

**Financial Development and Economic Growth – the Role of
Mobile Money: Empirical Evidence from Sub-Saharan
Africa and a comparative study of Kenya and Uganda**

By

Grace Ainomugisha Tinyinondi

Thesis presented for the degree of
DOCTOR OF PHILOSOPHY

In the School of Economics
UNIVERSITY OF CAPE TOWN

June, 2025

Supervisors:

Prof. Eftychia Nikolaidou

Dr. Trust Mpofu

The copyright of this thesis vests in the author. No quotation from it or information derived from it is to be published without full acknowledgement of the source. The thesis is to be used for private study or non-commercial research purposes only.

Published by the University of Cape Town (UCT) in terms of the non-exclusive license granted to UCT by the author.

Abstract

The relationship between financial development and economic growth is well established in the finance-growth literature, which is predicated on the existence of a well-functioning financial system that underscores the complementarity between financial institutions and financial markets. Financial inclusion, defined as the participation of individuals in the formal financial system, is a critical component of financial development and, by extension, the finance-growth nexus. In many developing countries, financial exclusion remains a significant challenge, with a substantial proportion of the population lacking access to formal financial services. However, the advent of mobile money, which achieved notable success in Kenya following its introduction in 2007, has provided a considerable boost to financial inclusion across the Sub-Saharan African (SSA) region, home to the largest concentration of low-income countries globally. Empirical evidence indicates that mobile money has enhanced financial inclusion by expanding access to financial services, thereby contributing to financial development through improved resource mobilization, increased savings, and broader participation in the financial sector. Notably, SSA continues to lead globally in mobile money adoption and usage.

This thesis examines the role of mobile money, an important driver of financial inclusion, in shaping the finance-growth nexus in Sub-Saharan Africa (SSA). It employs a broad measure of financial development that incorporates mobile money, financial institutions, and financial markets. The study contributes to the literature by providing empirical evidence from 17 SSA countries, selected based on data availability, covering the period from 2015 to 2022, a timeframe during which mobile money was widely adopted across the region. To gain deeper insights into the impact of enhanced financial inclusion on the finance-growth relationship in developing economies, Kenya and Uganda, two of the leading adopters of mobile money, are analyzed as case studies. While financial inclusion has gained increasing recognition, existing research on the finance-growth nexus in Kenya and Uganda often relies on a single proxy of financial development, typically bank credit to the private sector, thereby overlooking the broader dynamics of a more inclusive financial system.

The study constructs a broad-based financial development index encompassing mobile money services, financial institutions, and financial markets, measured across the dimensions of depth, access, and efficiency, to offer new evidence on the finance-growth nexus in Sub-Saharan Africa (SSA), with a particular focus on Kenya and Uganda. As a robustness check, the study employs Svirydzenka's (2016) multidimensional financial development index, which has been widely adopted in recent empirical literature. The Kenyan case study utilizes annual data spanning the period 1980 to 2022, while the Ugandan analysis covers the years 1982 to 2022. To investigate the relationship between financial development and economic growth, the study applies Granger causality tests and a formal growth model. The direction of causality is examined through Granger causality tests based on a Vector Autoregressive (VAR) framework. Furthermore, the analysis incorporates the system Generalized Method of Moments (GMM) panel estimator, along with the Johansen and Juselius (1990) cointegration approach and the Vector Error Correction Model (VECM), to address potential endogeneity concerns inherent in the finance-growth relationship.

The Granger causality test results for Sub-Saharan Africa (SSA) and Uganda reveal a unidirectional causality running from real GDP per capita to financial development. This finding lends empirical support to Patrick's (1966) supply-leading hypothesis, which posits that economic growth can be stimulated by the deliberate development of financial institutions and markets. In contrast, the results for Kenya are consistent with the demand-following hypothesis, also proposed by Patrick (1966), which argues that financial development occurs as a response to increasing demand generated by economic growth. These divergent patterns suggest that policy prescriptions should be context-specific: in the case of Uganda, strategies aimed at enhancing financial development may serve as a catalyst for economic growth, whereas in Kenya, promoting economic expansion may be a more effective means of fostering financial sector development.

The findings based on the growth model, utilizing an overall Mobile Money Index, constructed from six mobile money indicators (i.e., the value of mobile money transactions as a percentage of GDP; number of mobile money transactions per 1,000 adults; number of registered mobile money agent outlets per 100,000 adults; number of agent outlets per 1,000 km²; mobile cellular

subscriptions per 100 people; and number of registered mobile money accounts per 1,000 adults), indicate that financial inclusion positively influences the finance-growth nexus in Kenya and Uganda. However, when the analysis is disaggregated by individual mobile money indicators, the results for Sub-Saharan Africa (SSA), Kenya, and Uganda also reveal negative effects of mobile money on economic growth.

This apparent contradiction suggests that, despite notable improvements, financial inclusion remains relatively low in these regions. These results are consistent with prior studies which have shown that financial development may exert a negative effect on economic growth at early stages of financial inclusion. Moreover, the findings highlight several challenges and potential risks associated with mobile money, as identified in existing literature. These include issues related to integrity, privacy, and security; limitations in infrastructure and resources; insufficient alignment of stakeholder incentives; low levels of financial literacy; and the entry of unsophisticated borrowers into the financial system. Thus, this study underscores an important policy implication: while mobile money is a critical tool for advancing financial inclusion, it does not inherently lead to positive economic outcomes. Its benefits can only be fully realized when accompanied by appropriate institutional frameworks, regulatory safeguards, and targeted policy interventions that address its associated risks

Declaration

I hereby declare that this thesis is my own work and has not been submitted for a degree at any other university. I also declare that the intellectual content of this thesis is the product of my own work, except where acknowledged.

Dedication

First and foremost, I dedicate this dissertation to God. "Yet God has made everything beautiful for its own time. He has planted eternity in the human heart, but even so, people cannot see the whole scope of God's work from beginning to end." Ecclesiastes 3:11. To Him be all the glory.

I also dedicate this work to my family and friends. To my dear husband, our son, my parents, and the rest of my family, especially my mother during this season, and in loving memory of Mom Deborah. Thank you for your love and support: for celebrating the victories, and for your prayers and encouragement through the challenging times. May God richly bless you all.

To my supervisors. Thank you for your steady guidance and unwavering support throughout this journey. Your mentorship has been invaluable. May God continue to bless you.

And lastly, to my classmates. It has been a true blessing to walk this path alongside you. I am deeply grateful for the shared experiences, encouragement, and lasting camaraderie.

.

Acknowledgement

I acknowledge with deep gratitude the support of my employer, the Bank of Uganda, for granting me leave and providing the funding that enabled me to undertake this PhD.

I am especially thankful for the technical and emotional support of my supervisors, Prof. Eftychia Nikolaidou and Dr. Trust Mpfu, who walked with me from the beginning to the conclusion of this thesis.

Sincere thanks to the School of Economics faculty for their knowledge, insights, and encouragement throughout this journey. I am particularly grateful for the brown bag seminars, which provided a valuable space for engaging with the thesis process.

A heartfelt thank you to the amazing School of Economics administrators, Paula and Reza, for their unwavering support, especially during the challenging COVID-19 period.

Finally, I am deeply appreciative of my writing coordinators and my colleagues in the Writing for Completion (WFP) program. Your guidance, camaraderie, and inspiration were instrumental during the final phase of this thesis.

List of Abbreviations

ADF	Augmented Dickey Fuller
AIC	Akaike Information Criteria
ARDL	Autoregressive Distributed Lag
ATM	Automated Teller Machine
CADF	Cross-Sectionally Augmented Dickey-Fuller
CPI	Consumer Price Index
DSGE	Dynamic Stochastic General Equilibrium
EAC	East African Community
ECM	Error Correction Model
ECT	Error Correction Term
FDI	Financial Development Index/foreign direct investment
FI	Financial Institutions
FIA	Financial Institutions Access
FIA	Financial Institutions Access
FID	Financial Institutions Depth
FID	Financial Institutions Depth
FIE	Financial Institutions Efficiency
FIE	Financial Institutions Efficiency
FM	Financial Markets
FMA	Financial Markets Access
FMD	Financial Markets Depth
FME	Financial Markets Efficiency
FMOLS	Fully Modified Ordinary Least Squares
GDP	Gross Domestic Product
GFC	Gross Fixed Capital Formation/global financial crisis
GMM	Generalized Method of Moments
HIPC	Heavily Indebted Poor Countries

IMF	International Monetary Fund
MFI	Microfinance Institutions
MMA	Mobile Money Access
MMD	Mobile Money Depth
MNOs	Mobile Network Operators
MRW	Mankiw–Romer–Weil
MSEs	Micro and Small Enterprises
NARDL	Non-Linear Autoregressive Distributed Lag Model
PCA	Principal Component Analysis
PSC	Private Sector Credit
SSA	Sub-Saharan Africa
VAR	Vector autoregression
VECM	Vector Error Correction Model

Table of Contents

Abstract	i
Declaration	iv
Dedication	v
Acknowledgement	vi
List of Abbreviations	vii
Table of Contents	ix
Chapter 1	1
Introduction	1
Chapter 2	11
Literature Review	11
2.1 Theoretical literature	11
2.2 Empirical literature: finance-growth nexus	14
2.3 Conclusion	39
Chapter 3	41
3.1 Economic growth and financial development in Sub-Saharan Africa	41
3.2. Methodology	46
3.3. Results and Discussion	58
3.4. Conclusion	69
Chapter 4	71
4.1 Economic growth and financial development in Kenya	71
4.2 Economic growth and financial development in Uganda	74
4.3 Methodology	79
4.4. Results and Discussion	91
Chapter 5	130
Summary and Conclusion	130
References	138
Appendix	148
Table A1: List of the Sub-Saharan African Countries in the Sample	148
Table A2: List of variables, notation and data sources	149
Table A3a: Financial Inclusion (Financial Institutions) and Economic Growth	150
Table A3b: Financial Inclusion (Financial Institutions) and Economic Growth	151
Table A4: Unit root tests for Kenya data	152
Table A5: Zivot-Andrews Unit Root Test for Kenya data	153
Table A6: VAR Lag Selection for Kenya data	153
Table A8: Unit root tests for Uganda data	158
Table A9: Zivot-Andrews Unit Root Test for Uganda data	159
Table A10: VAR Lag Selection for Uganda data	159
Table A11: Cointegration test results for Uganda	160

