pension fund, and other financial institutions.

This study computes a financial depth index because the coverage of existing financial depth indexes is limited to selected countries and years, and to specific indicators such as stock market development. For example, the financial depth index by Lwesya and Ismali (2021) focuses on Tanzania and uses indicators such as stocks traded to GDP, stock market capitalization to GDP and international debt securities of government to GDP. What this study does instead is compute a financial depth index for three Ebola-hit SSA countries for the period spanning 1980 to 2022.

The indicators used to compute the financial depth index in this study are: 'bank deposits to GDP, 'deposit interest rate', and 'liquid liabilities to GDP'. 'Bank deposits to GDP' is defined according to the World Bank database as "the total value of demand, time and saving deposits at domestic deposit money banks as a share of GDP" (World Bank, 2024). 'Deposit interest rate' is defined as "the rate paid by commercial banks for demand, time or savings deposits." The 'liquid liabilities to GDP' as a standard indicator in the finance–growth literature. This indicator is defined is also known as broad money and captures the sum of currency and deposits in the central bank, electronic currency, foreign currency transferable and time deposits, travellers' checks, shares of mutual funds and securities repurchase agreements. The three indicators above-mentioned are widely applied to measure financial depth (see for example, Le, Ho &Vu, 2019, Odhiambo,2008)

Following Jankee's work (2006), we employ the principal component analysis (PCA), which is a parametric method, to construct the financial depth index covering the three Ebola-affected SSA countries for the years 1980 to 2022. The PCA is a statistical tool that helps with data reduction—it reduces the number of variables in the study and explains a series of

uncorrelated linear combinations of the variables that contain most of the variance. The PCA derives the eigenvectors, which help to describe the structure of the data.

Considering the PCA method, the financial depth indicators can be expressed as:

$$X_i^u = \propto_{1\ bankdepositi} + \propto_{2depositinteri} + \propto_{3liquidliabi} + \varepsilon_i \quad (7)$$

Where bankdeposit represents bank deposits to GDP, depositinter represents deposit interest rate, and liquidliab represents liquid liabilities to GDP.

X_i^u is unobserved endogenous variables, and it is estimated alongside $\propto$, the unknown parameter. We aggregate the indicators to form the financial depth index. Specifically, let $R_p, (pxp)$ be the correlation matrix of the p standardise indicators for the dimension. Let $\lambda_j (j = 1, \dots, p)$ be the jth eigen value, subscript j be the number of indicators p. $\phi_j (px1)$ denotes the eigen vector of the correlation matrix. Let us assume that $\lambda_1 > \lambda_2 > \cdots \lambda_p$ and indicate that the kth principal component is $P_k (k = 1, \dots, p)$. We obtain each financial depth index based on the weighted averages:

$$FDIndex_i = \frac{\sum_{j,k=1}^{p} \lambda_j P_{ki}}{\sum_{j=1}^{p} \lambda_j} \quad (8)$$

Where $FDIndex_i$ is the financial depth index, $P_k = Z\lambda_j$, Z represents the indicators matrix, λ_j denotes the weights, and P_k represents the variance of the kth principal component. The first principal component has the highest weight λ_1 and it explains the largest possible variance in each dimension. The second principal component with weight λ_2 is uncorrelated with the first principal component and accounts for additional information that the first component did not explain. The subsequent principal components are uncorrelated with the previous principal components and explain the remaining information. We consider all the principal components instead of the first few principal components only and discarding the other principal components. Our aim is to obtain an accurate index of financial depth.

Equation 8 can be written as:

$$FDIndex_i = \alpha_i + w_i X_i^{ind} + \varepsilon_i \quad (9)$$

Where $FDIndex_i$ is the financial depth index, w represents the weight of the dimension, i represents the country, and X_i^{ind}, represents the indicators of financial depth.

The principal components explain the total variation of the variables used in constructing the financial depth index. The cumulative proportions of the first principal components (above one) of the financial depth index are 90.30%, 88.11% and 72.94%, with eigen values of 2.71, 2.64 and 2.19 for Guinea, Liberia and Sierra Leone, respectively. However, we consider all the principal components to form the financial depth index rather than conserving only the principal components that are above one. Our goal is to present an accurate financial depth index that accounts for the total variation of the dataset. The factor loadings of the first principal components of the Guinea's financial depth index are 0.5918 for bank deposit to GDP, 0.5956 for deposit interest rate to GDP and 0.5432 for liquid liabilities to GDP. For Liberia, the factor loadings of the first principal components of the financial depth index are 0.5977 for bank deposit to GDP, 0.6007 for deposit interest rate to GDP and 0.5309 for liquid liabilities to GDP. The factor loadings of the first principal components of the financial depth index for Sierra Leone are 0.6538 for bank deposit to GDP, 0.2308 for deposit interest rate to GDP and 0.7206 for liquid liabilities to GDP. The squared factor loading of the first principal component (PC1) of the index sums up to one and it is defined as the percentage of the variance explained by each factor. We obtain the financial depth index by the weighted averages of the principal components. This study employs the financial depth index calculated here to investigate the impact of financial depth on economic growth.

Control variables:

Human capital

Human capital is measured as life expectancy at birth. According to Mankiw, Romer, and Weil (1992), human capital has a major impact of growth. SSA countries rank low on the quality of their human capital (Wall Street Journal, 2023) and that might be one of the reasons for the region's low levels of economic growth. Ogundari and Awokuse (2018) examine the impact of human capital on economic growth in 35 SSA countries. The study uses two measures of human capital, namely health (proxied as life expectancy) and education (average years of schooling and government expenditure on schooling). The study reveals that human capital in the form of health and education positively impact growth. However, the health component of

human capital contributes more to economic growth than the educational aspect of human capital.

Financial development

This study employs the widely used measure of financial development, domestic credit to private sector. As described in Section 2.3.2. above, domestic credit to private sector is defined by the World Bank dataset (2023) as financial resources provided to the private sector by financial corporations. The financial corporations include monetary authorities and deposit money banks, as well as other financial corporations such as finance and leasing companies, money lenders, insurance corporations, pension funds, and foreign exchange companies. Domestic credit to private sector excludes public and government lending.

King and Levine's (1993) seminal work finds that increased financial development significantly leads to economic growth, physical capital accumulation, and improvement in economic efficiency. This positive relationship between financial development and economic growth is supported by a range of scholars including Calderon and Liu (2003) and Hermes and Lensink (2003). Another strand of the literature suggests that higher financial development may reduce economic growth because the financial sector, like the other sectors in the economy, is competing over scarce resources (Cecchetti & Kharroubi, 2012). Moreover, a boom in the financial sector can be detrimental to economic growth, as was seen during the global financial crisis of 2007–2008.

Inflation

Inflation accounts for macroeconomic stability and it is measured as the consumer price index. As discussed in Section 2.3.2. above, studies conducted by Mahawiya (2015) and Barcola and Kebalo (2018) reveal that inflation has a threshold effect on economic growth, meaning that the former is beneficial to the latter up to a certain point, after which inflation can be detrimental to economic growth. In a study comparing countries in the Southern African Development Communities (SADC) and the Economic Community of West Africa States (ECOWAS), Mahawiya (2015) estimates that a 17.9% inflation threshold for ECOWAS countries and a 14.5% inflation threshold for SADC countries are required for financial development. In West Africa, Barcola and Kebalo (2018) conclude that the inflation threshold is between 8.01% and

15.46%. Inflation positively impacts economic growth when it is within that range, otherwise it bears a hindering effect.

In economic research, it is important to outline some of the features of the variables used in the study. Hence, Table 3.2. below presents the descriptive statistics of the variables used in the study, while Table B3.2, in Appendix B shows the correlation coefficient matrix of the impact of financial depth on economic growth.

Table 3.2. a) Descriptive statistics—Actual data

		Guinea			
Variable (actual data)	N	Mean	Std.Dev.	Min	Max
Real GDP per capita growth rate	43	1.701	1.988	-3.506	7.988
Financial depth: Bankdepo	42	8.860	5.652	3.268	18.888
Financial depth: DepositInt	42	11.952	6.715	3.105	23.000
Financial depth: liquidliabi	30	17.795	6.961	8.677	27.784
Domestic credit to private sector	42	5.065	2.826	1.751	11.821
Inflation	43	87.571	95.191	16.074	361.722
Life expectancy	42	52.205	5.307	42.884	59.720
		Liberia			
Variable (actual data)	N	Mean	Std.Dev.	Min	Max
Real GDP per capita growth rate	32	-0.166	6.075	-30.701	6.341
Financial depth: Bankdepo	42	8.384	7.153	1.451	21.670
Financial depth: DepositInt	42	5.853	2.150	3.033	10.944
Financial depth: liquidliabi	21	11.838	7.369	5.121	26.362
Domestic credit to private sector	42	5.499	5.326	1.015	16.976
Inflation	42	75.815	58.165	20.514	223.13
Life expectancy	42	51.626	7.503	36.688	61.104
		Sierra Leone			
Variable (actual data)	N	Mean	Std.Dev.	Min	Max
Real GDP per capita growth rate	43	0.238	7.393	-22.488	19.457
Financial depth: Bankdepo	42	12.673	4.918	5.466	23.66
Financial depth: DepositInt	43	12.721	10.602	4.486	54.667
Financial depth: liquidliabi	42	19.093	5.716	9.926	31.221
Domestic credit to private sector	42	4.559	1.881	1.604	8.224
Inflation	43	95.549	76.123	35.927	378.052
Life expectancy	42	48.678	6.242	42.071	60.255

N = number of observations, Std.Dev = standard deviation, Min = Minimum, Max = Maximum.
Where: Bankdepo = bank deposit to GDP; DepositInt = deposit interest rate; Liquidliabi = liquid liabilities to GDP
Source: World Bank (2024) database.

Table 3.2. b) Descriptive statistics—Log-transformed data

		Guinea			
Variable (log-transformed data)	N	Mean	Std.Dev.	Min	Max
Real GDP per capita growth rate	38	0.483	0.745	-1.692	2.078
Financial depth: Bankdepo	42	1.979	0.644	1.184	2.939
Financial depth: DepositInt	42	2.268	0.713	1.133	3.135
Financial depth: liquidliabi	30	2.798	0.420	2.161	3.324
Domestic credit to private sector	42	1.487	0.517	0.560	2.470
Inflation	43	3.981	0.955	2.777	5.891
Life expectancy	42	3.950	0.103	3.758	4.090
		Liberia			
Variable (log-transformed data)	N	Mean	Std.Dev.	Min	Max
Real GDP per capita growth rate	21	0.375	0.845	-0.670	1.847
Financial depth: Bankdepo	42	1.728	0.922	0.372	3.076
Financial depth: DepositInt	42	1.706	0.349	1.110	2.393
Financial depth: liquidliabi	41	2.292	0.591	1.633	3.272
Domestic credit to private sector	42	1.246	0.962	0.015	2.832
Inflation	42	4.078	0.693	3.021	5.408
Life expectancy	42	3.933	0.148	3.602	4.113
		Sierra Leone			
Variable (log-transformed data)	N	Mean	Std.Dev.	Min	Max
Real GDP per capita growth rate	29	0.908	0.885	-0.910	2.968
Financial depth: Bankdepo	42	2.460	0.413	1.699	3.164
Financial depth: DepositInt	43	2.355	0.551	1.501	4.001
Financial depth: liquidliabi	42	2.904	0.307	2.295	3.441
Domestic credit to private sector	42	1.43	0.432	0.472	2.107
Inflation	43	4.352	0.597	3.581	5.935
Life expectancy	42	3.878	0.124	3.739	4.099

N = number of observations, Std.Dev = standard deviation, Min = Minimum, Max = Maximum.
Where: Bankdepo = bank deposit to GDP; DepositInt = deposit interest rate; Liquidliabi = liquid liabilities to GDP
Source: World Bank (2024) database.

3.4 Results and analysis—Financial depth and economic growth

3.4.1. Results of the impact of financial depth on economic growth

Table 3.3. presents the empirical results of the financial depth–economic growth relationship for the three most Ebola-affected SSA countries under study. Columns 1, 3 and 5 of Table 3.3 show the results of the pre-Ebola sample that spans 1980 to 2014 for the countries - Guinea,

Liberia and Sierra Leone. The full sample consists of the pre-during-and-post-Ebola periods and to some extent the Covid-19 pandemic period. In columns 2, 4 and 6, the full sample (1980 to 2022) results for the three countries are reported. For all the eras (full sample and pre-Ebola) and for all the countries (Guinea, Liberia and Sierra Leone) reported in Table 3.3, the impact of financial depth on economic growth exhibits a positive sign and a statistically significant level.

Comparing the pre-Ebola era and the full sample of the three countries, the results show that the positive relationship between financial depth and economic growth in the pre-Ebola period is stronger than in the full sample, which comprises of the pre-during-and post-Ebola eras. The statistically significant levels of the relationship are at the 10% level of significance for the full sample and at the 5% level of significance for the pre-Ebola era for Guinea and Sierra Leone, respectively. Liberia maintains the same significant levels of 5% for both the pre-Ebola and full sample. The magnitude of financial depth on economic growth in the pre-Ebola era is greater than that of the full sample for all the countries under study. As reported in Table 3.3., in Guinea, the coefficient of financial depth is 2.372 of the pre-Ebola result and 1.140 of the full sample result. Therefore, in Guinea, a 1% increase in financial depth increases economic growth by 2.372% in the pre-Ebola period and by 1.140% in the full sample. In Liberia and Sierra Leone respectively, a 1% increase in financial depth increases economic growth by 1.432% and 0.365% and in the pre-Ebola period and by 0.264% and 0.271% and in the full sample.