List of Tables

Table 3.2.1: Summary Statistics (2015 to 2022).....	55
Table 3.2.2: Principal Component Analysis: Variance Explained by PCA.....	57
Table 3.2.3: Cross sectional dependence and unit root tests.....	59
Table 3.2.4. Granger causality Test	60
Table 3.2.5: SSA Financial Inclusion (Mobile Money) and Economic Growth (2015 – 2022)...	62
Table 3.2.6: System-GMM – SSA Financial Inclusion and Economic Growth (2015 – 2022) ...	64
Table 3.2.7: System-GMM – SSA Financial Development ^a and Economic Growth (2015 – 2022)	66
Table 3.2.8: System-GMM – SSA Financial Development (Mobile money adjusted Financial Development index) and Economic Growth (2015-2022).....	68
Table 4.3.3.1: Kenya Summary Statistics (1980 to 2022)	87
Table 4.3.3.2: Kenya Correlation Matrix.....	88
Table 4.3.3.3: Kenya Principal Component Analysis: Variance Explained by PCA	89
Table 4.3.3.4: Uganda Summary Statistics (1982 – 2022)	90
Table 4.3.3.5: Uganda Correlation Matrix.....	90
Table 4.3.3.6: Uganda Principal Component Analysis: Variance Explained by PCA	91
Table 4.4.4.1: Kenya VAR Granger Causality/Block Exogeneity Wald Tests	95
Table 4.4.4.2: Uganda VAR Granger Causality/Block Exogeneity Wald Tests	97
Table 4.4.5.1a: Kenya Financial Inclusion (Mobile Money) and Economic Growth - LR(1980 - 2022)	99
Table 4.4.5.1b: Kenya Financial Inclusion (Mobile Money) and Economic Growth – SR(1980 - 2022)	100
Table 4.4.5.2a: Kenya Financial Access, Financial Depth and Economic Growth - LR(1980– 2022)	101
Table 4.4.5.2b: Kenya Financial Access, Financial Depth and Economic Growth – SR(1980 - 2022)	102
Table 4.4.5.3a: Kenya Financial Development and Economic Growth – Long run results (1980 – 2022)	104
Table 4.4.5.3b: Kenya Financial Development and Economic Growth – SR (1980 – 2022).....	104
Table 4.4.5.4a: Uganda Financial Inclusion (Mobile money) and Economic Growth -LR(1982– 2022)	108
Table 4.4.5.4b: Uganda Financial Inclusion (Mobile money) and Economic Growth -SR(1982– 2022)	108
Table 4.4.5.5a: Uganda Financial Inclusion (Mobile Money, Financial institutions and Financial market) and Economic Growth -LR(1982 – 2022).....	111
Table 4.4.5.5b: Uganda Financial Inclusion -Short run (1982 – 2022)	112
Table 4.4.5.6a: Uganda Financial Development and Economic Growth – LR (1982 – 2022)...	114
Table 4.4.5.6b: Uganda Financial Development and Economic Growth – SR (1982 – 2022)...	114
Table 4.5.1.1: Summary Statistics (SSA, Kenya and Uganda).....	118

Table 4.5.2.1 Granger causality tests	120
Table 4.5.2.2. SSA System-GMM - Financial Inclusion and Economic Growth (2015-2022)..	121
Table 4.5.2.2a: Financial Development and Economic Growth in Kenya and Uganda – Long run results	123
Table 4.5.2.2.b: Kenya and Uganda Financial Development and Economic Growth – Short run dynamics	124
Table 4.5.2.3a: Kenya and Uganda Financial Development (Dimensions) and Economic Growth –	125
Long run results	125
Table 4.5.2.3b: Kenya and Uganda Financial Development (Dimensions) and Economic Growth – Short run dynamics	126

List of Figures

Figure 4.1.1: Trend in Real GDP Growth and Financial Development: FD (1980-2021)	72
Figure 4.1.2: Trend in Real GDP Growth and Financial Development: PSC (1980-2021)	72
Figure 4.1.3: Kenya Financial Development Index and its components (1980-2021)	73
Figure 4.1.4: MM accounts per 1,000 adults Figure 4.1.5: MM transactions per 1,000 adults....	74
Figure 4.2.1: Trend in Real GDP Growth and Financial Development Index (FD) (1980-2021)	76
Figure 4.2.2: Trend in Real GDP Growth and Credit to the Private Sector (PSC) (1980-2021)..	76
Figure 4.2.3: Uganda Financial Development Index and its components	77
Figure 4.2.4: MM accounts per 1,000 adults	78

Chapter 1

Introduction

The questions “What causes economic growth?” and “What accounts for differences in economic growth across countries?” remain central in empirical economic research due to their critical implications for human development. Among the various factors explored, the role of financial development has been a subject of extensive inquiry since the 19th century. However, the 2008/2009 global financial crisis sparked renewed interest in this relationship, particularly with respect to the importance of a “well-functioning financial system” (Khan, 2000; Levine, 2005; Mishkin, 2009; Law & Singh, 2014). This study aligns with that line of inquiry by examining financial inclusion as a core component of a well-functioning financial system. According to finance-growth theory, a well-functioning financial system, comprising both financial institutions and markets, contributes to economic growth by performing five key functions: (i) producing ex ante information about potential investments and allocating capital accordingly; (ii) monitoring investments and exerting corporate governance; (iii) facilitating the diversification and management of risk; (iv) mobilizing and pooling savings; and (v) enabling the exchange of goods and services (Levine, 2005). Financial development, therefore, is conceptualized as the enhancement of these critical functions. Technological advancements have significantly expanded the reach of financial services, thereby enhancing financial inclusion. The growing emphasis on financial inclusion within the finance-growth literature stems from increasing recognition of its role in promoting economic and social development, especially for marginalized populations that historically lack access to formal financial services (World Bank, 2013). Against this backdrop, this study seeks to investigate the question: Does financial development promote economic growth, and does financial inclusion, proxied by mobile money, contribute to this relationship?

Empirical research on the finance-growth nexus has traditionally employed measures of size or financial depth as proxies for financial development, particularly in the context of financial institutions. Common indicators include bank credit to the private sector and various monetary aggregates, such as the ratio of narrow money to GDP, broad money to GDP, or the difference

between broad and narrow money as a percentage of GDP (King & Levine, 1993; Levine, 2005; Valickova et al., 2015). In the case of financial markets, stock market capitalization (as a measure of depth) and stock market turnover (as a proxy for liquidity and efficiency) have been widely used to capture financial development (King & Levine, 1993; Levine, 2005). However, beyond these traditional size-based indicators, it is increasingly recognized that financial development must also encompass participation in the financial system, that is, financial inclusion. This dimension reflects financial system penetration, which includes both the distribution and reach of financial institutions and their branches, as well as the number and characteristics of their users. In this regard, financial inclusion addresses questions of access and usage, offering a more holistic view of how financial systems support economic activity.

Broadly defined, financial inclusion refers to "*the easy availability of all banking services at an affordable cost, within a reasonable time and adequate quantity, to all needy people and in appropriate forms.*" In narrower terms, it is defined as "*the easy access of all people to the minimum basic financial services*" (Anand & Chhikara, 2013, p. 103). Goldsmith (1975) emphasized the importance of financial penetration, arguing that this information is a crucial complement to size-based measures, without which the interpretation of aggregate financial indicators may be misleading (Goldsmith, 1975, p. 223). Until recently, empirical studies have primarily focused on financial depth as the main proxy for financial development, often neglecting the equally important dimensions of access and participation embodied in financial inclusion. This gap is increasingly being addressed as the limitations of size-based proxies become more apparent in assessing the true effectiveness and inclusivity of financial systems.

Prior to the 2008/2009 global financial crisis, empirical findings on the finance-growth nexus were largely inconclusive, with studies reporting either positive or negative effects depending on the specific proxy used for financial development, the sample of countries analyzed, or the estimation techniques employed. However, in the aftermath of the crisis, there has been a growing consensus that the relationship between financial development and economic growth is more complex than previously understood (Carré & L'oeillet, 2018). Recent empirical evidence increasingly supports the view that this relationship is non-linear, exhibiting asymmetric or non-uniform effects of

financial development on growth (Law & Singh, 2014; Arcand et al., 2015; Samargandi et al., 2015; Demetriades & Rousseau, 2016; Boukraine, 2020).

Several studies have identified financial inclusion as a key factor underlying this non-linearity. Chami and Yousefi (2013), Barajas et al. (2013), and Haini (2021) suggest that the level of financial access helps explain the differing effects of financial development across contexts. Specifically, Haini (2021) finds that financial development tends to have a negative impact on economic growth at low levels of financial inclusion, but a positive impact when financial access is more widespread. Moreover, the non-linear nature of the finance-growth relationship has also been attributed to risks inherent in bank-based financial development. These include the misallocation of credit to households instead of productive enterprises, speculative investor behavior during credit booms, systemic vulnerabilities due to increased interconnectedness within the financial system, and the participation of non-risk-averse or financially unsophisticated actors (Carré & L'oeillet, 2018). With this understanding of non-linearity in the finance-growth relationship, the role of financial inclusion as both a determinant of and a moderating factor, has underscored the importance of considering not just the depth of financial systems, but also their accessibility and inclusiveness.

Over the past two decades, Sub-Saharan Africa (SSA) has experienced a significant improvement in financial inclusion. This progress is reflected in the increased number and geographic distribution of various types of financial institutions, their branches, and clientele. Notably, the composition of financial service users has shifted to include individuals who were previously excluded from the formal financial system (World Bank, 2013). A central driver of this transformation has been the innovation of mobile money, which has played a pivotal role in expanding access to financial services across the region (Mas & Radcliffe, 2010; Suri et al., 2012; Suri, 2017; Chhabra & Das, 2019; Ahmad et al., 2020; Kouladoum et al., 2022). Kenya, a pioneer in mobile money adoption, achieved remarkable success following the introduction of M-Pesa in 2007, a development that inspired the uptake of similar mobile money platforms across several developing countries. Despite global adoption, SSA remains the leading user of mobile money

services (Chhabra & Das, 2019). The high prevalence of mobile phone ownership in the region catalyzed this financial innovation, enabling individuals to use mobile devices to store monetary value and conduct secure financial transactions (Hughes & Lonie, 2007; Suri & Jack, 2016). As a result, mobile money has substantially enhanced financial inclusion among previously marginalized groups, particularly the poor and rural populations in SSA (Andrianaivo & Kpodar, 2011; Demirgüç-Kunt & Klapper, 2012; IMF, 2019). However, despite the transformational impact of mobile money in a region characterized by a high proportion of financially excluded individuals and a concentration of low-income countries, its role in the finance-growth nexus has received limited attention in empirical research. This study therefore seeks to fill this gap by examining the contribution of financial inclusion, proxied by mobile money usage, to economic growth within the SSA context.

In the context of empirical analysis, recent studies on the finance-growth nexus have increasingly adopted broad-based indices to measure financial development. This shift reflects the recognition that finance is a multi-dimensional and evolving concept, which cannot be accurately captured by a single indicator. While banks continue to dominate the financial landscape, the number and role of non-bank financial institutions, such as insurance companies and microfinance institutions, have expanded significantly in both developed and developing economies. Furthermore, financial markets are playing an increasingly important role in mobilizing, diversifying, and allocating savings across firms and individuals (Svirydzenka, 2016; Carré & L'oeillet, 2018; Ehigiamusoe & Samsurijan, 2021). In response to these complexities, several recent studies (Aluko et al., 2020; Aluko & Ibrahim, 2020; Boukraine, 2020; Haini, 2021, inter alia) have employed the Financial Development Index (FDI) developed by Svirydzenka (2016). This index is comprehensive and multi-dimensional, combining three key dimensions: access, depth, and efficiency, across both financial institutions and financial markets. The access dimension captures financial penetration and the availability of financial services; depth reflects the usage of these services; and efficiency measures the cost-effectiveness and productivity of the financial system. Svirydzenka's (2016) Financial Development Index has been widely used in cross-country empirical studies examining the relationship between financial development and economic growth, including in both advanced

and developing country contexts (Aluko et al., 2020; Aluko & Ibrahim, 2020; Boukraine, 2020; Haini, 2021, *inter alia*). Its adoption underscores the growing emphasis on using nuanced, multidimensional measures to better understand the mechanisms through which financial systems influence economic outcomes.

To more accurately represent the relationship between financial development and economic growth in Sub-Saharan Africa (SSA), it is crucial to account for the substantial improvements in financial inclusion brought about by mobile money innovations (Dacanay & Buensuceso, 2011; Misati et al., 2021). Although Svirydzenka's (2016) Financial Development Index has been widely adopted in recent empirical studies, it primarily relies on traditional financial access indicators, such as the number of bank branches and ATMs per 1,000 adults, which do not adequately capture the transformative role of mobile money in expanding financial access, particularly in low-income and rural populations. Mobile money services, characterized by mobile money agents and accounts per adult population, have become the primary drivers of financial inclusion growth in many developing countries, especially in SSA. However, these innovations are not reflected in the Svirydzenka's (2016) Financial Development Index, limiting its applicability in contexts where non-traditional financial services dominate the financial landscape. Additionally, Svirydzenka's index does not incorporate access indicators from non-bank financial institutions, such as microfinance institutions, credit unions, and cooperatives, which have increasingly gained prominence in the region's financial systems.

To date, only a limited number of studies have sought to integrate mobile money within the finance-growth framework. Notably, Ugwuanyi et al. (2022) examined the role of mobile money in the finance-growth nexus in SSA. However, their analysis primarily focused on how financial technologies enhance communication between borrowers and lenders, emphasizing financial institutions, such as commercial banks, microfinance institutions, and credit cooperatives, while overlooking the role of financial markets. This narrow approach diverges from finance-growth theory, which advocates for a comprehensive view of financial development that recognizes the complementary roles of financial institutions and financial markets (Goldsmith, 1975; Levine,

2005). Accordingly, this study builds upon the finance-growth theoretical framework by constructing a broad-based financial development index that incorporates mobile money indicators alongside measures of financial institutions and financial markets. This comprehensive approach enables a more accurate assessment of the role of financial inclusion, proxied by mobile money, in the finance-growth nexus within the SSA context.

Due to the potential masking of country-specific heterogeneity inherent in panel data analysis, the results of such studies may not be generalizable to all countries within the sample (Ram, 1999; Driffill, 2003; Levine, 2005; Ang, 2008). To address this limitation, in addition to analyzing a panel of Sub-Saharan African (SSA) countries, this study also includes two country-specific case studies: Kenya and Uganda, both of which have demonstrated notable success in the adoption of mobile money technologies. Kenya is widely recognized for its pioneering and highly successful implementation of mobile money services, beginning with the launch of M-Pesa in 2007. It is also considered one of the most financially developed countries in the SSA region. Numerous empirical studies have investigated the finance-growth nexus in the Kenyan context; however, the findings remain mixed, partly due to variations in the indicators and methodologies used to measure financial development (Uddin et al., 2013; Rafindadi & Yusof, 2013; Onuonga, 2014; Nyasha & Odhiambo, 2017; Arayssi & Fakh, 2017; Misati et al., 2021). Given Kenya's remarkable success with mobile money, it has also attracted substantial empirical attention from scholars seeking to understand the socioeconomic impacts of this innovation. Several studies have examined the dynamics and outcomes of mobile money adoption in Kenya, highlighting its implications for financial inclusion, poverty alleviation, and economic activity (Kirui et al., 2007; Ngugi et al., 2010; Kusimba et al., 2013; Wamuyu, 2014; Muthiora, 2015; Onyuma, 2015; Suri & Jack, 2016; Islam et al., 2018; Fabregas & Yokossi, 2022, *inter alia*).

While numerous studies on mobile money innovation have focused primarily on the factors that contributed to its successful adoption in Kenya, only a few have examined the role of financial inclusion (proxied by mobile money and access to traditional financial institutions) within the

context of the finance-growth nexus. Notably, Musembi and Chun (2020) and Misati et al. (2021) have made attempts to explore this link. However, both studies have limitations in their scope. Musembi and Chun (2020) focused on financial indicators such as bank credit to the private sector and broad money, while Misati et al. (2021) concentrated on financial depth, measured by bank credit to the private sector. Both studies excluded non-bank financial institutions and financial markets, which are critical components of Kenya's financial system. Furthermore, these studies employ aggregate financial measures rather than indicators based on access and usage of financial services, as represented by the proportion of the adult population, which more accurately reflects the degree of financial inclusion (Sarma, 2008; Svirydzenka, 2016; Hasan et al., 2024). Previous studies examining the finance-growth nexus in Kenya, such as Nyasha and Odhiambo (2017) and Aduda et al. (2013), concentrated exclusively on the financial market, without considering the broader financial system. In contrast to these previous studies, Musembi and Chun (2020) and Misati et al. (2021) which focused solely on financial institutions, and Nyasha and Odhiambo (2017) and Aduda et al. (2013) which examined only the financial market, this study constructs a more comprehensive measure of financial development. This measure integrates financial institutions, non-bank financial entities, and the financial market, in alignment with finance-growth theory. This approach underscores the importance of examining the entire financial system to better understand the complex relationship between financial development and economic growth, as well as the complementary role of financial institutions and financial markets.

Uganda, the second country under examination in this study, is also situated within the East African region, which remains at the forefront of mobile money adoption in Sub-Saharan Africa (SSA) (Chhabra & Das, 2019). Since the introduction of mobile money in Uganda in 2009, its significance to the national economy has grown substantially. By 2021, the value of mobile money transactions as a percentage of GDP in Uganda reached 93.7 percent, surpassing Kenya's 57.1 percent, a pioneer in mobile money adoption. Despite this impressive growth, only a limited number of empirical studies have explored the finance-growth nexus in Uganda. As with the broader finance-growth literature and the case of Kenya, the empirical results for Uganda are mixed, with discrepancies primarily arising from the measures of financial development used

(Bwire & Musiime, 2015; Odhiambo & Nyasha, 2022; Twinamatsiko, 2022). Nampewo et al. (2016) examined the impact of mobile money on financial depth in Uganda and found that mobile money balances held by commercial banks contributed to increased deposits, thereby enhancing the supply of bank credit to the private sector. However, as observed in empirical studies for SSA and Kenya, the research on Uganda predominantly focuses on either financial institutions or the financial market, rather than employing a broad-based measure of financial development. This approach contrasts with the comprehensive financial development framework proposed by finance-growth theory, which advocates for the inclusion of both financial institutions and markets in analyzing their collective impact on economic growth.