The results of the two samples suggest that the Ebola crisis had an adverse effect on the three Ebola-epicentre countries. The Ebola epidemic, the deadliest that ever hit the three highly affected countries much more than the Covid-19 pandemic, did not only claim lives but also impacted the financial depth–economic growth relationship. The full sample result can be attributed to the aftermath of the crisis and to an extent the impact of Covid-19 restrictions on the economy. The main barriers to financial depth in developing countries is due to poor institutional quality and lack of competition in the financial institutions (Setiawan, 2015). The barrier to financial depth was intensified due to the Ebola crisis as there was altogether a loss of lives, livelihoods, and income. Due to fear of contracting the highly contagious disease, consumer participation in the formal financial sector was constrained, hence there was a decrease in trade, reduced access to loans, and therefore weaker institutional quality and low levels of financial depth.

The Ebola control preventive measures such as international travel bans, local travel restrictions, and quarantine mandates worsened the barriers to financial depth, which is evident in the full sample result of this study. Therefore, the main finding of this study is that financial depth impacts economic growth; however, infectious diseases such as Ebola can disrupt the financial depth and economic growth relationship.

According to the research surveyed, there is no existing study that compares the pre-Eobla and full sample (combination of the pre-and-post-Ebola) effects on the financial depth and economic growth nexus. Nevertheless, existing studies such as Khatri (2022), and Ghildiyal, Pokhriyal and Mohan's (2015) support a positive relationship between financial depth and economic growth, which aligns with the results of this study. Similar to the results of this study and specifically relating to SSA countries, Mangwiro, Maradze and Nyoni (2020) and Misati, Osoro and Odongo (2021) find that financial depth promotes economic growth in the SSA region.

Regarding the control variables, for all the countries, the financial development coefficient is positive and statistically significant, implying that financial development is a significant determinant of economic growth in Guinea, Liberia and Sierra Leone. Although human capital's coefficients are positive and statistically significant throughout the sample, the values of the coefficients are small. A possible explanation for this result is that human capital in the form of health and education is weak in the three countries studied, thus human capital positively but weakly contributes to economic growth.

Poor quality healthcare and a weak education system can affect the economic growth rate. In addition, the aftermath of the rebel war of the 1990s contributed to brain drain and weak human capital in the three countries. The inflation coefficient is negative and statistically significant in Sierra Leone, meaning inflation hinders economic growth in that country. The inflation coefficient is statistically insignificant for Guinea and Liberia, but past studies show that inflation has a threshold effect on economic growth, meaning that it can positively impact economic growth up to a certain threshold, after which inflation has detrimental effect on economic growth.

Table 3.3. Results of financial depth and economic growth in Ebola-hit SSA countries

Variable	Guinea		Liberia		Sierra Leone	
	Pre-Ebola (1980 – 2014)	Full sample (1980 – 2022)	Pre-Ebola (1980 – 2014)	Full sample (1980 – 2022)	Pre-Ebola (1980 – 2014)	Full sample (1980 – 2022)
	(1)	(2)	(3)	(4)	(5)	(6)
Fin. depth index	2.372**	1.140*	1.432**	0.264**	0.365**	0.271*
	(1.324)	(1.025)	(0.523)	(0.554)	(0.341)	(0.265)
Fin. Development	4.507**	3.246*	2.229**	0.291*	2.061***	1.716***
	(1.787)	(1.853)	(2.391)	(2.147)	(0.670)	(0.590)
Inflation	-0.007	-0.009	0.877	1.339	-3.622*	-3.338***
	(0.010)	(0.186)	(2.619)	(2.256)	(2.061)	(1.162)
Human capital	0.609*	0.392*	0.210**	0.104*	0.381**	0.346***
	(0.315)	(0.312)	(0.854)	(0.104)	(0.173)	(0.109)
Constant	-38.399**	-23.991	-8.780	-5.594	0.852	0.819*
	(18.285)	(17.577)	(11.109)	(9.520)	(1.560)	(2.232)
R-Squared		0.9194		0.7625		0.8502
Observation	23	30	24	30	28	30

Notes: The standard errors are in parentheses. Dependent variable: real GDP per capita growth rate (economic growth). ***significance at 1% level, **significance at 5% level, *significance at 10% level.

Table 3.4. below also provides the results of the Breusch-Pagan/Cook-Weisberg heteroscedasticity tests, as well as the result of the Durbin-Watson autocorrelation tests for Guinea, Liberia, and Sierra Leone. The results confirm the absence of autocorrelation and heteroscedasticity in the dataset. The null hypothesis of the autocorrelation tests is 'no autocorrelation' versus the alternative hypothesis of 'autocorrelation'. The Durbin-Watson test fails to reject the null hypothesis of 'no autocorrelation', thus indicating the absence of autocorrelation. Similarly, Breusch-Pagan / Cool Weisberg test fails to reject the null hypothesis of 'homoscedasticity'. This indicates the 'absence of heteroscedasticity' among the data series for the three countries.

Table 3.4. Autocorrelation and heteroscedasticity tests results

Tests	Guinea	Liberia	Sierra Leone
Autocorrelation Durbin-Watson Test	Durbin-Watson d-statistic (5, 30) = 1.868661	Durbin-Watson d-statistic (5, 30) = 2.266932	Durbin-Watson d-statistic(5, 30) = 1.935082
Breusch-Pagan / Cook-Weisberg test for heteroskedasticity	chi2(1) = 2.34 Prob > chi2 = 0.1264	chi2(1) = 2.04 Prob > chi2 = 0.1529	chi2(1) = 2.20 Prob > chi2 = 0.1380

3.4.2. Financial depth and economic growth: Granger causality results

This study uses the existing financial depth index described in section 3.3.2 to examine the causal link between financial depth and economic growth within the framework of Toda Yamamoto (1995) Granger causality test. In the Granger causality model, the stationary test of the regressors is essential in obtaining a consistent result. The model requires that the order of integration of the regressors be stationary at level or at first difference—in this instance, I(1) or I(0). To establish that regressors used in the study are I(0) or I(1), we employ two unit root tests, namely Augmented Dicker Fuller (ADF) and Phillips-Perron (PP). These tests are suitable for timeseries dataset and allow for an unbalanced dataset. Tables 3.5 and 3.6. provide the unit root result for the variables used to examine the impact of financial depth on economic growth in Guinea, Liberia and Sierra Leone. The unit root results show that the data used in this study contains both stationary at level and stationary at first differenced series. Real GDP per capita growth rate is stationary at level for the three countries, whilst financial depth is stationary at first differenced of the three countries.

3.4.2.1. Unit root test results*:*

Table 3.5. Unit root test results – Dickey-Fuller test

	Guinea		Liberia		Sierra Leone	
Variable	Level	1st diff	Level	1st diff	Level	1st diff
Real GDP per capita growth rate	-4.173*** (0.0007)	-	-3.384** (0.0115)	-	-4.480*** (0.0002)	-
Financial depth	-0.885 (0.7928)	-4.430*** (0.0003)	-0.275 (0.9283)	11.5530*** (0.0088)	-1.032 (0.7413)	-5.156*** (0.0000)

Notes: The standard errors are in parentheses. Dependent variable: real GDP per capita growth rate (economic growth). ***significance at 1% level, **significance at 5% level, *significance at 10% level.

Table 3.6. Unit root test results – Phillips and Perron test

	Guinea		Liberia		Sierra Leone	
Variable	Level	1st diff	Level	1st diff	Level	1st diff
Real GDP per capita growth rate	-4.563*** (0.0002)	-	-5.120*** (0.0000)	-	-6.524*** (0.0000)	-
Financial depth	-0.991 (0.7566)	-5.624*** (0.0000)	-0.196 (0.9390)	-5.480*** (0.0000)	-1.146 (0.6963)	-6.252*** (0.0000)

Notes: The standard errors are in parentheses. Dependent variable: real GDP per capita growth rate (economic growth). ***significance at 1% level, **significance at 5% level, *significance at 10% level.

Table 3.7 presents the Granger causality tests results for Guinea, Liberia and Sierra Leone. In Guinea, financial depth Granger causes economic growth, without feedback. Economic growth does not Granger cause financial depth, but financial depth Granger causes economic growth in Liberia. A unidirectional causality from financial depth to economic growth is found in Guinea and Liberia. Misati, Osoro and Ondongo (2021) observe the same unidirectional causality result between financial depth and economic growth in Kenya. Bidirectional relationship is found between financial depth and economic growth in Sierra Leone. Economic growth Granger causes financial depth and in turn financial depth Granger causes economic growth in Sierra Leone, a finding consistent with Afzal's (2023) result. The unidirectional causality and the bidirectional causality outcomes obtained for Guinea, Liberia and Sierra Leone respectively suggest that the size of the financial sector / financial depth leads to economic growth.

Table 3.7: Granger causality tests result

Toda Yamamoto Granger causality block exogeneity Wald tests between financial depth and economic growth			
Guinea			
Dependent variables	Independent variable	chi2	Prob>Chi2
Financial depth	Economic growth	0.204	0.651
Economic growth	Financial depth	3.130	0.077
Liberia			
Dependent variables	Independent variable	chi2	Prob>Chi2
Financial depth	Economic growth	1.474	0.225
Economic growth	Financial depth	8.896	0.003
Sierra Leone			
Dependent variables	Independent variable	chi2	Prob>Chi2
Financial depth	Economic growth	7.340	0.007
Economic growth	Financial depth	5.476	0.019

Source: Author's compilation.

3.4.3. Robustness test

The computed financial depths index of this study comprises three indicators, namely 'bank deposits to GDP', 'deposit interest rate', and the 'liquid liabilities to GDP'. For the robustness check, this study examines the impact of one of these financial depth indicators on economic growth. Hence, this study investigates the impact of financial depth (measured as liquid liabilities to GDP) on economic growth for the three countries, because the liquid liabilities to GDP also known as broad money, is more comprehensive as it includes money in circulation

and those in the central bank. Table 3.4. reports the results of the robustness checks. The coefficients of the financial depth indicator (liquid liabilities to GDP) for the three countries are positive and statistically significant. The results of Table 3.5. (an indicator of financial depth – liquid liabilities) correspond with the results of Table 3.3., wherein financial depth index positively and significantly impacts economic growth. Therefore, based on the robustness checks results presented in Table 3.4., this study concludes that the main result reported in Table 3.3. is indeed robust.

Table 3.8. Results of financial depth (liquid liabilities to GDP) and economic growth

	Full Sample (1980–2022)		
Variable	Guinea	Liberia	Sierra Leone
Fin. depth: liquid liabilities to GDP	0.258*	0.194**	0.047*
	(0.158)	(0.071)	(0.046)
Fin. Development	4.038**	2.229**	1.716***
	(1.717)	(2.393)	(0.590)
Inflation	-0.008	1.350	-3.338***
	(0.010)	(2.619)	(1.162)
Human capital	0.616*	0.210 **	0.346***
	(0.292)	(0.085)	(0.109)
Constant	-27.847*	-11.081	-0.052
	(14.484)	(11.728)	(1.019)
Observations	30	30	28

Notes: The standard errors are in parentheses. Dependent variable: real GDP per capita growth rate (economic growth). ***significance at 1% level, **significance at 5% level, *significance at 10% level.

3.5. Conclusion

This study investigates the impact of financial depth on economic growth in three Ebola-affected SSA countries for the period 1980 to 2022. The main contribution this study makes is that it empirically examines the impact of financial depth on economic growth—considering whether there is a difference in the impact of financial depth on economic growth before and 'pre-during-and-post' a public health crisis. Analysing a public health crisis in the financial depth and economic growth relationship is relevant because this kind of crisis can affect the economy beyond the period of its prevalence. The Covid-19 pandemic and the 2022 Monkeypox outbreak have stoked a keen interest in policymakers to the impact of infectious

diseases on the financial sector. Another way that this paper contributes to the current literature is by constructing a financial depth index that is used to estimate the financial depth–economic growth relationship. This study provides the direction of causality for each country used in the sample. Focusing exclusively on the three highly hit and under-researched SSA countries serves as another key contribution of this study.

By using the ordinary least square estimation technique and the Toda Yamamoto (1995) Granger causality test and focusing on three-Ebola hit SSA countries between the period 1980 and 2022, this study finds that financial depth has a positive and statistically significant relationship with economic growth. To get a clear picture on whether the Ebola period resulted in different dynamics in the relationship between financial depth and economic growth, this study examines two samples: the full sample (spanning1980–2022) and the pre-Ebola era (1980–2014). The full sample consists of the pre-during-and-post-Ebola eras, and to some extent the Covid-19 pandemic eras. For all the eras (full sample and pre-Ebola) and for all the countries (Guinea, Liberia and Sierra Leone), the impact of financial depth on economic growth exhibits a positive sign and a statistically significant level.