To address the limitations of previous studies on Sub-Saharan Africa, Kenya, and Uganda, which have primarily focused on either financial institutions, the financial market, or mobile money, this study constructs a broad-based financial development index that incorporates all three components of the financial system. The study aims to answer the research question: Does financial development promote economic growth in the SSA region, Kenya, and Uganda? Furthermore, it investigates whether financial inclusion, proxied by mobile money, plays a significant role in this relationship. In addition to the financial depth measures, such as bank credit to the private sector (PSC), and mobile money indicators considered in prior research, the study contributes new empirical evidence to the finance-growth nexus in SSA, Kenya, and Uganda. This is achieved by constructing a more comprehensive measure of financial development that integrates financial institutions, mobile money, and financial market indicators. Specifically, the study extends Svirydzenka's (2016) Financial Development Index by incorporating indicators for non-bank financial institutions (such as microfinance and insurance institutions) and mobile money indicators. The index is constructed using the principal component analysis (PCA) approach, as employed by Svirydzenka (2016) and other studies on the finance-growth nexus (Jalil et al., 2010; Chen et al., 2020, *inter alia*).

As a robustness check, and to explore potential non-linearity in the finance-growth nexus arising from financial inclusion, this study employs a multiplicative interaction model approach, commonly adopted in recent empirical literature (Ehigiamusoe & Samsurijan, 2021; Haini, 2021). This approach is particularly useful for examining the moderating role of financial inclusion, proxied by mobile money, in the relationship between financial development and economic growth within the panel of Sub-Saharan African (SSA) countries. The core variable of interest in this framework is the interaction term between financial development and mobile money indicators, which allows for an assessment of how financial inclusion conditions the effect of financial development on growth. To empirically analyze this relationship, the study employs two widely used methodologies in the finance-growth literature: (i) a formal endogenous growth model, and (ii) Granger causality tests. The endogenous growth model is adopted because it permits finance to influence long-term economic growth through its effects on technological progress and, consequently, on the productivity of capital. These two approaches are applied across the panel of SSA countries as well as to the two country case studies, Kenya and Uganda, providing both cross-sectional and country-specific insights into the finance-growth-inclusion nexus.

This study contributes to the existing literature by providing empirical evidence from a panel of 17 Sub-Saharan African (SSA) countries, selected based on data availability, covering the period 2015 to 2022, a timeframe that captures the widespread adoption of mobile money across the region. To address potential endogeneity issues commonly associated with the finance-growth relationship, the study employs the System Generalized Method of Moments (GMM) panel estimator, which is widely recognized for its robustness in dynamic panel data analysis. For the country-specific case studies, annual data spanning 1980 to 2022 for Kenya and 1982 to 2022 for Uganda were utilized. In both cases, the analysis is grounded in an endogenous growth framework. To examine long-run relationships among the variables, the Johansen and Juselius (1990) cointegration approach and the Vector Error Correction Model (VECM) were employed. These techniques allow for the estimation of both short-run dynamics and long-run equilibrium relationships. Additionally, the direction of causality between financial development and

economic growth was assessed using Granger causality tests based on a Vector Autoregressive (VAR) model.

The remainder of this thesis is structured as follows: Chapter 2 presents a comprehensive review of the relevant literature on the finance-growth nexus and the role of financial inclusion. Chapter 3 begins with an overview of financial development and economic growth trends in Sub-Saharan Africa, followed by a detailed discussion of the model specification, data sources, estimation methods, and the empirical findings for the SSA panel. Chapter 4 provides an overview of financial development and economic growth in the case study countries, Kenya and Uganda, and presents the corresponding empirical evidence. Finally, Chapter 5 summarizes the key findings, discusses policy implications, and concludes the study.

Chapter 2

Literature Review

2.1 Theoretical literature

The importance of finance in promoting economic growth is grounded in finance-growth theory, which dates to Bagehot's (1873) foundational argument that the financial system plays a critical role in allocating capital to its most productive uses, thereby fostering profitable economic activity. This proposition has been supported and expanded upon by several influential scholars, including Schumpeter (1912), Gurley and Shaw (1955), Hicks (1969), Goldsmith (1969), McKinnon (1973), and Hilferding (1981). These contributions emphasize that finance facilitates economic growth through key functions such as the mobilization of savings, efficient allocation of capital, and risk mitigation. A comprehensive review of the theoretical literature is provided by Levine (2005) and Stolbov (2013), with Levine (2005) identifying five core functions through which the financial system, comprising both bank-based and market-based institutions, promotes economic growth. First, financial intermediaries and markets generate *ex ante* information about potential investments and allocate capital accordingly. Second, they monitor investments and enforce corporate governance mechanisms post-financing. Third, they enable risk amelioration through risk trading, diversification, and management. Fourth, they mobilize and pool savings, facilitating the accumulation of capital for productive investment. Lastly, they reduce transaction costs in the exchange of goods and services, thereby enhancing market efficiency, encouraging specialization, and fostering technological innovation, all of which contribute to sustained economic growth.

Levine (2005) defines financial development as any improvement in the five core functions performed by the financial system, which together constitute a "well-functioning" financial system. According to this framework, differences in the impact of financial systems on economic growth are primarily attributed to variations in how effectively these functions are performed. Consequently, a poorly functioning financial system can hinder, rather than support, economic growth. This notion is consistent with earlier findings by McKinnon (1973) and Shaw (1973), who demonstrated that financial repression, characterized by interest rate controls, directed credit

programs, and high reserve requirements, was a significant constraint on growth in developing countries. These insights laid the groundwork for the financial liberalization reforms that were widely adopted in the 1990s (Gibson & Tsakalotos, 1994; Khan, 2000). Regarding the structure of the financial system, Levine (2005) further argued that the emphasis should be placed on the overall level of financial development, rather than on whether the system is predominantly bank-based or market-based. This perspective supports the theoretical notion that both financial structures can be complementary in promoting economic growth, countering earlier theoretical debates that sought to determine the superiority of either bank-based or market-based systems. In this view, the effectiveness of the financial system in performing its core functions is more critical than its structural composition.

In contrast to the proponents of the finance-growth theory, some scholars have questioned the direction and significance of the relationship between financial development and economic growth. Robinson (1952) argued that finance does not play a causal role in economic growth; rather, it is economic growth that drives financial development. This view emphasizes a reverse causality in the finance-growth nexus. Similarly, Lucas Jr. (1988, p. 6), in his influential work on the Mechanics of Economic Development, stated: “*In general I believe that the importance of financial matters is over-stressed,*” thereby casting doubt on the centrality of finance in the development process and giving rise to the neutrality hypothesis, which posits that finance is neither a driver nor a consequence of economic growth in any meaningful way. Adding further nuance to the debate, Patrick (1966) proposed a more dynamic framework for understanding the finance-growth relationship. He identified three possible forms of causality. First, the supply-leading hypothesis suggests that the establishment of financial institutions and instruments at the early stages of development facilitates resource mobilization and efficient allocation, thereby stimulating economic growth. Second, the demand-following hypothesis posits that financial development is a response to increased demand for financial services resulting from economic growth. Third, Patrick acknowledged that the relationship may be bidirectional or stage-dependent, whereby the direction of causality evolves over time based on the level of a country's economic

development. This perspective accommodates the possibility of both supply-leading and demand-following dynamics coexisting or alternating throughout the development process.

The finance-growth theory is grounded in both neoclassical and endogenous growth theories, which provide the conceptual basis for examining the role of finance in economic growth (Ciftci et al., 2017; Carré & L'oeillet, 2018). In empirical applications based on the neoclassical growth theory, particularly the Solow growth model, researchers have extended the Mankiw–Romer–Weil (MRW) framework by incorporating indicators of financial development to better explain differences in the steady-state level of per capita income across countries. However, the neoclassical framework treats technological progress, and by extension, the financial mechanisms that support it, as exogenous. The development of endogenous growth theory addressed this limitation by internalizing technological progress within the model. This paradigm shift enabled a more nuanced understanding of the role of finance, treating it as an endogenous driver of long-term growth (Romer, 2012; Carré & L'oeillet, 2018). Pagano (1993, p. 1) succinctly captured this shift, stating that "*financial intermediation can be shown to have not only level effects, but also growth effects.*" Within this framework, finance contributes to economic growth by enhancing the accumulation and diffusion of technology. This contribution occurs through several channels: financial systems facilitate risk diversification, which encourages innovation and expedites technological change; they also provide the necessary capital for research and development (R&D), which directly contributes to technological advancement. As a result, financial development enhances the productivity of both human and physical capital, thereby sustaining long-run economic growth (Levine, 2005).

2.2 Empirical literature: finance-growth nexus

The empirical literature on the finance-growth nexus is vast and continually evolving. Carré and L'oeillet (2018) provide a useful synthesis by categorizing the empirical work into two broad periods: before and after the 2008/2009 global financial crisis. This division highlights the pivotal role of the crisis in reshaping scholarly perspectives on the relationship between financial development and economic growth. While earlier studies predominantly emphasized a positive, linear relationship between finance and growth, more recent research has acknowledged the complex, and often non-linear, nature of this relationship, particularly in the context of financial instability, institutional quality, and structural differences across countries. Recent empirical studies have primarily concentrated on three key issues: the complexity of the finance-growth relationship, the measurement of financial development (including efforts to capture its multi-dimensional nature), and the growing relevance of financial innovation and inclusion, particularly in developing economies where traditional financial access remains limited. This review is organized in three parts. First, it presents the general empirical literature on the finance-growth nexus, followed by a focused examination of studies specific to Sub-Saharan Africa (SSA). Finally, it considers country-specific empirical evidence from Kenya and Uganda, which are both representative of the mobile money revolution and expanding financial inclusion in the region.