However, the results show that the positive financial depth–economic growth relationship in the pre-Ebola period is stronger than in the full sample, which comprises of the pre-during-and-post-Ebola eras. This difference means that financial depth significantly promoted economic growth before the deadly Ebola crisis, and that the Ebola crisis did not only claim lives but also impacted the financial depth–economic growth relationship. Therefore, the main finding of this study is that financial depth positively impacts economic growth; however, infectious diseases such as Ebola can disrupt the relationship.

Furthermore, the Granger causality results depict that a unidirectional causality from financial depth to economic growth is found in Guinea and Liberia. Hence, financial depth Granger causes economic growth in Guinea and Liberia, but economic growth does not Granger cause financial depth. Sierra Leone's Granger causality result shows that a bidirectional relationship is found between financial depth and economic growth. Financial depth Granger causes economic growth, with a feedback effect in Sierra Leone. The policy implication based on the Granger causality result suggests that the three countries should implement more financial depth enhancing policies aim at increasing the access and usage of the financial sector, fostering competition among banks, and developing the stock market.

Regarding the limitations of the study, this paper only covers the financial depth dimension of bank-based and other financial institutions operating in the three countries, due to a lack of available data for the other dimensions of financial depth such as the stock and bond markets. The other dimensions of financial depth are underdeveloped in these countries. A comparison of the impact of financial depth on economic growth for Ebola-hit regions and Ebola-free regions can be considered a potential further research topic. In addition, a global study on the effect of the Covid-19 pandemic on the financial depth and economic growth nexus can also be considered for possible further research.

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Appendix B

Appendix B3.1. Variable list, descriptions, and sources

Variable list	Description	Source
Domestic credit to private sector (% of GDP)	Domestic credit to private sector refers to financial resources provided to the private sector by financial corporations.	WDI, 2024
Inflation	Consumer price index (2010 = 100).	WDI, 2024
Real GDP per capita growth rate	Annual percentage growth rate of GDP per capita based on constant local currency. GDP per capita is gross domestic product divided by midyear population. GDP at purchaser's prices is the sum of gross value added by all resident producers in the economy plus any product taxes and minus any subsidies not included in the value of the products. It is calculated without making deductions for depreciation of fabricated assets or for depletion and degradation of natural resources.	WDI, 2024
Deposit interest rate	The rate paid by commercial or similar banks for demand, time, or savings deposits.	WDI, 2024
Private credit by deposit money banks and other financial institutions to GDP	Claims on the private sector by deposit money banks and other financial institutions to GDP.	GFD, 2024
Bank deposit to GDP	The total value of demand, time, and saving deposits at domestic deposit money banks as a share of GDP.	GFD, 2024
Life expectancy at birth	The number of years a newborn infant would live if prevailing patterns of mortality at the time of their birth were to stay the same throughout their life.	WDI, 2024
Liquid liabilities to GDP	The sum of currency and deposits in the central bank, electronic currency, foreign currency transferable and time deposits, travellers' checks, shares of mutual funds and securities repurchase agreements.	GFD, 2024

WDI = World Bank Development Indicators

GFD = Global financial development

Appendix B3.2. Matrix of correlations

Guinea

Variables	RGrowth	Bankdepo	depositint	liquidliabi	DomCred	cpi	lifeexp
RGrowth	1.000						
bankdepo	0.355	1.000					
depositint	-0.441	-0.772	1.000				
liquidliabi	0.333	0.593	-0.721	1.000			
DomCred	0.473	0.421	-0.684	0.740	1.000		
Cpi	0.402	0.577	-0.675	0.649	0.679	1.000	
Lifeexp	0.399	0.536	-0.741	0.522	0.728	0.651	1.000

Where RGrowth = Real GDP per capita growth rate, DomCred = domestic credit to the private sector, Inf = inflation, LifeExp = Life expectancy, Bankdepo = bank deposit, Liquidliab = liquid liabilities to GDP, and DepositInt = deposit interest rate.

Liberia

Variables	RGrowth	Bankdepo	depositint	liquidliabi	DomCred	cpi	lifeexp
RGrowth	1.000						
bankdepo	0.142	1.000					
depositint	-0.038	-0.733	1.000				
liquidliabi	0.150	0.498	-0.742	1.000			
DomCred	0.030	0.715	-0.630	0.710	1.000		
Cpi	-0.031	0.563	-0.617	0.556	0.736	1.000	
Lifeexp	0.049	0.596	-0.518	0.486	0.639	0.623	1.000

Where RGrowth = Real GDP per capita growth rate, DomCred = domestic credit to the private sector, Inf = inflation, LifeExp = Life expectancy, Bankdepo = bank deposit, Liquidliab = liquid liabilities to GDP, and DepositInt = deposit interest rate.

Sierra Leone

Variables	RGrowth	Bankdepo	depositint	liquidliabi	DomCred	cpi	lifeexp
RGrowth	1.000						
bankdepo	0.042	1.000					
depositint	-0.221	-0.423	1.000				
liquidliabi	-0.023	0.549	-0.331	1.000			
DomCred	0.117	0.735	-0.249	0.661	1.000		
Cpi	0.078	0.656	-0.345	0.489	0.355	1.000	
Lifeexp	0.189	0.679	-0.406	0.456	0.477	0.688	1.000

Where RGrowth = Real GDP per capita growth rate, DomCred = domestic credit to the private sector, Inf = inflation, LifeExp = Life expectancy, Bankdepo = bank deposit, Liquidliab = liquid liabilities to GDP, and DepositInt = deposit interest rate.

CHAPTER 4

THE IMPACT OF FINANCIAL INNOVATION ON ECONOMIC GROWTH IN SSA COUNTRIES

4.1. Introduction and background

Financial innovation is the creation of new financial instruments, products or institutions and includes mundane financial improvements such as new financial reporting procedures, improvements in data processing and credit scoring (Laeven, Levine & Michalopoulos, 2015:3). As described in Chapter 1, theoretical contributions to the financial innovation and economic growth relationship can be divided into two broad categories, namely 'innovation-growth' and 'innovation-fragility'. The 'Innovation-growth' view suggests that financial innovation such as electronic payments technologies, information exchange (credit reports and credit scoring), and securities (such as bonds and shares) improves the quality of banking services such as deposits, and offers diverse banking products, which in turn expand economic growth (Allen & Gale, 1991, Berger, 2003, Dynan, Elmendorf & Sichel, 2006). The 'innovation-fragility' perspective suggests that financial innovation creates financial fragility, that is, small financial shocks with detrimental effects (Allen & Carletti, 2006, Wagner, 2007, Gennaioli, Shleifer & Vishny, 2012). Financial innovation stimulates fire sales when both investors and intermediaries try to sell out cash flow securities with neglected risks, thereby creating financial fragility as evidenced in the 2007–2008 global financial crisis. Due to the lack of consensus on the relationship between financial innovation and economic growth, this paper empirically investigates the impact of financial innovation on economic growth.

Existing studies have examined the impact of financial innovation along various dimensions. Some studies, such as Attanasio, Guiso and Jappelli's (2002), focus on financial innovation and money demand while others explore financial innovation and welfare, for example Allen (2012). Additionally, Laeven, Levine and Michalopoulos (2015) and Xu, Qamruzzaman and Adow (2021), and Naeem et al. (2023) analyse financial innovation and economic growth. These studies highlight the high development rate of financial innovation in both developed and developing economies. Previous research uses diverse indicators to account for financial innovation: research and development spending, mobile money, banking sector credit to private sector to gross domestic product (GDP), and the ratio of broad money to narrow money (Bara, Mugano & Le Roux, 2016, Bernier & Plouffe, 2019, Laeven, Levine

& Michalopoulos, 2015, Xu, Qamruzzaman & Adow, 2021, Calderon & Liu, 2003, Ahmad et al., 2023). While these proxies do account for financial innovation, the movement (either positive or negative) of financial innovation on economic growth remains unanswered.

The questions this study addresses are 1) Does financial innovation have a symmetric (same magnitude) and asymmetric (different magnitude) impact on economic growth? 2) Are there short-run and long-run impacts of financial innovation on economic growth? The asymmetric disaggregates financial innovation into positive and negative changes to investigate how these changes in financial innovation improve or hamper economic growth. The symmetric does not decompose financial innovation into positive and negative changes but investigates the aggregate financial innovation impacts on economic growth. According to the research surveyed, there is no existing study that examines the symmetric and asymmetric impact of financial innovation on economic growth.

In macroeconomics, long run denotes the time over which firms can enter or leave an industry, the time wherein capital stock can be replaced and the period over which all prices, wage contracts, tax rates and expectations can fully adjust (Samuelson & Nordhaus, 2004). The opposite is true in the short run. In other words, short run is a period in which one of the factors of production remains unchanged (for example, capital) while long run is a time horizon in which all the factors of production are flexible (for example, when a firm purchases additional capital). The concept of short and long run is relevant to economic growth (and not just to firms) because it reveals how the economy absorbs and reacts to time horizon and volatility in financial innovation. Therefore, an investigation on the short run and long run impact of the financial innovation and economic growth relationship is relevant.

Motivated by the above background information, the research objective of this study is to investigate the impact of financial innovation on economic growth in SSA. This thesis aims to fill the gap in the existing literature on financial innovation by contributing to the debate on the relationship between financial innovation and economic growth in four important ways. The first contribution of the paper in this regard is to empirically examine the symmetric and asymmetric impacts of financial innovation on economic growth. The purpose is to ascertain if there is a presence of linear and nonlinear impacts in the financial innovation and economic growth relationship. The symmetric estimation examines if there is a presence of linear impact in the financial innovation and economic growth relationship. The asymmetric impact, unlike the symmetric impact, decomposes financial innovation into positive (increase) and negative

(decrease) components to examine how economic growth reacts to these components of financial innovation. The asymmetric estimation examines if there is a presence of nonlinear impact in the financial innovation and economic growth relationship.

The second contribution of this study is the investigation of the time-varying (short-run and long-run) relationship between financial innovation and economic growth. This is relevant because it presents whether the impact of financial innovation on economic growth experiences a temporal gain (short run) or long-term benefits or decline (long run). The third contribution of this study is to examine the asymmetric impacts of financial innovation on economic growth per country. The reason for estimating per country is to reveal how increase and decrease changes in financial innovation impact economic growth for the individual countries used in the sample. Lastly, this study focuses exclusively on SSA, a region that is exposed to relatively new financial innovative processes, operators, and products. SSA accounts for the highest cohort of mobile money (a type of financial innovation) users worldwide, with Kenya in East Africa taking the lead (Demirguc-Kunt et al., 2015, Anderson-Manjang & Naghavi, 2021). As such, a thesis on this topic focusing exclusively on SSA is relevant.

This study employs two panel econometric techniques, namely autoregressive distributed lag (ARDL) and nonlinear autoregressive distributed lag (NARDL). As will be described in section 4.3.3. ahead, the linear ARDL model tests for the symmetric relationship between financial innovation and economic growth. The nonlinear ARDL tests for the asymmetric relationship, that is the impact of the positive and negative changes of financial innovation on economic growth.

Using data from 20 SSA countries between the period 1990 and 2020, this study concludes that financial innovation has a symmetric impact on economic growth in SSA—the relationship is positive and statistically significant in the long run. The result of the asymmetric impact of the two variables shows that an increase in financial innovation has a positive and significant impact on economic growth in both the short-run and long-run. In the long-run, a decrease in financial innovation has a negative asymmetric relationship with economic growth. The policy implication of this study is that SSA should invest more in developing and promoting financial innovative products, processes, and institutions to enhance economic growth. Other forms of localised financial innovation targeting the underprivileged or disadvantaged groups of the respective populations should be implemented. Governments

should implement and reinforce policies that will advance financial innovation and promote economic growth.

The remainder of this chapter is organised as follows: Section 4.2, which presents the theoretical and empirical literature review of financial innovation on economic growth. Section 4.3, which describes the data, model specification and methodology used in this paper. Section 4.4, which reports the result of the impact of financial innovation on economic growth. And finally, Section 4.5, which concludes this chapter.

4.2. Theoretical and empirical literature review—Financial innovation and economic growth

4.2.1. Theoretical literature

The theoretical link between financial innovation and economic growth can be understood from Schumpeter's (1939) view as well as Hicks and Niehans's (1983) perspectives. In addition, this section categorises the financial innovation–economic growth link into the 'innovation-growth' strand and the 'innovation-fragility' strand.

Schumpeter (1939) was one of the first scholars to develop the theory of entrepreneurship. According to him, innovation, entrepreneurial activities, and market power are critical dimensions in economic growth (Carroll, 2006). In Schumpeter's view, technological innovation creates temporary monopolistic power and excess profits. These two factors serve as an incentive for entrepreneurs to develop new products and services. In the process of developing new products and services, entrepreneurs seek investment funds from financiers (banks). These financiers then invent new screening and monitoring procedures to circumvent the problems of asymmetric information that may emerge between them and entrepreneurs.

The Schumpeterian theory claims that the financiers' screening innovation leads to economic growth and technological innovation. The financier (bank) stimulates economic growth through innovation by monitoring the activities of firms (entrepreneurs) to manage high-risk and costly innovative activities (King & Levine, 1993, Levine, 1997). Financiers also channel innovation into growth by financing innovative activities such as new and/or improved products and processes that expand financial services (King & Levine, 1993, Michalopoulos, Laeven & Levine, 2009, Rousseau, 1998).

Although the Schumpeterian theory has been widely used in the financial sector, it has not been exempted from criticism. Upadhyay and Rawal (2018) criticise the theory to only focus on the innovative role of entrepreneurs and excludes the other critical aspects of entrepreneurs such as organisation and management skills. Another criticism of the theory is that it does not emphasise on risk bearing (acknowledging and accepting potential loss from a risk taken) as it does with innovation, even though entrepreneurship involves risk bearing and risk assessment (Upadhyay & Rawal, 2018).

Hicks and Niehans (1983) identify three ways in which financial innovation differs from innovation in other sectors: the exchange of current cash against future cash, connecting borrowers and lenders, and executing payment on behalf of customers. Hicks and Niehans (1983) introduce the idea that the core of financial innovation is to reduce transaction costs. With financial innovation, depending on the size of the payment system, the interpersonal cash transfer cost is reduced. If the cash transaction cost is lower within the same payment system than in other payment systems, Hicks and Niehans (1983) conclude that centralisation of the payment system is more efficient than its decentralisation.

One of the ways in which financial innovation lowers cash transfer costs is through the interpersonal transfer of interest-bearing assets. Because of financial innovation, assets can easily be transferred at a reduced transaction cost. Hence the demand for non-cash asset increases. In addition, financial innovation lowers the transaction cost of inter-bank-branch transfer compared to the transaction costs of inter-bank transfer. This means that both transaction and communication costs among local and international bank branches of the same parent bank are relatively lower than the transaction cost between different banks. Therefore, financial innovation positively affects financial services and hence economic growth by reducing transaction cost.

The evidence provided in the theoretical literature depicts two categories of the effect of financial innovation on the economy: ‘innovation-growth’ and ‘innovation-fragility’. The ‘innovation-growth’ view is supported by Allen and Gale (1991), Berger (2003), and Dynan, Elmendorf and Sichel (2006). Allen and Gale (1991) point out that firms innovate by issuing securities such as bonds, stocks, and shares, thus promoting risk-sharing due to financial innovation. Berger (2003) suggests that financial innovation such as internet banking, electronic payment technologies, and information exchange (credit reports/credit scoring) improves the quality of the banking services and offers diverse banking products. Dynan,

Elmendorf and Sichel (2006) state that financial innovation facilitates economic activities. The authors describe financial innovation as development in the lending and loan market that enables individuals and companies to borrow while also creating reforms in government policies.

Comparatively, the 'innovation-fragility' perspective is supported by Allen and Carletti (2006), Wagner (2007), and Gennaioli, Shleifer and Vishny (2012). Gennaioli, Shleifer and Vishny (2012) demonstrate that financial innovation creates financial fragility (that is, small financial shocks with detrimental effects) when intermediaries promote cash flow securities as demanded by investors. These cash flow securities are exposed to risks that are neglected by investors. When investors realise that these securities exhibit neglected risks, both investors and intermediaries try to sell them out, leading to financial fragility due to fire sales. Investors no longer demand the innovated cash flow securities but now demand safer traditional securities. Therefore, financial fragility occurs due to the increased demand for safer traditional securities.

According to Wagner (2007), financial development, and to an extent, financial innovation, have the advantages of reducing the cost of doing businesses in banks and improving the transparency of banking current assets. However, the disadvantage is that it can cause inefficiency in banks if bank managers engage in asset substation (opaque assets with lower profits). Banks engaging in opaque assets (not transparent and low performing assets) are prone to bank run, hence, bank regulation improves both the transparency and efficiency of the banking industry. Thus, financial development and financial innovation increase the transparency of banks' current assets but create incentive for banks to opt for assets that earn lower profits.

4.2.2. Empirical literature

Existing literature shows that financial innovation has a 'bright side' and a 'dark side'. Remarking on the former, Laeven, Levine and Michalopoulos (2015) state that financial innovation accelerates financial deepening and the rate of economic growth. Laeven, Levine and Michalopoulos (2015) conclude that without financial innovations, economies will stagnate regardless of their initial level of financial development. Prior and Santoma (2010) claim that financial innovation (for example, mobile banking, mobilisation of funds, and

strengthening of overall financial regulation) can contribute significantly to infrastructure investment and balanced economic growth.

Beck et al. (2014) analyse the 'bright and dark sides of financial innovation'. The bright side of financial innovation brings about capital and GDP per capita growth and growth in firms that rely on innovation. Qamruzzaman and Jianguo (2017) document that financial innovation expedites economic growth through financial development and in the efficient allocation of economic resources. This claim is supported by Forgor and Julie (2020), who state that financial innovation accelerates economic growth through financial development because financial development creates diverse financial products and services and, in the process, integrates the unbanked into the formal financial system and consequently improves economic growth. Further evidence of the positive financial innovation–economic growth relationship is observed in a recent study by Xu, Qamruzzaman and Adow (2021), demonstrating that financial innovation strengthens the financial system and introduces financial reforms into the economy.

On the 'dark side' of financial innovation, Henderson and Pearson (2011) state that financial innovation can be complex and has the potential to exploit investors and purchasers who lack adequate information about the financial market. Beck et al. (2014) provide evidence that financial innovation can cause higher growth volatility on firms that rely on external funding and innovation, higher bank losses, and greater bank profit volatility. Additionally, financial innovation in the form of credit default swaps, securitisation, and sub-prime mortgages has been considered one of the attributing factors to the 2007–2008 global financial crisis (Allen, 2012, Crotty, 2009, Llewellyn, 2009).

However, Allen (2012) deems financial liberalisation to be a greater contributor to the 2007–2008 global financial crisis than financial innovation, because financial liberalisation exposed banks and other financial intermediaries to the equity and real estate market, compounded with the exchange rate crisis that occurred when fiscal policies favoured a lower interest rate to cushion the banking crisis or raised interest rates to strengthen the currency. Yogesh (2017) claims that on one hand, financial innovation improves capital allocation and thereby promotes economic growth. On the other hand, Yogesh (2017) suggests that financial innovation leads to significant fragility in the financial sector due to the concealed risks that are primarily associated with derivative and speculative trading.

A recent study by Afzal and Gauhar (2020) offers that financial innovation by itself is good but has a detrimental effect on economic growth when it is misused or unchecked. The authors support these findings based on Johnson and Kwak's (2012) explanation that financial innovative instruments such as sub-prime mortgage and credit default swaps may hinder the aim of financial innovation, which is to allocate credit more efficiently. Therefore, empirical findings confirm that financial innovation indeed has a dark side.

Considering low- and middle-income countries (predominantly in the Asia-Pacific, Latin America, Caribbean, and SSA regions), Qureshi et al. (2021) analyse and compare innovation in Asia-Pacific and Latin America. The analysis reveals that both regions should invest more in innovation for sustainable economic growth. However, Asia-Pacific invests more in innovative activities than Latin America, leading to Asia-Pacific performing better in terms of economic growth. The study highlights that research and development, human capital, infrastructure access, and financial development are determinants of innovation in both regions.

Furthermore, it has been observed that in middle-income countries, financial development significantly boosts economic growth through the physical capital stock and total factor productivity channels (Yang, 2019). By using panel data of 72 countries, 34 high-income countries and 38 low- and middle-income countries between 2000 and 2015, Cheng, Chien and Lee (2021) find that financial development negatively affects economic growth, especially in high-income countries. The reason is that malfunctioning financial systems cause wastage of resources, lower investment, and poor financial regulation and supervision, which in turn hinders economic growth. In low- and middle-income countries, their results reveal that mobile growth (a form of financial innovation) is cost-effective, beneficial, and improves economic growth, while internet services (another type of innovation) cannot promote economic growth due to its unreasonable/high cost.

In Africa, the effect of financial innovation on economic growth has shown mixed results. Considering the case studies on the African continent, most of the research investigates the long- and short-run relationships between financial innovation and economic growth. In economics, 'long-run' is a term used to denote a period over which full adjustment to changes can take place. 'Long-run' is applied to the time over which firms can enter or leave an industry and the capital stock can be replaced, and the period over which all prices, wage contracts, tax rates, and expectations can fully adjust (Samuelson & Nordhaus, 2004). The opposite is true for 'short-run'.

Idun and Aboagye (2014) find that in Ghana for example, financial innovation (measured as the 'growth of bank credit to private sector % of GDP') has a negative relationship with economic growth in the long-run but has a positive relationship in the short-run. This result can be attributed to the nature of the innovative products. Meanwhile, Ansong, Marfo-Yiadom and Ekow-Asmah (2011) explore the effects of financial innovation on financial savings in Ghana. The results depict that financial innovation is positively related to financial savings in the long-run, but it is negatively related to financial savings in the short-run in the country. The reason for this is that Ghana has financial innovative products that encourage withdrawals rather than deposits (Ansong, Marfo-Yiadom & Ekow-Asmah, 2011). In Kenya, Mwinzi (2014) concludes that mobile banking (a type of financial innovation) has a greater impact on the financial sector and that there is a positive insignificant relationship between financial innovation and economic growth. Another study conducted by Bara and Mudzingiri (2016) demonstrates that in Zimbabwe, there is a long-run relationship between financial innovation and economic growth.

However, the result of the relationship between financial innovation and economic growth depends on the variables used to measure financial innovation. This finding is supported by Motsatsi (2016), who depicts that financial innovations in Botswana such as ATMs, electronic funds, transfers at point of sale, bank deposits, and credit to private sector have a positive impact on economic growth. Likewise, in Nigeria, recent findings by Adesete, Mohammed and Risikat (2021) support the finance–growth theory, which states that financial innovation boosts economic growth. Bara, Mugano and Le Roux (2016) establish the relationship between financial innovation and economic growth in the SADC region. The results demonstrate that there is a positive (although weak) long-run relationship between financial innovation and economic growth. In the short-run, financial innovation is statistically insignificant.

Recent evidence in SSA finds that financial innovation expands economic growth (Bekana, 2021), while Forgor and Julie (2020) find that financial innovation, measured as mobile banking, negatively impacts financial development and growth. Other research studies discuss financial innovation issues from another angle. Dunne and Kasekende (2018), for instance, find a negative long-run effect of financial innovation on money demand for 34 SSA countries for the period 1980 to 2013. Dunne and Kasekende (2018) maintain that their result supports the expectation that enhancing financial innovation leads to individuals holding fewer

liquid assets, thus lowering money demand. It is important to note that the studies reviewed do not consider the asymmetric or nonlinear aspect of the financial innovation–economic growth relationship. This study fills this gap in the literature.

Table 4.1. Selected empirical literature on the financial innovation–economic growth relationship

Author(s) and Year	Countries	Period	Method	Finding/Direction of Causality
Idun and Aboagye (2014)	Ghana	1990–2009	Bound testing ARDL and Granger causality test	Existence of a negative long-run relationship between financial innovation and economic growth. In the short-run, financial innovation positively relates to economic growth. A bidirectional causal relationship between economic growth and financial innovation exists in Ghana.
Bara, Mugano and Le Roux (2016)	SADC	1985–2014	ARDL and Granger causality test	There is a positive but weak relationship between financial innovation and economic growth. No causality is found between financial innovation and economic growth in SADC.
Bernier and Plouffe (2019)	23 countries	1996–2014	Within-country variation	Financial innovation (measured as research and development spending in the financial sector) is positively associated with economic growth.
Bekana (2021)	37 SSA countries	1996–2016	GMM, fixed and random effects	Institutional quality impacts economic growth through innovation.
Forgor and Julie (2020)	SSA	2011–2017	Linear regression model	Financial innovation (measured as mobile banking) has a negative relationship with financial development and economic growth.
Adesete, Mohammed and Risikat (2021)	Nigeria	2010–2020	ARDL and Polynomial distributed lag mixed data sampling model	The study supports the finance–growth theory. Financial innovation plays a significant role in Nigeria's economic growth.
Otekunrin, Chinoda and Matowanyika (2021)	30 African countries	2004–2018	Vector error correction model and Granger Causality test	Causality exists between financial innovation and economic growth, and financial innovation widens economic activities in Africa.

Nazir, Tan & Nazir (2021)	China, India, and Pakistan	1970–2016	ARDL and Granger causality test	There is a positive and statistically significant relationship between financial innovation and economic growth. The financial sector supports financial innovation in African countries.
Shehzad et al. (2021)	China	2000–2019	ARDL model	Financial innovation has a direct impact on economic growth.
Xu, Qamruzzaman and Adow (2021)	India and Pakistan	2004–2018	ARDL, nonlinear ARDL and Granger causality tests	A positive link exists between financial innovation and economic growth in India and Pakistan.
Misati et al. (2022)	Kenya	2009–2020	ARDL	Financial innovation in the form of internet and mobile banking has a strong impact on financial depth, while bank branches and automated teller machines (types of financial innovation) have lower impacts on financial depth.
Effiom and Edet (2022)	Nigeria	2009–2017	ARDL	Financial innovation is a positive and significant determinant of small and medium enterprises in Nigeria.
Ahmad et al. (2023)	146 countries	1994–2016	Fixed and random effects, and system GMM	Mobile money, a type of financial innovation, has a significant impact on economic growth.
Naeem et al. (2023)	92 countries	2002–2020	Random and fixed effects	There is a negative relationship between financial innovation and economic growth.