From their comprehensive survey of both pre- and post-crisis empirical literature, Carré and L'oeillet (2018) concluded that there is growing consensus around the idea that the finance-growth relationship is more complex than the linear, uniformly positive link proposed by early finance-growth theory. The 2008/2009 global financial crisis served as a critical turning point in this discourse, prompting scholars to reconsider the potentially non-linear and context-dependent nature of financial development's impact on economic growth. In the aftermath of the crisis, a substantial body of empirical research has emerged highlighting the non-linearities and asymmetric effects in the finance-growth nexus. Studies by Wachtel (2011), Law and Singh (2014), Beck et al. (2014), Gaffeo and Garalova (2014), Arcand et al. (2015), Samargandi et al. (2015), Demetriades and Rousseau (2016), Benczúr et al. (2019), Boukrajne (2020), Swamy and Dharani (2020), and Purewal and Haini (2021), among others, provide compelling evidence that

the effects of financial development on growth are not always positive and may vary depending on the level or type of financial development. For example, while credit growth can stimulate investment and output under certain conditions, excessive expansion of bank credit, often observed during credit booms, may lead to financial instability and diminishing or even negative returns to growth (Wachtel, 2011; Breitenlechner et al., 2015). In addition, market-based financial systems, though often praised for their efficiency, can generate negative growth outcomes when complex financial products (such as sub-prime mortgages) are traded in environments of imperfect information and weak regulation, as evidenced during the global financial crisis. These findings also help explain the mixed results reported in earlier empirical studies, which oscillated between finding positive, negative, or insignificant relationships between finance and growth (e.g., Ram, 1999; Driffill, 2003; Levine, 2005). The recent literature suggests that such inconsistencies may stem from differences in financial system structure, institutional quality, and the level of financial inclusion, factors that were not always accounted for in earlier analyses.

Recent empirical studies increasingly emphasize the role of institutional quality and macroeconomic conditions, such as inflation and income levels, in shaping the non-linear relationship between financial development and economic growth (Law et al., 2013; Carré & L'oeillet, 2018; Ehigiamusoe & Samsurijan, 2021). These factors act as moderating variables that influence whether financial development positively or negatively affects economic outcomes. Importantly, this non-linear dynamic is not confined to advanced economies. A growing body of empirical evidence suggests that developing countries also exhibit non-linearities in the finance-growth nexus (Rioja & Valev, 2004; Chami & Yousefi, 2013; Haini, 2021). Chami and Yousefi (2013) and Haini (2021) demonstrate that the relationship between financial development and economic growth varies significantly depending on the level of financial inclusion. Their findings reveal that at low levels of financial access, financial development may have negligible or even adverse effects on growth, whereas at higher levels of inclusion, the relationship becomes positive. These results are particularly relevant for developing economies, where financial access remains uneven and where informal financial systems often dominate. The evidence therefore underscores the importance of contextual and structural factors, such as financial inclusion, in understanding

the finance-growth relationship. It challenges the assumption that financial development is uniformly beneficial and suggests that policies aimed at deepening the financial sector must be complemented by efforts to expand access, improve institutional quality, and maintain macroeconomic stability.

To test the theoretical propositions underlying the finance-growth nexus, empirical studies have predominantly employed formal growth models and Granger causality tests to examine both the nature and direction of the relationship. A significant portion of this empirical work is grounded in endogenous growth models, where financial development is theorized to enhance the productivity of human and physical capital by facilitating innovation and research and development (Carré & L'oeillet, 2018). However, a persistent methodological challenge in the finance-growth literature is the measurement of financial development, which remains a key point of divergence across studies. Different proxies often yield inconsistent or contradictory results (Levine, 2005; Ang, 2008; Valickova et al., 2015). In line with the finance-growth theory and constrained by data availability, most empirical studies have relied on size-based indicators. For financial institutions, common proxies include bank credit to the private sector and various monetary aggregates such as the ratios of narrow or broad money to GDP (King & Levine, 1993; Levine, 2005; Valickova et al., 2015). In the context of financial markets, traditional size indicators like stock market capitalization are complemented by measures of liquidity and efficiency, such as stock market turnover (King & Levine, 1993; Levine, 2005). Despite their widespread use, these individual indicators may not fully capture the multidimensional nature of financial development. Recognizing this limitation, a growing number of studies have employed composite indices that combine various dimensions of the financial system (Carré & L'oeillet, 2018; Ehigiamusoe & Samsurijan, 2021). These indices offer a more holistic measure of financial development, aligning more closely with the finance-growth theory's emphasis on a well-functioning financial system (Levine, 2005) and comprehensive financial coverage, which encompasses both institutions and markets, as well as access and participation by a broad spectrum of economic agents (Goldsmith, 1975).

The role of financial inclusion in fostering economic growth has received increasing attention in recent empirical literature. Notably, the study by Nandi et al. (2022) provides compelling evidence that financial inclusion significantly contributes to economic growth in developing countries. The authors examined the financial inclusion–economic growth nexus across 76 developing countries over the period 2011 to 2017, focusing on how varying levels of financial inclusion influence growth outcomes. To capture the multidimensional nature of financial inclusion, the study constructed a composite index comprising indicators such as the number of bank accounts per 1,000 adults, the number of ATMs and bank branches per 100,000 adults, and the volume of credit and deposits relative to GDP. This index allowed for a more comprehensive assessment of access and usage dimensions of financial services. The empirical methodology incorporated Granger causality tests and three panel cointegration techniques, the Kao test, Pedroni test, and Westerlund test—to explore the long-run relationship between financial inclusion and economic growth. Additionally, a fixed effects instrumental variable (IV) model was used to address potential endogeneity between financial inclusion and per capita GDP. The findings revealed a strong and positive impact of financial inclusion on per capita GDP growth. More importantly, the results indicated that developing economies with higher levels of financial inclusion experienced stronger economic growth, thereby reinforcing the argument that promoting inclusive access to financial services is essential for sustainable economic development in the Global South.

The positive impact of financial inclusion on economic growth is further supported by empirical studies such as Anand and Chhikara (2013), who examined a cross-sectional sample of 49 developed and developing countries for the year 2007. The study constructed a multi-dimensional financial inclusion index based on three key components: depth (measured by the number of bank accounts per 1,000 population), availability (measured by the number of bank branches and ATMs per 100,000 population), and usage (proxied by the volume of credit and deposits as a share of GDP). Their findings indicate that the depth ratio contributed the most to the overall financial inclusion index. Furthermore, the study revealed an inverse relationship between financial inclusion indicators and poverty levels, underscoring the role of inclusive finance in poverty reduction and social development. Similarly, Sethi and Acharya (2018) provided further evidence

of a positive relationship between financial inclusion and economic growth using panel data from 31 developed and developing countries over the period 2004 to 2010. Their study employed Sarma's (2012) Financial Inclusion Index, which incorporates indicators such as banking penetration, availability of banking services, and the credit and deposits mobilized from the private sector relative to GDP. The results of the study showed a long-run positive association between financial inclusion and economic growth, suggesting that broader access to financial services contributes meaningfully to sustained economic development.

Empirical evidence from Kim et al. (2018), based on a cross-country analysis of 55 countries, including 20 from Sub-Saharan Africa, over the period 1990 to 2013, reveals a positive relationship between financial inclusion and economic growth. The study employed five indicators of financial inclusion: the number of ATMs and bank branches per 100,000 adults, deposit accounts and borrowers from commercial banks per 1,000 adults, and the volume of life insurance premiums relative to GDP. Similarly, Van et al. (2021) provided empirical evidence from emerging market economies using a multidimensional index of financial inclusion comprising: commercial bank branches per 100,000 adults, ATMs per 100,000 adults, and the ratio of bank credit to the private sector to GDP. Their findings indicate a positive relationship between financial inclusion and economic growth, with the effect being more pronounced in low-income and low-financial inclusion countries. In another study, Haini (2021) examined the role of financial inclusion in the finance-growth nexus using Svirydzenka's (2016) multidimensional Financial Development Index, which incorporates the access and depth dimensions of financial institutions. Based on a sample of 51 low- and lower-middle-income countries from 1996 to 2017, the study found that both financial access and financial depth had a positive effect on economic growth. Importantly, the analysis of marginal effects revealed that the impact of financial development on growth is non-linear—negative at low levels of financial access, but positive at higher levels, underscoring the critical role of financial inclusion in mediating the finance-growth relationship.

In terms of econometric approaches and estimation techniques, recent empirical studies on the finance-growth nexus increasingly employ panel data analysis, which enhances efficiency and

robustness by combining cross-sectional and time-series dimensions (Carré & L'oeillet, 2018). This methodological approach helps overcome the limitations commonly associated with purely cross-sectional or time-series analyses, such as omitted variable bias and the constraints of low-frequency data. In addition to standard panel data techniques, such as panel cointegration tests and panel error correction models, many studies also apply instrumental variable (IV) estimation methods, most notably the Generalized Method of Moments (GMM), to address issues of potential endogeneity in the finance-growth relationship (Valickova et al., 2015). The use of GMM is particularly suitable for dynamic panel data models, where explanatory variables may be endogenous or correlated with past and present error terms.

2.2.1 Sub-Saharan Africa (SSA)

Several empirical studies have examined the finance-growth nexus in Sub-Saharan Africa (SSA), with many confirming that financial development promotes economic growth (Trabelsi, 2002; Agbetsiafa, 2004; Adusei, 2013; Walle, 2014). Empirical evidence suggests that countries with more developed financial systems tend to experience faster economic growth (Rioja & Valev, 2004; Demetriades & James, 2011; Barajas et al., 2013; Demetriades & Rewilak, 2020). For instance, Rioja and Valev (2004) found that countries such as South Africa and Mauritius, which possess moderately developed financial systems, recorded higher growth rates compared to countries like Senegal and Rwanda, which had less developed financial systems. However, consistent with broader empirical findings, the results from SSA are highly sensitive to the proxies used to measure financial development. This sensitivity is reflected both in Granger causality tests and in formal growth model estimates. Regarding Granger causality, some studies (Agbetsiafa, 2004; Walle, 2014) report unidirectional causality from financial development to economic growth, supporting Patrick's (1966) supply-leading hypothesis. Others, such as Acaravci et al. (2009), identify unidirectional causality running from economic growth to financial development, which aligns with Patrick's demand-following hypothesis. Additionally, several studies (Acaravci et al., 2009; Fowowe, 2011; Adusei, 2013; Walle, 2014; Aluko et al., 2020) find bidirectional

causality, supporting Patrick's stage-of-development hypothesis. Notably, Acaravci et al. (2009) also found evidence of both unidirectional and bidirectional causality, depending on the specific financial development indicator used, further highlighting the methodological challenges in the finance-growth empirical literature.

Agbetsiafa (2004) examined the causal relationship between financial development and economic growth using a sample of eight Sub-Saharan African (SSA) countries; Ghana, Ivory Coast, Kenya, Nigeria, Senegal, South Africa, Togo, and Zambia over the period 1963 to 2001. The study employed five measures of financial development: (i) the ratio of money to income, (ii) the ratio of banking deposit liabilities to income, (iii) the ratio of private sector credit to income, (iv) the share of private sector credit in domestic credit, and (v) the ratio of domestic credit to income. The results indicated unidirectional causality from financial development to economic growth in six countries—Ghana, Nigeria, Senegal, South Africa, Togo, and Zambia, while in Ivory Coast and Kenya, the direction of causality ran from economic growth to financial development. In contrast to Agbetsiafa's findings, Acaravci et al. (2009), using a broader sample of 24 SSA countries for the period 1975 to 2005, found unidirectional causality from real GDP per capita to liquid liabilities, and a bidirectional causal relationship between domestic credit by the banking sector and GDP per capita. Similarly, Walle (2014), who analyzed the same period using a sample of 17 SSA countries, found unidirectional causality from credit to the private sector to economic growth, a result consistent with Agbetsiafa (2004). However, Walle's findings on liquid liabilities to GDP supported the opposite causality direction, from economic growth to financial development, in line with Acaravci et al. (2009). These contrasting findings emphasize the sensitivity of causality results to the specific financial development indicators used and underscore the complexity of the finance-growth relationship in SSA countries.

Fowowe (2011) found evidence of bi-directional causality between financial development and economic growth in a panel of 17 Sub-Saharan African (SSA) countries, a result that aligns with the findings of Acaravci et al. (2009). Fowowe measured financial development using two indicators: the ratio of credit provided by banks to the private sector to GDP and the ratio of deposit

liabilities to GDP. Extending the empirical investigation, Aluko et al. (2020) employed a multi-dimensional financial development index, in contrast to the use of single proxies, to examine the finance-growth nexus across 33 SSA countries from 1990 to 2015. To ensure robustness, the study utilized four different panel causality testing approaches: (i) Dumitrescu and Hurlin (2012) panel Granger causality test; (ii) Panel causality test based on error correction models; (iii) Panel causality test using the Pooled Mean Group (PMG) estimator, and (iv) Panel Vector Autoregressive (VAR) causality test based on the Generalized Method of Moments (GMM) estimator. The results confirmed bi-directional causality between financial development and economic growth, consistent with prior studies (Acaravci et al., 2009; Fowowe, 2011; Walle, 2014). Moreover, Aluko et al. (2020) emphasized that the finance-growth nexus in SSA is sensitive to both the financial development measure employed and the econometric methodology adopted, underscoring the methodological challenges that characterize empirical studies in this field.

To address the limitations associated with single financial development indicators, some empirical studies on Sub-Saharan Africa (SSA) have aligned with broader trends in the finance-growth literature by employing composite financial development indices. These indices provide a more comprehensive view of the financial system by incorporating multiple dimensions such as access, depth, and efficiency. In this context, Aluko et al. (2020) examined the finance-growth nexus for a panel of 33 SSA countries over the period 1990 to 2015, utilizing Svirydzenka's (2016) multi-dimensional Financial Development Index, which captures the performance of both financial institutions and financial markets. The study found bi-directional causality between financial development and economic growth, a result consistent with earlier findings based on single indicators such as bank credit to the private sector and liquid liabilities (Acaravci et al., 2009; Fowowe, 2011; Walle, 2014). The convergence of findings across both single-indicator and index-based approaches underscores the continued dominance of the banking sector in SSA's financial systems. Despite the inclusion of financial market indicators in the composite index, the evidence suggests that banks remain the primary conduit for financial intermediation in the region.

In addition to Granger causality tests, several empirical studies on Sub-Saharan Africa (SSA) have employed endogenous growth models estimated using panel cointegration techniques (Acaravci et al., 2009; Demetriades & James, 2011; Aluko et al., 2020) as well as dynamic panel estimators such as the Generalized Method of Moments (GMM) to address econometric challenges including endogeneity and serial correlation (Ibrahim & Alagidede, 2018; Demetriades & Rewilak, 2020; Mohamed, 2021; Olaniyi & Oladeji, 2021; Abeka et al., 2021). Similar to findings from Granger causality analyses, the results from these studies demonstrate a high degree of sensitivity to the financial development proxy employed. For instance, Demetriades and James (2011), using a panel of 18 SSA countries from 1975 to 2006, found no cointegration between bank deposits or private sector credit and real GDP per capita, suggesting a lack of long-run relationship. However, they did find cointegration between liquid liabilities and economic growth, indicating that the choice of financial development indicator can significantly influence the conclusions drawn. This finding contrasts with Acaravci et al. (2009), who also applied panel cointegration methods to a broader sample of 24 SSA countries over the period 1975 to 2005 but reported no evidence of cointegration between liquid liabilities and economic growth. These contrasting results further underscore the methodological complexity and the importance of indicator selection in empirical assessments of the finance-growth nexus in SSA.

Aluko et al. (2020) investigated the finance-growth nexus in Sub-Saharan Africa (SSA) using a panel dataset comprising 33 countries over the period 1990 to 2015, employing Svirydzenka's (2016) multi-dimensional financial development index, which captures both financial institutions and financial markets. The study found a positive long-run relationship between financial development and economic growth. This result contrasts with Acaravci et al. (2009), who found no such relationship using liquid liabilities as the proxy for financial development, but aligns with Demetriades and James (2011), who used bank deposits and private sector credit and found a positive association. Expanding on this approach, Aluko and Ibrahim (2020) applied a threshold regression model to a sample of 28 SSA countries for the period 1996 to 2015, also using Svirydzenka's financial development index. Their results similarly confirmed that financial development contributes positively to economic growth, reinforcing the findings by Aluko et al.

(2020). The convergence of findings across studies employing a broad-based financial development index suggests that such composite indices may help to mitigate the mixed empirical results, positive, negative, or insignificant, often reported in the finance-growth literature, which tend to arise due to variations in the proxy used for financial development. Furthermore, these studies highlight the importance of controlling for additional macroeconomic variables that influence the finance-growth relationship. Variables such as trade openness (Aluko & Ibrahim, 2020; Abeka et al., 2021; Mohamed, 2021), initial income, government consumption, investment, human capital, and inflation (Aluko & Ibrahim, 2020) have been incorporated as control variables to account for country-specific growth dynamics.

Recent empirical studies have increasingly explored the non-linear dynamics in the finance-growth relationship, a complexity previously highlighted in the broader empirical literature. These studies have uncovered evidence of non-linearity, suggesting that the impact of financial development on economic growth is not uniformly positive and may depend on institutional quality and macroeconomic conditions. Specifically, research shows that factors such as the quality of institutions (Ibrahim & Alagidede, 2018; Olaniyi, 2021; Mohamed, 2021) and the level of inflation (Ehigiamusoe & Lean, 2018) play significant roles in shaping the nature and strength of the finance-growth nexus. For instance, Ibrahim and Alagidede (2018) analyzed data from 29 Sub-Saharan African (SSA) countries over the period 1980 to 2014 and found a positive relationship between private sector credit and economic growth. However, the study also revealed a threshold effect, where the relationship turned negative when domestic credit to GDP exceeded 29 percent, indicating diminishing returns or potential financial instability at higher levels of credit penetration. In contrast, Demetriades and Rewilak (2020), using data from an unbalanced panel of SSA countries covering the period 1998 to 2017, emphasized the importance of credit quality. Their findings indicate that when measures of credit quality are incorporated, the relationship between financial development and economic growth remains consistently positive. This suggests that not just the quantity, but the quality and allocation efficiency of financial resources is critical in fostering sustainable economic growth in the SSA context.

Mohamed (2021) provides empirical evidence on the non-linear relationship within the finance-growth nexus based on data from four North African countries; Tunisia, Morocco, Algeria, and Egypt, covering the period 1991 to 2015. The study highlights a more pronounced positive impact of financial development on economic growth when interacted with trade openness, suggesting that the benefits of financial development are amplified in more open economies. Similarly, Olaniyi and Oladeji (2021) investigated the finance-growth nexus across 13 West African countries; including Burkina Faso, Côte d'Ivoire, Gambia, Ghana, Guinea, Guinea-Bissau, Liberia, Mali, Niger, Nigeria, Sierra Leone, Senegal, and Togo, over the period 1986 to 2015. Their findings indicate that institutional quality plays a critical role in shaping the finance-growth relationship. Specifically, financial development was found to exert a positive effect on economic growth only when the institutional quality index exceeded a threshold level of 4.77 (on a 1 to 10 scale, where 1 indicates low and 10 indicates high financial development). This underscores the importance of institutional frameworks in ensuring that financial development translates into meaningful and sustained economic growth in the Sub-Saharan African context

Recent empirical studies on the finance-growth nexus in Sub-Saharan Africa (SSA) have increasingly focused on the role of financial inclusion, a key aspect of financial development that has significantly progressed in the region over the past two decades. Chinoda et al. (2021) suggest that economic growth drives financial inclusion, rather than the reverse. The study analyzed the relationship between financial inclusion, financial innovation (measured by depositors with commercial banks, ATMs per 100,000 adults, commercial bank branches per 100,000 adults, and credit to the private sector), and economic growth for 23 African countries during 2004 to 2018. Using the panel autoregressive distributed lag (ARDL) estimation method, the study found a positive and significant impact from economic growth on financial inclusion in both the short and long run. In contrast, Ikhida (2015) explored the finance-growth nexus for 21 SSA countries from 1970 to 2014 and examined the role of financial inclusion (measured by the number of commercial bank branches per 1,000 adults) and financial development (proxied by domestic credit to the private sector). The study found that the coefficient for financial inclusion was both positive and significant, influencing financial depth in countries with advanced financial systems (such as South