In summary, existing empirical literature on this topic, particularly in Africa, focuses on the long- and short-run, positive and negative, relationships between financial innovation and economic growth. (for example, Idun & Aboagye, 2014, Forgor & Julie, 2020). Others focus on the causality between financial innovation and economic growth (for example, Bara, Mugano & Le Roux, 2016, Otekunrin, Chinoda & Matowanyika, 2021). This study differs from existing studies as it examines the symmetric and asymmetric effects of financial innovation on economic growth, this means, whether an increase or a decrease in financial innovation has different effects on economic growth.

4.3. Data, model specification, and methodology: Financial innovation and economic growth

4.3.1. Data sources and variables

The panel data consists of annual data for 20 SSA countries between 1990 and 2020. The data is obtained from the World Bank's World Development Indicators (2023). The choice of the number of countries and the period is based on the availability of data. The list of countries and a description of the variables used in this study are detailed in Appendices C4.1. and C4.2. The dependent variable is real GDP per capita growth rate, which measures economic growth, other literature such as Bernier and Plouffe's (2019) uses real GDP per capita growth rate, as a dependent variable in investigating the relationship between financial innovation and economic growth in a panel study of 23 countries.

The main independent variable of interest in this study is financial innovation since this is used to estimate its impact on economic growth. Financial innovation is proxied as the growth rate of credit to the private sector to GDP, the ratio of broad money to narrow money (M2/M1). Some of the other proxies of financial innovation are not used in this study because they are relatively new, for example, mobile money and ATM concentration. These types of financial innovation were introduced in Africa around the year 2004, thus data is unavailable for earlier years. This study includes the following control variables: trade openness to proxy for the extent of openness in the economy, inflation to proxy for macroeconomic stability, government expenditure to measure the size of the government, and capital formation, which accounts for investment.

Measures of financial innovation:

The growth rate of credit to the private sector to GDP

In line with Laeven, Levine and Michalopoulos's (2015) work, this study uses the growth rate of credit to the private sector to GDP as a proxy for financial innovation. A higher credit to the private sector to GDP depicts an improvement in financial services (Laeven, Levine & Michalopoulos, 2015, Calderon & Liu, 2003). This measure captures the credits that are issued by the private sector and excludes those issued by the public sector and central bank. More specifically, it is the credit extension by the private sector, although it excludes credit extension

by the central bank to the private sector, which is typically important for repurchase agreements and short-term or overnight loans from the central bank to commercial banks.

Ratio of broad money to narrow money (M2/M1)

Another measure of financial innovation used in this study is the ratio of broad money to narrow money (M2/M1). M2/M1 affects the demand for money and the demand for real cash balances. The ratio of broad money to narrow money (M2/M1) is commonly used as a financial innovation measure (Ansong, Marfo-Yiadom & Ekow-Asmah, 2011, Bara, Mugano & Le Roux, 2016, Mannah-Blankson & Belnye, 2004).

Control variables:

Inflation

Inflation is measured by the consumer price index and accounts for macroeconomic stability. Studies conducted by Mahawiya (2015) and Barcola and Kebalo (2018) reveal that inflation has a threshold effect on economic growth, meaning that it is beneficial to economic growth up to a certain point, after which it can be detrimental to economic growth. In a study comparing the SADC and ECOWAS regions, Mahawiya (2015) estimates necessary inflation thresholds of 14.5% and 17.9% for financial development in each region, respectively. In West Africa, Barcola and Kebalo (2018) conclude that the inflation threshold is between 8.01% and 15.46%. Inflation positively impacts economic growth when it is within that range, otherwise it bears a hindering effect.

Government expenditure

Government expenditure is an indication of the size of the government and fiscal stability. It does not necessarily imply a causal relationship with economic growth according to Wagner's (1958) law, which states that as the economy grows, there is a corresponding and inevitable increase in public sector spending relative to the overall economy. Depending on the productivity of government projects, government expenditure may have either a positive or negative impact on economic growth. Government expenditure that is focused on developmental activities such as education and infrastructure promote economic growth, while non-developmental activities may impede economic growth.

Gross fixed capital formation

Gross fixed capital formation is an indication of investment. Capital formation captures the value of fixed assets in the economy. In SSA, capital formation and economic growth have a bidirectional relationship. This means that as economic growth expands, so too does capital formation. Therefore, higher capital formation leads to higher economic growth (Uneze, 2013).

Trade openness

Trade openness is the sum of export and import as per GDP. It is expected to positively impact economic growth. Theoretical literature such as that of Thirlwall (2000) asserts that trade openness enables local entrepreneurs to gain access to international markets. It also promotes competition in an economy (Rajan & Zingales, 2003).

4.3.2. Descriptive statistics

Table 4.2 indicates the descriptive statistics of the variables used in this study. The average ratio of the different measures of financial innovation (the ratio of broad money to narrow money and the growth rate of credit to private sector to GDP) used in this study suggests that SSA's economies should invest more on financial innovation. All the measures of financial innovation show that the mean values are below 15% (see Table 4.2.), which means that the SSA economies are characterised by low levels of financial innovation. However, the wide variation on the maximum and minimum values of different measures of financial innovation depicts that financial innovation products are more developed in some SSA countries than others. For example, the average ratio of broad to narrow money is 11.5% and the ratio ranges from 0.2% to 101.4%.

The descriptive statistics display a wide disparity among the variables of interest in this study. The real GDP per capita growth rate shows that countries in SSA are at different income levels and that the growth rate overall is low. The economic growth rate in SSA has currently been negatively impacted by the Covid-19 pandemic, which could lead to low rates of economic growth. As such, the data suggest that countries in SSA are heterogeneous due to different political and economic backgrounds, policies, and reforms. However, it is worth examining SSA at whole (panel study) and analysing each country separately, because SSA as

a region is exposed to similar financial innovative processes, operators, and products. For example, the presence of mobile money (a form of financial innovation) is common in SSA countries. The region's economies are also faced with similar challenges, especially in relation to economic growth.

Table 4.2. a) Descriptive statistics—Actual data

Variable (actual data)	Obs	Mean	Std.Dev.	Min	Max
Real GDP per capita growth rate	620	1.017	5.087	-47.503	37.535
Fin. Inn /broad-narrow money	620	11.253	52.654	0.191	101.425
Fin. Inn /growth rate of credit PS/GDP	600	0.032	0.164	-0.574	0.739
Inflation	618	93.759	156.05	0.188	336.82
Government expenditure	620	14.338	6.544	0.911	39.451
Capital formation	620	21.669	9.567	2.781	81.021
Trade	620	67.963	39.868	0.785	225.023

Obs = Number of observations, Std. Dev = Standard deviation, Min = Minimum, Max = Maximum.
Source: World Bank (2022) database Where: Fin. Inn – Financial innovation, Broad-narrow money – the ratio of broad money to narrow money, and Growth rate of credit PS/GDP - the growth rate of credit to private sector to GDP.

Table 4.2. b) Descriptive statistics—Log-transformed data

Variable	Obs	Mean	Std.Dev.	Min	Max
Log real GDP per capita growth rate	431	0.766	1.023	-6.317	3.625
Log fin. inn / broad-narrow money	620	1.144	1.191	-1.656	6.923
Log fin. inn / growth rate of credit PS/GDP	357	-2.551	1.160	-7.597	-0.303
Log inflation	618	4.184	0.916	-1.670	8.121
Log government expenditure	620	2.541	0.546	-0.093	3.675
Log capital formation	620	2.980	0.456	1.023	4.395
Log trade	620	4.040	0.673	-0.243	5.416

Obs = Number of observations, Std. Dev = Standard deviation, Min = Minimum, Max = Maximum.
Source: World Bank (2022) database Where: Fin. Inn – Financial innovation, Broad-narrow money – the ratio of broad money to narrow money, and Growth rate of credit PS/GDP - the growth rate of credit to private sector to GDP.

Tables C4.3. to C4.5. in Appendix C Appendix C display the correlation matrix of the association between the independent variables and the real GDP per capita growth rate. The measure of financial innovation (the growth rate of credit of the private sector to GDP) used in this study shows a positive relationship with economic growth. The other measure of financial innovation, which is the ratio of broad money to narrow money depicts a negative relationship with economic growth. Hence, a further empirical investigation is conducted to assess the asymmetric and symmetric impacts of financial innovation on economic growth.

4.3.3. Model specification and methodology

To empirically examine the impact of financial innovation on economic growth, this study adopts the theoretical underpinning of the 'AK' endogenous growth model proposed by Pagano (1993). The AK model shows that financial development may boost economic growth through technology, innovation, income distribution, and institutional quality.

Let us consider a simple endogenous AK model, wherein output is a linear function of capital stock. The production function is expressed as:

$$Y_t = AK_t \qquad (1)$$

Where Y – output, K – capital stock, t – time and A – marginal productivity of capital.

The model simplifies the production function and assumes that population is constant and that the economy produces only one good that can either be consumed or invested. If the single good produced is invested and not consumed, it depreciates at a rate of δ per period. Hence, gross investment is expressed as:

$$I_t = K_{t+1} - (1 - \delta)K_t \qquad (2)$$

In a closed economy, with no government intervention, for capital market equilibrium condition to occur, gross saving S_t must be equal to gross investment I_t. The model also assumes that a proportion of the flow of saving $(1 - \emptyset)$ is lost by means of financial intermediation. Thus we obtain:

$$\emptyset S_t = I_t \qquad (3)$$

From equation 1, the growth rate at time (t+1) is expressed as:

$$g_{t+1} = (Y_{t+1}/Y_{t-1}) = (K_{t+1}/K_{t-1}) \qquad (4)$$

By using equation 2 and eliminating the time factor, the steady-state growth rate is obtained as:

$$g = A\frac{I}{Y} - \delta = A\emptyset S - \delta \qquad (5)$$

Therefore, from equation 5, it can be said that the growth rate (g) is a function of marginal productivity of capital A, savings rate S and the proportion of savings invested less

depreciation δ. The model suggests that financial development boosts economic growth through the following ways: increase in savings rate, increase in investment obtained by savings, and decrease in the proportion of savings spent on inefficient intermediations. However, the endogenous growth theory states that there are other factors that affect economic growth other than an increase in capital stock. As such, 'A' in equation 5 can represent the total factor productivity (TFP) and it is endogenously determined. Factors such as innovation/financial innovation, research and development, and human capital can affect economic growth through the TFP channel in addition to capital accumulation. Idun and Aboagye (2014) propose that the endogenous growth model allows diverse factors in an open economy, especially, to influence economic growth through the TFP channel.

Based on the theoretical framework discussed above and following the study by Laeven, Levine and Michalopoulos (2015), this study empirically examines the impact of financial innovation on economic growth in SSA. The estimation equations are outlined below:

The long-run model between financial innovation and economic growth is expressed as:

$$RGDPPC_{it} = \alpha_i + \beta FI_{it} + \delta X_{it} + \varepsilon_{it} \quad (6)$$

Where real GDP per capita growth rate (RGDPPC) is the dependent variable. Financial innovation (FI) is the independent variable and X represents the control variables, which consist of inflation, government expenditure, capital formation, and trade.

To account for both the long-run and short-run estimates, this study redefines equation (1) by employing the ARDL model proposed by Paseran and Shin (1995).

The generalised ARDL (p, q, q... q) model can be expressed as:

$$RGDPPCG_{it} = \Sigma_{j-1}^{p} \alpha_j RGDDPCG_{i,t-j} + \Sigma_{j-0}^{q} \beta_{ij}' FI_{i,t-j} + \Sigma_{j-0}^{q} \delta_{ij}' X_{i,t-j} + \gamma_i + \varepsilon_{it} \quad (7)$$

Where $RGDPPCG_{it}$ represents the dependent variable, $FI_{i,t}$ and $X_{i,t}$ are the vectors that assume that the variables are strictly either I (1) or I (0). These variables are financial innovation and the control variables. α is the coefficient of the lagged dependent variables, β represents the coefficient vectors, γ_i is the unit-specific fixed effects, ε_{it} is the error term, p and q represent the maximum lags for the dependent and independent variables, respectively, and i and t represent country and time, respectively. The generalised ARDL (p, q, q... q) model can be re-parameterised and expressed in an error correction form.

The details of the ARDL model expressed in an error correction form as follows:

$$\Delta RGDPPC_{it} = \theta_i\left[RGDPPC_{i,t-1} - \lambda_i' FI_{i,t} - \lambda_i' X_{i,t}\right] + \Sigma_{j=1}^{p-1} \alpha_{ij} \Delta RGDPPC_{i,t-j} + \Sigma_{j=0}^{q-1} \beta_{ij}' \Delta FI_{i,t-j} + \Sigma_{j=0}^{q-1} \delta_{ij}' \Delta X_{i,t-j} + \gamma_i + \varepsilon_{it} \quad (8)$$

Where θ_i is the group specific speed of adjustment coefficient, $\theta_i = -(1-\eta_i)$; λ_i' represents the vector of long-run relationships; $\left[RGDPPC_{i,t-1} - \lambda_i' FI_{i,t} - \lambda_i' X_{i,t}\right]$ is the error correction term; both δ_{ij} and β_{ij}' are the short-run dynamic coefficients.