Africa, Seychelles, Mauritius, Tunisia, and Namibia). Specifically, the study revealed that a one percent increase in commercial bank branches per 1,000 adults led to a 5.1 percent increase in real GDP per capita. Furthermore, the impact of financial inclusion led to a shift in the financial depth coefficient from negative to positive in these countries. These findings were corroborated by Abeka et al. (2021), who observed that telecommunications infrastructure development (measured by the number of cellular and fixed telephones and internet subscriptions) enhanced the relationship between financial development (proxied by domestic credit to the private sector) and economic growth. Moreover, Sarpong & Nketiah-Amponsah (2022) also provided evidence of a positive relationship between financial inclusion and economic growth in SSA. Using a sample of 46 SSA countries for the period 2004 to 2018, their study considered three dimensions of financial inclusion: financial availability (measured by ATMs and commercial bank branches per 100,000 adults), financial services usage (measured by private sector credit as a percentage of GDP), and financial knowledge (measured by the depth of credit information index). The study concluded that a unit increase in the usage of financial services led to a 0.03-unit improvement in inclusive growth, further supporting the positive role of financial inclusion in fostering economic development.

The study by Ugwuanyi et al. (2022) examined the impact of traditional finance and digital financial inclusion (specifically mobile money) on economic growth for 29 Sub-Saharan African countries during the period 2012 to 2020. The study utilized the panel feasible generalized least squares (GLS) and Generalized Method of Moments (GMM) estimation methods, alongside the panel vector autoregression Granger causality test, to analyze the data. The findings revealed that both traditional financial inclusion and digital financial inclusion had a positive and significant impact on economic growth. However, traditional financial inclusion was found to have a greater impact than digital financial inclusion. The study also indicated that while both forms of financial inclusion were positively significant in middle-income countries, only digital finance (proxied by mobile money) was significant in low-income countries. These results support the growing evidence of non-linearity in the finance-growth relationship, as suggested by recent studies. Similarly, Asongu and Le Roux (2024) explored the effect of mobile money innovation on poverty

in Sub-Saharan Africa for the period 1980 to 2019. Their study uncovered a threshold effect, indicating that the mobile money innovation significantly mitigated the positive effect of income inequality on poverty, but only at higher levels of mobile money usage (such as sending money and bill payments). The findings suggest that for mobile money to have a positive effect on income levels, its usage needs to reach a sufficiently high threshold.

The empirical evidence from panel studies reveals mixed results, influenced by factors such as the measure of financial development, estimation method, and the sample of countries and period covered (Valickova et al., 2015). Therefore, alongside panel studies, several case studies have been employed to investigate country-specific factors that influence the finance-growth nexus. In this study, in addition to the panel analysis based on 17 Sub-Saharan African countries, the country case studies of Kenya and Uganda, two of the leading users of mobile money in Sub-Saharan Africa, are examined to explore the role of mobile money financial innovation.

2.2.2 Case studies: Kenya and Uganda

The selection of Kenya and Uganda as case studies is both strategic and illustrative. These two countries represent early adopters and regional leaders in mobile money innovation within Sub-Saharan Africa (SSA), yet they also exhibit meaningful institutional and structural differences that enrich comparative analysis. Kenya is widely recognized as a global pioneer in mobile money, primarily due to the success of M-Pesa, which was launched in 2007 by Safaricom. Its rapid adoption was facilitated by a permissive regulatory environment, strong telecommunications infrastructure, and a dominant mobile network operator that benefited from first-mover advantage (Jack & Suri, 2011; Muthiora, 2015). Neighboring countries such as Uganda and Tanzania followed closely, drawing on Kenya's early success and implementing robust regulatory frameworks to support their own mobile money ecosystems.

The rapid expansion of mobile money in Kenya and Uganda, relative to other low-income Sub-Saharan African (SSA) countries, can be attributed to several interrelated factors. In response to historically underdeveloped financial systems, mismanaged economies, and widespread exclusion from formal financial services, a range of interventions have been implemented. These include comprehensive economic and financial sector reforms, the enhancement of regulatory frameworks governing both financial institutions and mobile network operators (MNOs), and the intentional development of microfinance institutions (MFIs) aimed at broadening financial inclusion. By 2005, prior to the widespread adoption of mobile money, the penetration of microfinance services was already notably higher in East African Community (EAC) countries, particularly Kenya, Uganda, and Tanzania, than in other SSA nations (Pattillo et al., 2006). In addition to persistently low levels of financial inclusion, the high volume of remittances and the expansion of MFIs, underpinned by financial sector reforms, further contributed to the acceleration of mobile money adoption. These institutional and regulatory developments collectively created an enabling environment for the proliferation of digital financial services in the region.

By comparing Kenya and Uganda, the thesis captures both shared regional dynamics and country-specific divergences that shape the trajectory of mobile money adoption and its developmental outcomes. This comparative lens enhances the generalizability of findings while allowing for a nuanced understanding of how variations in regulatory regimes, market structure, and institutional capacity influence the effectiveness of mobile money as a tool for financial inclusion and economic growth.

2.2.2.1. Kenya

Empirical studies examining the finance-growth nexus in Kenya reveal that Granger causality results are contingent upon both the period analyzed and the measure of financial development employed. Studies by Agbetsiafa (2004), Odhiambo (2008b), Uddin et al. (2013), Arayssi and Fakhri (2017), Musembi and Chun (2020), and Misati et al. (2021) identify a unidirectional causality from financial development to economic growth across various timeframes, including

1963 to 2001, 1968 to 2004, 1971 to 2011, 1960 to 2013, 2007 to 2018, and 2005 to 2020 (quarterly data), respectively. In the study by Uddin et al. (2013), a composite financial development index was constructed using three distinct indicators: the ratio of domestic credit provided by the banking sector to GDP, the ratio of domestic credit to the private sector to GDP, and the ratio of money plus quasi-money to total money. Odhiambo (2008b) utilized broad money, whereas Arayssi and Fakh (2017), Musembi and Chun (2020), and Misati et al. (2021) relied on credit to the private sector as their principal measure of financial development. In contrast, Agbetsiafa (2004) incorporated a broader set of five financial development indicators: the ratio of money to income, the ratio of banking deposit liabilities to income, the ratio of private sector credit to income, the share of private sector credit in domestic credit, and the ratio of domestic credit to income.

In contrast, other studies have found evidence of bi-directional causality between financial development and economic growth. For instance, Wolde-Rufael (2009) identified bi-directional causality for Kenya during the period 1966 to 2005, utilizing three different measures of financial development: (i) domestic credit provided by the banking sector, (ii) total domestic credit provided by the banking sector, and (iii) liquid liabilities. Similarly, Maturu (2022) found bi-directional causality between bank credit and economic growth for the period from 2009Q1 to 2017: Q2. Odhiambo (2008a) also observed bi-directional causality between financial development and economic growth in Kenya for the period 1968 to 2002, using broad money as the financial development proxy. However, in a subsequent study covering 1969 to 2006, Odhiambo (2009) reversed the direction of causality, finding uni-directional causality from economic growth to financial development (broad money). Nyasha and Odhiambo (2015) extended the analysis to both bank-based financial development (represented by a means-removed average of M2, M3, and credit to the private sector) and stock market development (measured by a means-removed average of stock market capitalization, stock market traded value, and stock market turnover) for the period 1980 to 2012. The study found uni-directional causality from economic growth to bank-based financial development in Kenya, but no causal relationship between market-based financial development and economic growth. These findings appear to align with Patrick's (1966) stage of development hypothesis, which posits that as economies progress, they transition from a supply-

leading financial development model (evidenced by uni-directional causality from finance to economic growth) to a demand-following financial development model (manifested by either uni-directional causality from economic growth to finance or bi-directional causality).

Empirical studies examining the finance-growth nexus in Kenya also yield contrasting results depending on the estimation techniques employed. Rafindadi and Yusof (2013) utilized the ARDL (Autoregressive Distributed Lag) approach to investigate the impact of the 2008/2009 global financial crisis on the finance-growth relationship in Kenya. Using data from 1980 to 2011, their study found no evidence of a long-run or non-linear relationship between financial development and economic growth. In contrast, Chen et al. (2020), employing a non-linear autoregressive distributed lag (NARDL) model, found evidence of a long-run relationship and an asymmetric effect of financial development on economic growth for the period 1972 to 2017. Their results indicated that the positive partial sum of squares of financial development was associated with a 12.15 percent increase in economic growth in the short run, but a 1.98 percent reduction in growth in the long run. Musembi & Chun (2020), analyzing the period from 2007 to 2018, used a vector error-correction model (VECM) and found results consistent with those of Chen et al. (2020), highlighting a negative effect of financial development on economic growth. Furthermore, Maturu (2022) employed a dynamic stochastic general equilibrium (DSGE) modeling approach to examine the finance-growth nexus during the period preceding the COVID-19 pandemic (from July 2009 to December 2017). Using monthly data and Bayesian estimation techniques, the study found that an increase in real bank credit by 1 percentage point resulted in a 0.532 percentage point increase in domestic final output.