To test the asymmetric impact of financial innovation on economic growth, this study applies the NARDL model recommended by Shin, Yu and Greenwood-Nimmo (2014), which considers the positive and negative changes of the independent variables (financial innovation). These changes in financial innovation are derived by using the positive and negative partial sum decomposition of financial innovation and specified as:

$$\mathrm{FI}_t^+ = \Sigma_{n=1}^{t} \Delta \mathrm{FI}_t^+ = \Sigma_{n=1}^{t} \max\left(\Delta \mathrm{FI}_t^+, 0\right) \quad (9)$$

$$\mathrm{FI}_t^- = \Sigma_{n=1}^{t} \Delta \mathrm{FI}_t^- = \Sigma_{n=1}^{t} \max\left(\Delta \mathrm{FI}_t^-, 0\right) \quad (10)$$

Since the NARDL model is an extension of the ARDL technique, substituting equations (9) and (10) into equation (8) gives the asymmetric equation, which is expressed as:

$$\Delta RGDPPC_{it} = \theta_i\left[RGDPPC_{i,t-1} - \lambda_i' \mathrm{FI}_{i,t}^+ - \lambda_i' \mathrm{FI}_{i,t}^- - \lambda_i' X_{i,t}\right] + \Sigma_{j=1}^{p-1} \alpha_{ij} \Delta RGDPPC_{i,t-j} + \Sigma_{j=0}^{q-1} \beta_{ij}' \Delta \mathrm{FI}_{i,t-j}^+ + \Sigma_{j=0}^{q-1} \beta_{ij}' \Delta \mathrm{FI}_{i,t-j}^- + \Sigma_{j=0}^{q-1} \delta_{ij}' \Delta X_{i,t-j} + \gamma_i + \varepsilon_{it} \quad (11)$$

The advantages of the ARDL and NARDL models are that they provide long-run and short-run estimates, which are unbiased and reliable. Similar to the ARDL, the NARDL requires the confirmation of the cointegration in order to test the long-run relationship between financial innovation and economic growth. Both the ARDL and NARDL models require a panel stationary test and accept regressors with different orders of integration, either I(0) or I(1) and not higher order of integration.

Diagnostic tests

This study utilises the following diagnostic tests: the panel unit root test and panel heterogeneity test.

Panel unit root tests

To obtain the order of integration for each of the variables under investigation, the Im-Pesaran-Shin (IPS) and the Fisher-type unit root are conducted. Both unit root tests can be used for an unbalanced panel. The IPS unit root test developed by Im, Pesaran and Shin (2003) assumes that all panels do not share a common autoregressive parameter ($P_i \neq$P; for all 'i'; where i – country). This means that the rate of convergence is not the same for all panels under examination. This assumption is practical because the panel dataset is influenced by different factors such as culture, politics, and institutions.

The IPS unit root test is a set of Dickey-Fuller regression, and it is specified as:

$$\Delta y_{it} = \emptyset_i y_{i,t-1} + Z_{it}^{/}\gamma_i + \varepsilon_{it} \qquad (12)$$

Where: $\emptyset$ - panel-specific and it is a constant

Δy_{it} – variables to be tested

ε_{it} – stationary error term. (ε_{it}) has heterogeneous variance (σ_i^2) across panels and is independently distributed normally for all i and t

z_{it} – panel-specific means and equal to one

$Z_{it}^{/}\gamma_i$ – panel-specific means (fixed effects)

i – panels (for example, countries)

t – time

Maddala and Wu (1999) describe the IPS as applying the above equation (12) separately to each panel and then averaging the resulting test statistic. The null hypothesis of the IPS test indicates that 'all panels contain a unit root' – that is $\emptyset_i = \emptyset$. The alternative hypothesis states that 'some panels are stationary'. The alternative hypothesis means that the fraction of panels that are stationary is nonzero – that is, as N goes to infinity ($N \to \infty$), the fraction $\frac{N_i}{N}$ converges to a nonzero value, where N is the number of panels and N_i is the number of stationary panels.

The Fisher-type of unit root test performs the Augmented Dickey Fuller (ADF) and the Phillips-Perron (PP) unit root tests. The Fisher-type of unit root test performs an independent unit root test on each panel, after which it combines the p-values to obtain an overall test statistic. Choi (2001) proposes four different methods that can be used to combine the p-values obtained from the independent unit-root test on each panel: the inverse chi-squared (x^2), the inverse normal, the inverse-logit transformation of p-values, or the modification of the inverse chi-squared transformation. The modification of the inverse chi-squared transformation can only be used when N goes to infinity. The others are suitable regardless of whether N tends to infinity or not. In this study, we perform the ADF and PP Fisher-type unit root tests. This study uses the inverse normal Z statistics results, because that is the recommended option according to StataCorp. (2019) software.

Panel autocorrelation

This study applies the Durbin-Watson panel data autocorrelation test. This test determines the presence or absence of autocorrelation in the data series. The null hypothesis is given as 'no panel autocorrelation' against the alternative hypothesis, which is 'panel autocorrelation'. In the presence of autocorrelation, the 't'- and 'f'-statistics of the regression result become insignificant.

Panel heteroscedasticity

The test for heteroscedasticity determines whether heteroscedasticity is present among the variables under investigation. This study utilises the Breusch-Pagan Lagrange Multiplier panel heteroscedasticity test, which assesses whether the variance of the errors from an estimation depends on the values of the explanatory variables. It allows for unbalanced panel data and the result is reported as chi-squared (x^2).

The null hypothesis of the Breusch-Pagan Lagrange Multiplier panel heteroscedasticity test is 'panel homoscedasticity', while the alternative hypothesis states 'panel heteroscedasticity'. Rejecting the null hypothesis indicates the presence of heterogeneity among the variables. This means that the regression result is inefficient and that the test statistics (t-test, f-test) are invalid.

4.4. Results—Financial innovation and economic growth

4.4.1. Diagnostic tests

4.4.1.1 Panel unit root test results

In the ARDL and NARDL models, the panel stationary test of the regressors is essential in obtaining a consistent result. The models require that the order of integration of the regressors be stationary at level or at first difference—in this instance, I(1) or I(0). Higher orders of integration produce inconsistent and spurious regression results with ARDL and NARDL models. To establish that regressors used in the study are I(0) or I(1), we employ three unit root tests, namely Im-Pesaran-Shin (IPS), Augmented Dicker Fuller (ADF), and Phillips-Perron (PP). These tests are suitable for dynamic heterogeneous panel datasets and allow for unbalanced panel datasets. Table 4.3. provides the panel unit root result for the variables used to examine the impact of financial innovation on economic growth. The unit root results show that the data used in this study contains both stationary at level and stationary at first differenced series.

Unit root tests

Table 4.3. Panel unit root results

	IPS		ADF		PP	
Variable	Level	1st diff	Level	1st diff	Level	1st diff
Real GDP per capita growth rate	-8.2650*** (0.0000)	-	16.0948*** (0.0000)	-	35.6488*** (0.0000)	-
Fin Inn: Broad/narrow money	-5.7294*** (0.0000)	-	11.5530*** (0.0000)	-	10.1913*** (0.0000)	-
Fin Inn: Growth rate of credit PS / GDP	-9.7775*** (0.0000)	-	20.9788*** (0.0000)	-	42.9938*** (0.0000)	-
Inflation	11.6396 (1.0000)	-2.9100*** (0.0000)	-4.0524 (1.0000)	13.6079*** (0.0000)	-4.2731 (1.0000)	17.0002*** (0.0000)
Government expenditure	-0.6787 (0.2487)	-13.8668*** (0.0000)	2.2521** (0.0122)	-	1.7633** (0.0389)	-
Capital formation	-2.2992** (0.0107)	-	2.7059*** (0.0034)	-	3.7786*** (0.0000)	-
Trade	-1.1839 (0.1182)	-13.8173*** (0.0000)	1.0121 (0.1553)	31.9498*** (0.0000)	8.2771*** (0.0000)	-

Notes: The standard errors are in parentheses. Dependent variable: real GDP per capita growth rate (economic growth). ***significance at 1% level, **significance at 5% level, *significance at 10% level. Where: Fin. Inn – Financial innovation,

Broad-narrow money – the ratio of broad money to narrow money, and Growth rate of credit PS/GDP - the growth rate of credit to private sector to GDP.

4.4.1.2. Autocorrelation, and heteroscedasticity tests

Table 4.4. below also provides the results of the Breusch-Pagan Lagrange Multiplier panel heteroscedasticity tests, as well as the result of the Durbin-Watson panel autocorrelation test. The results confirm the presence of autocorrelation and heteroscedasticity in the dataset used in Models 1, and 2. The null hypothesis of the autocorrelation tests is 'no autocorrelation' versus the alternative hypothesis of 'autocorrelation'. Both tests reject the null hypothesis of 'no autocorrelation', thus indicating the presence of autocorrelation.

Similarly, the null hypothesis of 'panel homoscedasticity' was rejected. This indicates the 'presence of heteroscedasticity' among the data series. To correct for the presence of autocorrelation and heteroscedasticity, this study uses the robust standard errors. In the presence of heteroscedasticity and autocorrelation, the estimators produce unbiased and consistent coefficients, but biased standard errors of the coefficients. The robust standard errors produce unbiased standard errors of the coefficient in the presence of heteroscedasticity and autocorrelation.

Table 4.4. Panel autocorrelation and panel heteroscedasticity tests results

Tests	Model 1: Financial innovation (M2/M1) on economic growth	Model 2: Fin Inn (growth rate of credit PS/GDP) on economic growth
Panel Autocorrelation Durbin-Watson Test	df: (6, 430) = 0.8912 Panel Rho Value = 0.2779	df: (6, 254) = 0.7273 Panel Rho Value = 0.2354
Panel heteroscedasticity test Breusch-Pagan Lagrange Multiplier	LM Test = 495.65017, P-value > Chi2(19) = 0.00000	LM Test = 548.69816, P-value > Chi2(19) = 0.00000

Source: Author's compilation. Where: Fin. Inn – Financial innovation, M2/M1 – the ratio of broad money to narrow money, and Growth rate of credit PS/GDP - the growth rate of credit to private sector to GDP.

4.4.2 Empirical results

In this section, two sets of symmetric and asymmetric estimated results are presented in the following order. Model 1 presents the impact of financial innovation (measured as the ratio of broad money to narrow money) on economic growth and is displayed in Table 4.5. Model 2 presents the impact of financial innovation (measured as growth rate of credit to private sector to GDP) on economic growth and is reported in Table 4.6. Table 4.7 reports the asymmetric impact of financial innovation on economic growth per country.

4.4.2.1. Results of the impact of financial innovation on economic growth

The results of the asymmetric relationship between financial innovation and economic growth are reported in column 2 of Tables 4.5 and 4.6. This study performs two NARDL tests based on the two proxies of financial innovation, namely, 'the ratio of broad money to narrow money', and 'the growth rate of credit to private sector to GDP'. The results show that the impact of financial innovation on economic growth is stronger when financial innovation increases than when financial innovation decreases.

In the short-run, an increase in financial innovation (measured as the ratio of broad money to narrow money) leads to a 0.004% increase in economic growth, while a decrease in financial innovation leads to a 0.003% decrease in economic growth (see Table 4.5.). However, an increase and a decrease in financial innovation exhibit a statistically insignificant impact on economic growth in the short-run when financial innovation is measured as the ratio of broad money to narrow money.

A financial innovation increase (measured as growth rate of credit to the private sector to GDP) positively and statistically significantly impacts economic growth in the short-run. A financial innovation decrease (measured by the above-mentioned) negatively impacts economic growth, and it is not statistically significant. Hence, In the short-run, an increase in financial innovation (measured as the growth rate of credit to the private sector to GDP) leads to a 1.998% increase in economic growth and it is statistically significant, while a decrease in financial innovation leads to a 0.355% decrease in economic growth which is statistically insignificant (see Table 4.6.). So, in the short-run, financial innovation impacts economic growth with regards to the increase and decrease changes of financial innovation.

In the long-run, an increase in financial innovation has a positive and significant impact in economic growth for all the models. The coefficients of 0.011 from column 2 of Table 4.5., and 1.041 from column 2 of Tables 4.6. are all positive and statistically significant. The decrease in financial innovation exhibits mixed results in the long-run. The coefficients for financial innovation decrease in the long-run is statistically insignificant for the growth rate of credit to the private sector proxy of financial innovation. A decrease in financial innovation (measured as the ratio of broad money to narrow money) negatively and significantly impacts economic growth in the long-run. Regarding the long-run elasticities, a 10% decrease in

financial innovation reduces economic growth by 0.044% when financial innovation is measured as the ratio of broad money to narrow money.

The Wald test results establish that there is a short-run and a long-run asymmetric relationship between financial innovation and economic growth. The null hypothesis of the Wald test is that 'there is no asymmetry', while the alternative hypothesis is 'there is asymmetry'. The Wald test coefficients for all the models are statistically significant, confirming that asymmetric relationship does exist between financial innovation and economic growth.

The symmetric results of the impact of financial innovation on economic growth by the linear ARDL model is reported in column 1 of Tables 4.5., and 4.6. The results show that financial innovation has a positive and significant long-run relationship with economic growth. In the long-run, for example, financial innovation measured as 'the ratio of broad money to narrow money' exhibits a coefficient of 0.013, this means that 1 unit increase in financial innovation leads to a 0.013 unit increase in economic growth and 1 unit decrease in financial innovation leads to a 0.013 unit decrease in economic growth. In the short-run, financial innovation measured as 'the growth rate of credit to the private sector to GDP' displays a negative and significant relationship with economic growth, while financial innovation proxied as 'broad to narrow money' exhibits a negative and insignificant relationship with GDP. The error correction term (ECT) measures the speed of adjustment of the dependent variable from its short-run disequilibrium to its long-run equilibrium. The ECT coefficients for all models exhibit the following: a negative sign, an absolute value that is less than one, and statistically significance at the 1% level. This indicates cointegration, which means that there is a long-run relationship between financial innovation and economic growth.

Based on Tables 4.5., and 4.6., this study concludes that financial innovation has a positive and significant long-run symmetric impact on economic growth in SSA. An increase in financial innovation has a positive and significant long-run asymmetric impact on economic growth. This result is consistent with the 'innovation-growth' theoretical framework. See the work of, for example, Allen and Gale (1991); Berger (2003); and Dynan, Elmendorf and Sichel (2006). The aforementioned result is also in accordance with empirical literature such as the work produced by Laeven, Levine and Michalopoulos (2015), Qamruzzaman and Jianguo (2017), and Prior and Santoma (2010), among others. These studies, as discussed in the literature review section 4.2., maintain that financial innovation boosts economic growth. A

positive impact of financial innovation on economic growth in SSA is expressed by Bara, Mugano and Le Roux (2016), Ajide (2016), and Forgor and Julie (2020).

Furthermore, studies on low-middle-income countries (predominantly those in Asia-Pacific, Latin America, and SSA) support the positive link between financial innovation/financial development and economic growth (Qureshi et al., 2021, Yang, 2022, Cheng, Chien & Lee, 2021). A possible explanation for the positive impact of financial innovation on economic growth is the development and expansion of financial innovation products (such as mobile money, ATM concentration and bank branches) in SSA. The huge development and expansion of these money transfer methods create financial inclusion, foster job creation, and alleviate poverty, all of which positively contribute to economic growth.

However, the negative impact of financial innovation on economic growth in SSA cannot be ignored. A decrease in financial innovation has a negative asymmetric relationship with economic growth in the long-run, as seen by the results of Models 1 and 2 as reported in Tables 4.5. and 4.6., respectively. Ansong, Marfo-Yiadom and Ekow-Asmah (2011) explain that most financial innovation products promote withdrawals as opposed to savings. This provides a likely explanation for the negative effect of financial innovation. Although Bara, Mugano and Le Roux (2016) conclude a positive relationship between financial innovation and economic growth, the relationship is said to be weak as some variables the authors used to measure financial innovation resulted in a negative relationship. The ratio of broad money to narrow money (M2/M1) as a measure of financial innovation is one such variable that brings about a negative impact on economic growth, according to Bara, Mugano and Le Roux (2016).

Similarly, this study finds a decrease in financial innovation (the ratio of broad money to narrow money) negatively and significantly impacts economic growth in the long-run. The finding is consistent with the theory documented by Shaw (1973). When the financial system expands or is in the presence of financial deepening, savings deposits increase faster than transactions, which in turn promotes economic activities and growth. In developing countries, financial and economic growth are associated with financial deepening (Shaw, 1973). Hence, economic decline occurs with financial system contraction and the absence of financial deepening.

Regarding the control variables, trade openness plays a significant effect on economic growth in all the models. A positive and significant link between trade and economic growth

is expected and corresponds with studies conducted by Brueckner and Lederman (2015) and Keho (2017). Capital formation (investment) is positively but insignificantly related to economic growth in Models 1, and 2. This finding contradicts the bidirectional positive and significant relationship between capital formation and economic growth in SSA, as noted by Uneze (2013).

One possible reason for this result is that capital formation faces constraints (for example, high interest rates and low savings rates), which are prevalent in many SSA countries. These constraints affect the performance of capital formation and may have resulted in an insignificant impact on economic growth. In SSA, firms and non-financial corporations direct their income more towards consumption than towards the replacement of worn-out machinery and other capital, which may be another reason for the insignificant relationship. The sign of the coefficient shows that government expenditure has a negative impact on economic growth in all models.

Surprisingly, inflation has a negative and statistically insignificant impact on economic growth in all estimation techniques and models. A negative and significant impact of inflation on economic growth is observed by both theoretical and empirical studies. However, recent studies suggest a threshold effect of inflation on economic growth (Bandura, 2022, Barcola & Kebalo, 2018). Government expenditure is greatly influenced by the productivity of the government projects and/or how they are funded. Government expenditure allocated to non-developmental activities may deter growth, and similarly, government expenditure financed by borrowing or taxation may impair economic growth (Barro, 1991, Le Roux, 2015, Snowdon & Vane, 2005).

Table 4.5. Model 1: Financial innovation (measured as the ratio of broad money to narrow money) on economic growth

Variables	ARDL	NARDL
Dependent variable: RGDPPCG	(1)	(2)
	Short-run estimates	
Fin Inn: Ratio: Broad/Narrow money	-0.004	--
	(0.006)	
Fin Inn: Ratio: Broad/Narrow money (decrease)	--	0.003
		(0.018)
Fin Inn: Ratio: Broad/Narrow money (increase)	--	0.004
		(0.006)
Inflation	-0.004	-0.004
	(0.003)	(0.003)
Govt expenditure	-0.299**	-0.299
	(0.131)	(0.131)

Capital formation	0.052	0.052
	(0.054)	(0.054)
Trade	0.079***	0.079***
	(0.026)	(0.026)
ECT	-0.788***	-0.765***
	(0.074)	(0.076)
Constant	2.136***	2.780***
	(0.519)	(0.544)
	Long-run estimates	
Fin Inn: Ratio: Broad/Narrow money	0.013***	--
	(0.004)	
Fin Inn: Ratio: Broad/Narrow money (decrease)	-	-0.044***
		(0.016)
Fin Inn: Ratio: Broad/Narrow money (increase)	-	0.011**
		(0.004)
Inflation	-0.003	-0.003
	(0.001)	(0.001)
Govt expenditure	-0.062**	-0.062**
	(0.035)	(0.035)
Capital formation	0.029	0.029
	(0.023)	(0.023)
Trade	0.013**	0.012**
	(0.006)	(0.006)
Observations	599	599
Number of countries	20	20
	Long-run and short-run symmetry and asymmetry tests	
Ramsey RESET linearity test	1.82	-
	(0.142)	
Wald test for short-run asymmetry	--	3.58*
		(0.0587)
Wald test for long-run asymmetry	--	3.08*
		(0.0791)

Notes: The standard errors are in parentheses. Dependent variable: real GDP per capita growth rate (economic growth). ***significance at 1% level, **significance at 5% level, *significance at 10% level. Where: Fin Inn: Broad/Narrow money – the ratio of broad money to narrow money.

Table 4.6. Model 2: Financial innovation (measured as growth rate of credit to the private sector /GDP) on economic growth

Variables Dependent variable: RGDPPCG	ARDL (1)	NARDL (2)
	Short-run estimates	
Fin Inn: Growth rate of credit PS /GDP	-1.197 **	--
	(1.014)	
Fin Inn: Growth rate of credit PS /GDP (decrease)	--	0.355
		(1.160)
Fin Inn: Growth rate of credit PS /GDP (increase)	--	1.998**
		(1.247)
Inflation	-0.007	-0.001
	(0.003)	(0.003)
Govt expenditure	-0.276**	-0.274**
	(0.132)	(0.132)
Capital formation	0.043	0.042
	(0.053)	(0.053)
Trade	0.077***	0.077***

	(0.027)	(0.026)
ECT	-0.701***	-0.702***
	(0.082)	(0.084)
Constant	0.720***	0.973***
	0.645	0.662
	Long-run estimates	
Fin Inn: Growth rate of credit PS /GDP	2.427**	--
	(1.136)	
Fin Inn: Growth rate of credit PS /GDP (decrease)	--	-1.358
		(1.722)
Fin Inn: Growth rate of credit PS /GDP (increase)	--	1.041**
		(1.673)
Inflation	-0.001	-0.001
	(0.013)	(0.013)
Govt expenditure	-0.799**	-0.077**
	(0.035)	(0.035)
Capital formation	0.033	0.019
	(0.024)	(0.024)
Trade	0.013**	0.016**
	(0.006)	(0.006)
Observations	599	599
Number of countries	20	20
	Long-run and short-run symmetry and asymmetry tests	
Ramsey RESET linearity test	1.59	-
	(0.1905)	
Wald test for short-run asymmetry	--	4.78**
		(0.0292)
Wald test for long-run asymmetry	--	2.74*
		(0.0982)

Notes: The standard errors are in parentheses. Dependent variable: real GDP per capita growth rate (economic growth). ***significance at 1% level, **significance at 5% level, *significance at 10% level. Where: Fin Inn: Growth rate of credit PS /GDP – the growth rate of credit to the private sector to GDP.

4.4.3. Country-specific results

Table 4.7. below presents the results of the asymmetric impacts of financial innovation on economic growth per country. The rationale for estimating per country is to reveal how increase and decrease changes in financial innovation impact economic growth for the individual country explored in the sample. Out of the results for 20 countries in the sample, 10 countries confirmed that financial increase statistically significantly impact economic growth in the short-run, when financial innovation is proxied as the ratio of board money to narrow money. Like the panel study results, a decrease in financial innovation is insignificant for most of the countries, and those that exhibit statistically significance have a negative sign.

Decrease in financial innovation has a long-run insignificant impact or a negative and significant impact on economic growth for the individual countries. In the long-run, an increase in financial innovation positively and significantly impacts economic growth in 12 countries as reported in Table 4.7 below. According to the data surveyed, no existing study examines the

asymmetric (increase and decrease) impact of financial innovation on economic growth per country. This study compares the asymmetric results to the symmetric results of existing studies per individual country.

For instance, this study finds that in the long-run, a decrease in financial innovation exhibits a negative relationship with economic growth in Ghana. For the same country, an increase in financial innovation positively impacts economic growth in the short-run. This result corresponds with the study by Idun and Aboagye (2014), who find that in Ghana, financial innovation (measured as the 'the growth rate of credit to private sector to GDP') has a negative relationship with economic growth in the long-run but has a positive relationship in the short-run — this can be attributed to the nature of the innovative products.

In Kenya, a financial innovation decrease exhibits a positive but insignificant impact on economic growth in the long-run. This is supported by the study of Mwinzi (2014) in that a positive insignificant relationship exists between financial innovation and economic growth in the country. A positive impact of financial innovation increases on economic growth in both short-run and long-run for Botswana is supported by the study of Motsatsi (2016), who depicts that financial innovation has a positive impact on economic growth in the country. The same is true in Nigeria, where an increase in financial innovation in the country promotes economic growth both in the long and short-run. This finding aligns with Adesete, Mohammed and Risikat (2021) who supports the finance–growth theory, which states that financial innovation boosts economic growth.

Table 4.7. Country-specific results—Short-run and long-run

Financial Innovation: the ratio of broad money to narrow money				
Country	FI decrease	FI increase	FI decrease	FI increase
	Short-run		Long-run	
Botswana	-4.788	0.215*	-1.446	1.262**
	(11.777)	(10.610)	(8.231)	(7.149)
Burundi	-0.269	-0.090	0.185	0.030
	(0.694)	(0.422)	(0.477)	(0.341)
Cameroon	-0.013*	0.006**	-0.007	0.016**
	(0.018)	(0.014)	(0.019)	(.0146)
Central African Republic	-3.217	-4.106*	-2.845*	1.174*
	(4.825)	(4.544)	(4.058)	(3.772)
Chad	-0.020	-0.056	-0.073	-0.003
	(0.046)	(0.042)	(0.044)	(0.043)
Congo. Republic	0.0657	0.103	0.044	0.064***
	(0.086)	(0.063)	(0.113)	(0.094)
eSwatini	1.327	1.644**	-1.471	1.790**

	(1.765)	(1.545)	(2.693)	(2.285)
Gabon	-0.218**	0.044	0.015	-0.050
	(0.096)	(0.029)	(0.114)	(0.031)
Gambia The	2.401	2.348*	0.323	-0.169
	(2.507)	(2.064)	(2.081)	(1.682)
Ghana	-0.290**	0.137***	-0.793*	0.342**
	(0.844)	(0.678)	(0.689)	(0.570)
Guinea	-0.142	-0.043	0.459**	0.229*
	(0.144)	(0.097)	(0.170)	(0.124)
Kenya	0.615*	0.068	0.069	0.020**
	(0.184)	(0.068)	(0.238)	(0.074)
Madagascar	-1.042	-0.869	0.727	-0.030
	(1.679)	(1.269)	(0.798)	(0.540)
Mauritius	-1.611	-1.271	-0.277	0.172*
	(1.535)	(1.315)	(0.524)	(0.437)
Nigeria	-0.632	0.139**	-1.351	0.545**
	(1.304)	(0.812)	(1.045)	(0.652)
Rwanda	-5.113	3.502*	-4.293	-1.978*
	(3.557)	(1.785)	(5.347)	(4.155)
Seychelles	-0.003	0.031**	-0.101	-0.199
	(0.392)	(0.293)	(0.258)	(0.205)
South Africa	0.126*	0.114**	0.193*	0.115**
	(0.130)	(0.097)	(0.109)	(0.080)
Sudan	0.011	0.005	-0.027	-0.010**
	(0.033)	(0.006)	(0.029)	(0.004)
Tanzania	0.559	0.316*	-2.195**	1.467***
	(0.938)	(0.711)	(0.553)	(0.423)

Where FI = financial innovation.

Notes: The standard errors are in parentheses. Dependent variable: real GDP per capita growth rate (economic growth). ***significance at 1% level, **significance at 5% level, *significance at 10% level.

4.4.4. Robustness test

In addition to the panel regression results on the financial innovation–economic growth relationship (shown in Tables 4.5., and 4.6.), this study estimates the impact of financial innovation on economic growth per country (recorded in Table 4.7.). These estimates serve as robustness checks. The study also employs two econometric techniques—ARDL and NARDL, which depict the robustness of the results.

4.5. Conclusion

This study investigates the symmetric and asymmetric impacts of financial innovation on economic growth in 20 SSA countries and addresses the asymmetric relationship between the two elements per individual country. The main contribution that this study makes is the empirical examination of the symmetric and asymmetric impacts of financial innovation on economic growth by using the linear ARDL and nonlinear ARDL techniques. This study provides an asymmetric result for each country used in the sample. Another way this paper contributes to the current literature is by investigating the time-varying (short-run and long-

run) relationship between financial innovation and economic growth. Focusing exclusively on SSA serves as another key contribution of this research.

By using the ARDL and NARDL techniques, the overall finding of this study is that financial innovation has a symmetric impact on economic growth in SSA, the relationship is positive and statistically significant in the long-run. The result of the asymmetric impact of the two variables shows that an increase in financial innovation has a positive and significant impact on economic growth in both the short-run and long-run. In the long-run, a decrease in financial innovation has a negative asymmetric relationship with economic growth.

The policy implication of this study is that SSA should invest more in developing and promoting financial innovative products, processes, and institutions to enhance economic growth. Other forms of localised financial innovation targeting the underprivileged or disadvantaged groups of the respective populations should be implemented. Governments should implement and reinforce policies that will advance financial innovation and promote economic growth.

Regarding the limitations of the study, different countries have different particularities when it comes to financial innovation. For this reason, further research per country is suggested to determine the symmetric and asymmetric impacts between financial innovation and economic growth by using the measure of financial innovation that is specific and relevant to an individual country.

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Appendix C

Appendix C4.1. List of SSA countries used in this study

1. Botswana
2. Burundi
3. Cameroon
4. Central African Republic
5. Chad
6. Congo. Rep.
7. eSwatini
8. Gabon
9. Gambia, The
10. Ghana
11. Guinea
12. Kenya
13. Madagascar
14. Mauritius
15. Nigeria
16. Rwanda
17. Seychelles
18. South Africa
19. Sudan
20. Tanzania

Appendix C4.2. Variable list, descriptions, and sources

Variable list	Description	Source
Broad money to GDP (M2/GDP)	Sum of currency outside banks; demand deposits other than those of the central government; the time, savings, and foreign currency deposits of resident sectors other than the central government; bank and traveller's checks; and other securities such as certificates of deposit and commercial paper.	WDI, 2021
Banking sector credit to private sector to GDP (Bank credit)	Credit provided by the financial sector (for example, deposit banks) but excludes the credit to the central government.	WDI, 2021
Ratio of broad money to narrow money (M2/M1)	Measurement money supply. The ratio of broad money (liquid and less liquid forms of money) to narrow money (liquid forms of money for example banks and coins).	WDI, 2021
Inflation	Consumer price index (2010 = 100).	WDI, 2021
Real GDP per capita growth	Annual percentage growth rate of GDP per capita based on constant local currency. GDP per capita is gross domestic product divided by midyear population. GDP at purchaser's prices is the sum of gross value added by all resident producers in the economy plus any product taxes and minus any subsidies not included in the value of the products. It is calculated without making deductions for depreciation of fabricated assets or for depletion and degradation of natural resources.	WDI, 2021
General government final consumption expenditure (% of GDP)	All government current expenditures for purchases of goods and services (including compensation of employees).	WDI, 2021
Gross fixed capital formation (% of GDP)	All land improvements, machinery, and equipment purchases, and the construction of roads, railways, etc.	WDI, 2021

Trade (% of GDP)	Sum of exports and imports of goods and services measured as a share of gross domestic product.	WDI, 2021

WDI = World Bank Development Indicators.

Appendix C4.3. Matrix of correlations: Financial innovation measured as broad money to GDP

Variables	RGDPPCG	BroadM	CPI	GGFC	GFCF	Trade
RGDPPCG	1.000					
BroadM	0.022	1.000				
CPI	-0.076	0.045	1.000			
GGFCEXPEN	-0.084	0.459	0.116	1.000		
GFCFORM	0.061	0.121	0.124	0.089	1.000	
Trade	0.089	0.443	-0.102	0.418	0.375	1.000

Where: RGDPPCG = real GDP per capita growth rate, BroadM = Broad money to GDP, CPI = inflation, GGFCE = Government expenditure, GFCF = Capital formation.

Appendix C4.4. Matrix of correlations: Financial innovation measured as broad money to narrow money

Variables	RGDPPCG	BroadN	CPI	GGFCE	GFCF	Trade
RGDPPCG	1.000					
BroadN	-0.079	1.000				
CPI	-0.076	0.130	1.000			
GGFCEXPEN	-0.084	-0.021	0.116	1.000		
GFCFORM	0.061	-0.032	0.124	0.089	1.000	
Trade	0.089	-0.137	-0.102	0.418	0.375	1.000

Where: RGDPPCG = real GDP per capita growth rate, BroadN = Broad money to narrow money, CPI = inflation, GGFCE = Government expenditure, GFCF = Capital formation.

Appendix C4.5. Matrix of correlations: Financial Innovation as domestic credit to private sector by banks

Variables	RGDPPCG	DCPSB	CPI	GGFCE	GFCF	Trade
RGDPPCG	1.000					
DCPSBank	0.026	1.000				
CPI	-0.076	0.015	1.000			
GGFCEXPEN	-0.084	0.274	0.116	1.000		
GFCFORM	0.061	-0.021	0.124	0.089	1.000	
Trade	0.089	0.235	-0.102	0.418	0.375	1.000

Where: RGDPPCG = real GDP per capita growth rate, DCPSB = Bank credit, CPI = inflation, GGFCE = Government expenditure, GFCF = Capital formation.

CHAPTER 5

CONCLUSION AND POLICY IMPLICATONS

5.1 Summary of findings

Chapter 2: Domestic savings and economic growth: This study investigates the threshold effect of domestic savings on economic growth in 35 SSA countries from the period 1980 to 2022. The main contribution of this study is the indication of a threshold effect in the relationship between domestic savings and economic growth. This study provides a threshold level for each country used in the sample. Another contribution that this paper makes is applying the dynamic threshold model by Kremer, Bick and Nautz (2013) to estimate the domestic savings and economic growth relationship. Focusing exclusively on SSA offers another key contribution to the current literature.

By using the Kremer, Bick and Nautz (2013) dynamic threshold model, the overall finding of this study is that there is a threshold effect in the relationship between domestic savings and economic growth in SSA. The empirical result shows that the impact of domestic savings on growth is positive and statistically significant if domestic savings are lower than the threshold. In particular, domestic savings (% of GDP) below 31.15% (the estimated value) are associated with higher economic growth in SSA. This means that domestic savings promote economic growth if they fall below the threshold. In contrast, the impact of domestic savings on growth is positive and statistically insignificant if domestic savings are above the threshold. However, the threshold effects on economic growth are dynamic, it should be revised as countries move from one income level to another, for instance low-income countries may move to a middle-income or upper-income category, which may increase the countries' domestic saving rates and may require higher thresholds.

Chapter 3: Financial depth and economic growth: This study investigates the impact of financial depth on economic growth in three Ebola-affected SSA countries for the period 1980 to 2022. The main contribution this study makes is analysing the impact of financial depth on economic growth pre-during-and-post public health crisis. Analysing a public health crisis in the financial depth and economic growth relationship is relevant because this kind of crisis can affect the economy beyond the period of its prevalence. The Covid-19 pandemic and the 2022 Monkeypox outbreak have stoked a keen interest in policymakers to the impact of infectious diseases on the financial sector. Another way that this paper contributes to the current literature

is by constructing a financial depth index that is used to estimate the financial depth–economic growth relationship. This study examines the causal link between financial depth and economic growth for each country used in the sample. Focusing exclusively on the three highly hit and under-researched SSA countries serves as another key contribution of this study to the canon.

By using the ordinary least square estimation technique and the Toda Yamamoto (1995) Granger causality test and focusing on three-Ebola hit SSA countries between the period 1980 and 2022, this study finds that financial depth has a positive and statistically significant relationship with economic growth. To get a clear picture on whether the Ebola period resulted in different dynamics in the relationship between financial depth and economic growth, this study examines two samples: the full sample (spanning1980–2022) and the pre-Ebola era (1980–2014). The full sample consists of the pre-Ebola, Ebola, post-Ebola, and to some extent the Covid-19 pandemic eras. For all the eras (full sample and pre-Ebola) and for all the countries (Guinea, Liberia and Sierra Leone), the impact of financial depth on economic growth exhibits a positive sign and a statistically significant level.

However, the results show that the positive financial depth–economic growth relationship in the pre-Ebola period is stronger than in the full sample, which comprises of the pre-Ebola, Ebola and post-Ebola eras. This difference means that financial depth significantly promoted economic growth before the Ebola crisis, and that the Ebola crisis did not only claim lives but also impacted the financial depth–economic growth relationship. Therefore, the main finding of this study is that financial depth positively impacts economic growth; however, infectious diseases such as Ebola can disrupt the relationship.

Furthermore, the Granger causality results depict that a unidirectional causality from financial depth to economic growth is found in Guinea and Liberia. Hence, financial depth Granger causes economic growth in Guinea and Liberia, but economic growth does not Granger cause financial depth. Sierra Leone's Granger causality result shows that a bidirectional relationship is found between financial depth and economic growth. Financial depth Granger causes economic growth, with a feedback effect in Sierra Leone.

Chapter 4: Financial innovation and economic growth: This study investigates the symmetric and asymmetric impacts of financial innovation on economic growth in 20 SSA countries and addresses the asymmetric relationship between the two elements per individual country. The main contribution that this study makes is the empirical examination of the

symmetric and asymmetric impacts of financial innovation on economic growth by using the linear ARDL and nonlinear ARDL techniques. This study provides an asymmetric result for each country used in the sample. Another way this paper contributes to the current literature is by investigating the time-varying (short-run and long-run) relationship between financial innovation and economic growth. Focusing exclusively on SSA serves as another key contribution of this research.

By using the ARDL and NARDL techniques, the overall finding of this study is that financial innovation has a symmetric impact on economic growth in SSA—the relationship is positive and statistically significant in the long run. Furthermore, an increase in financial innovation has a positive and significant asymmetric impact on economic growth in both the short-run and long-run. In the long-run, a decrease in financial innovation has a negative asymmetric relationship with economic growth.

5.2 Policy Implications

Chapter 2: Domestic savings and economic growth: The policy implication of this study is that SSA's policymakers should be guided by the threshold level of domestic savings and may promote domestic saving activities to increase the size of domestic savings. Policymakers can utilise and control domestic savings amid high inflation through taxation. For instance, tax exemptions on some saving schemes such as pension saving funds can be used to encourage domestic savings. Governments can increase the size of domestic savings through government debt reduction and by reducing unproductive government expenditure. In addition, policymakers should create access to pension schemes as only 8.9% of the working-age population contributes to a pension fund in SSA (ILO 2021). However, higher domestic savings should be transmitted to productive activities such as investment for the expansion of economic growth.

Chapter 3: Financial depth and economic growth: The policy implication based on the Granger causality result suggests that the three countries should implement more financial depth enhancing policies aim at increasing the access and usage of the financial sector, fostering competition among banks, and developing the stock market.

Chapter 4: Financial innovation and economic growth: The policy implication of this study is that SSA should invest more in developing and promoting financial innovative products,

processes, and institutions to enhance economic growth. Other forms of localised financial innovation targeting the underprivileged or disadvantaged groups of the respective populations should be implemented.

5.3 Limitations of the study and areas for further research

Chapter 2: Domestic savings and economic growth: This study only employs aggregate domestic savings data, however, domestic savings are broadly disaggregated into household savings and government savings. Household savings or personal savings are defined as any current income not consumed at a given time. Pension and insurance contributions form part of household savings. Government savings are the savings obtained from tax and non-tax revenues. A disaggregated domestic threshold effect on economic growth (though beyond the scope of this paper) can provide guided information on the nonlinear relationship between domestic savings and economic growth by sector. This topic can be considered for further research.

Chapter 3: Financial depth and economic growth: This paper only covers the financial depth dimension of bank-based and other financial institutions operating in the three countries, due to a lack of available data for the other dimensions of financial depth such as the stock and bond markets. The other dimensions of financial depth are underdeveloped in these countries. A comparison of the impact of financial depth on economic growth for Ebola-hit regions and Ebola-free regions can be considered a potential further research topic. In addition, a global study on the effect of the Covid-19 pandemic on the financial depth and economic growth nexus can also be considered for possible further research.

Chapter 4: Financial innovation and economic growth: Different countries have different particularities when it comes to financial innovation. For this reason, further research per country is suggested to determine the symmetric and asymmetric impacts between financial innovation and economic growth by using the measure of financial innovation that is specific and relevant to an individual country.