Most empirical studies on the finance-growth nexus in Kenya have utilized the Autoregressive Distributed Lags (ARDL) cointegration approach to estimate both the short-run and long-run relationships between financial development and economic growth (Uddin et al., 2013; Rafindadi & Yusof, 2013; Onuonga, 2014; Nyasha & Odhiambo, 2017; Misati et al., 2021). The ARDL model is favored for its superior small sample properties and its ability to accommodate a mixed order of integration (I(1) or I(0)) (Pesaran & Shin, 1999), in contrast to other cointegration methods

such as those proposed by Johansen (1988) and Engle and Granger (1987). As with Granger causality results, the empirical findings from ARDL models reveal sensitivity to the period considered and the measure of financial development employed. For instance, Onuonga (2014) and Nyasha & Odhiambo (2017) found a positive relationship between financial development and economic growth, while Rafindadi & Yusof (2013), who also used the ARDL approach, found mixed results. Specifically, they observed that in the short run, bank credit to the private sector (as a ratio to GDP) was associated with a decrease in economic growth, whereas the ratio of liquid liabilities to nominal GDP led to increased growth, and the ratio of commercial bank assets to central bank assets had no significant effect on economic growth. In a study focusing on the financial market, Aduda et al. (2013) found that three out of five financial deepening variables; stock market size, stock market turnover ratio, and bond market turnover ratio, had a significant positive effect on economic growth. Conversely, market capitalization and the value traded ratios were found to have a negative effect, suggesting that market listings do not necessarily correlate with market efficiency (Levine & Zervos, 1998, as cited in Aduda et al., 2013). More recent studies, such as that by Chen et al. (2020), have highlighted the sensitivity of results to the measure of financial development used. By constructing a financial depth index that incorporates broad money/GDP, real interest rate, domestic credit to private sector/GDP, and trade openness, Chen et al. (2020) found that an increase in their financial development index led to an increase in economic growth in the short run, but a decrease in the long run.

In terms of the economic significance of financial development, the empirical evidence from Kenya suggests that its contribution is substantial and aligns with the general empirical findings that countries with lower levels of financial development tend to experience higher growth effects (Rioja & Valev, 2004; Levine, 2005; Barajas et al., 2013). For example, Onuonga (2014) found that a one percent increase in financial development (proxied by broad money) led to a 0.141 percent and 4.626 percent increase in GDP in the short-run and long-run, respectively. The study also revealed that a one percent increase in private credit led to a 0.45 percent increase in economic growth in the short run, although private credit did not exhibit a significant effect in the long run. In contrast, Nyasha and Odhiambo (2017) found that bank-based financial development had no

impact on economic growth in Kenya, both in the short and long run. However, the authors found that market-based financial development contributed to GDP growth, with increases of 0.17 percentage points in the short-run and 0.21 percentage points in the long-run. While Onuonga (2014) controlled for trade openness in the finance-growth analysis, the effect of trade openness was found to be statistically insignificant. Additionally, in their analysis, Nyasha and Odhiambo (2017) included gross fixed capital formation (GFC), savings, and trade openness as control variables. They found that the coefficient for GFC was both positive and statistically significant in both the short and long run, while the coefficients for savings and trade openness were not significant in either the short or long run.

Due to its phenomenal success, Kenya's experience with mobile money adoption, particularly through M-PESA, has attracted considerable empirical scrutiny. Notably, Suri and Jack (2016) found that access to M-PESA significantly contributed to poverty reduction, lowering poverty rates by approximately 2 percent among Kenyan households. Several studies have explored the microeconomic impacts of mobile money, with Kirui and Onyuma (2015), Islam et al. (2018), and Fabregas and Yokossi (2022) identifying positive effects on local economic activity, sales turnover, and investment in Micro and Small Enterprises (MSEs). Other scholars have investigated the factors driving the successful adoption and diverse uses of mobile money in Kenya and similar contexts (e.g., Hughes & Lonie, 2007; Ngugi et al., 2010; Kusimba et al., 2013; Wamuyu, 2014; Muthiora, 2015). Furthermore, micro-level studies such as Jack et al. (2013), Jack & Suri (2014), and Kikulwe et al. (2014) provide evidence that mobile money has had welfare-enhancing effects, including increased household income and savings, and improved risk management strategies.

Notwithstanding these overwhelmingly positive findings, some studies have raised concerns about the limitations and unintended consequences of mobile money adoption in Kenya. Bharadwaj & Suri (2020), for instance, highlighted that mobile savings and credit uptake remained relatively low, limiting the broader transformative potential of mobile money. More critically, Bateman et al. (2019) argued that M-PESA has not delivered the significant positive impacts on poverty alleviation and economic development that are often claimed. They cite issues such as rising

formal and informal indebtedness among households and the displacement of more sustainable microenterprises. Similarly, Osabutey and Jackson (2024) contend that the benefits of mobile money have been disproportionately captured by wealthier segments of society, rather than the poor who were expected to benefit most. They further emphasize that concerns around integrity, privacy, and security, as well as infrastructure limitations and poor stakeholder integration, have undermined the potential of mobile money to advance financial inclusion across African countries.

Despite the notable success of mobile money adoption in Kenya and its recognized contribution to financial inclusion, empirical studies that explicitly examine the role of financial inclusion, proxied by mobile money, within the finance-growth nexus remain limited. A key contribution in this area is Musembi and Chun (2020), who analyzed the impact of financial development (proxied by private sector credit and broad money) and financial inclusion (proxied by mobile money) on economic growth in Kenya over the period 2007 to 2018. Using a Vector Error Correction Model (VECM), the study found evidence of a long-run relationship among the variables, with financial inclusion exerting a significant positive effect on economic growth, whereas financial development had a negative effect. However, the study's operationalization of financial inclusion, the ratio of mobile money transactions to GDP, may be insufficient as a standalone proxy. This indicator primarily captures transaction value and does not adequately reflect access or usage dimensions of financial inclusion, particularly in terms of demographic reach and frequency of service utilization.

As highlighted in the broader empirical literature (e.g., Sarma, 2008; Ikhide, 2015; Svirydzenka, 2016; Haini, 2021; Hasan, 2024), more robust indicators would include metrics based on adult population coverage such as: the number of mobile money transactions per 1,000 adults, registered agent outlets per 100,000 adults, commercial bank branches per 1,000 km², and ATMs per 1,000 km². These measures offer a more comprehensive representation of financial inclusion, encompassing both accessibility and usage dimensions. Additionally, Musembi and Chun's (2020) approach to financial development, which is limited to private sector credit and broad money, overlooks critical components of Kenya's broader financial ecosystem, such as non-bank financial

institutions and financial markets. This narrow focus is somewhat inconsistent with finance-growth theoretical frameworks, which emphasize the complementarity between financial institutions and financial markets in facilitating resource allocation, risk management, and capital formation. A more holistic treatment of financial development would improve the explanatory power and theoretical alignment of future analyses.

A subsequent study by Misati et al. (2021) investigated the contribution of financial innovation and financial access to economic growth in Kenya but similarly fell short of employing measures that adequately capture the multidimensional nature of financial access. This shortcoming may reflect a limitation in data availability, as the study utilized quarterly data spanning the period 2005 to 2020, while robust indicators of financial access and usage, such as account ownership, demographic coverage of financial services, and usage frequency, are typically available on an annual basis. In terms of measurement, the study used the number of bank branches and number of bank accounts as proxies for access to traditional financial services. Credit to the private sector as a share of GDP was employed to measure financial depth. For financial innovation, indicators included the value of mobile transactions, number of mobile money accounts, number of mobile money agents, value of ATM transactions, and the proportion of individuals using the internet. Using an endogenous growth model framework and the Autoregressive Distributed Lag (ARDL) approach to cointegration, the study found that in the short run, credit to the private sector, the value of mobile transactions, and the value of ATM transactions had a positive and statistically significant effect on economic growth. In contrast, variables related to financial access, namely, the number of mobile money agents, bank branches, and mobile accounts, were statistically insignificant. In the long run, however, none of the financial innovation or access indicators exerted a direct influence on economic growth, whereas bank credit to the private sector continued to have a positive and significant effect. These findings suggest that financial depth may play a more sustained role in supporting economic growth in Kenya than access or innovation indicators—at least as currently measured. Furthermore, the lack of long-run effects from financial access indicators highlights the need for more comprehensive and high-frequency data on financial

inclusion, particularly in capturing quality of access, frequency of use, and distributional reach across different socioeconomic groups.

The empirical studies by Musembi & Chun (2020) and Misati et al. (2021) offer valuable insights into the role of financial inclusion, particularly through mobile money, in Kenya's finance-growth nexus. However, the proxies used to measure financial inclusion in both studies, such as the value of mobile money transactions, number of mobile accounts, and number of mobile agents, do not comprehensively capture the multidimensional aspects of financial inclusion, namely access, usage, and quality. More robust and widely accepted indicators, such as those based on the proportion of the adult population with access to financial services, the geographical distribution of financial access points, and frequency of usage, would offer a more accurate assessment of financial inclusion (Sarma, 2008; Svirydzenka, 2016). Moreover, a notable limitation of these studies is the incomplete representation of the financial system. According to finance-growth theory, the financial system comprises a range of complementary institutions and markets, including banks, non-bank financial institutions, and financial markets, that jointly facilitate efficient resource allocation, risk management, and capital mobilization. However, both studies primarily focus on bank-based indicators and mobile money usage, while non-bank financial institutions (such as microfinance institutions and savings and credit cooperatives) and the financial market (including capital markets and insurance) are excluded from the analysis. This omission potentially underestimates the holistic contribution of the financial sector to economic growth and limits the scope for evaluating the complementarity between financial sub-sectors as suggested by the finance-growth theoretical framework (Levine, 2005).

2.2.2.2. Uganda

Empirical studies on the finance-growth nexus in Uganda have employed both formal growth models and Granger causality tests to examine the impact of financial development on economic growth and the direction of causality. Grounded in the endogenous growth theory augmented to include financial development, these studies utilize a range of econometric techniques to estimate

both short-run and long-run relationships. Earlier works such as Kasekende and Atingi-Ego (2003), Bwire and Musiime (2015), and Nampewo et al. (2016) employed the Johansen and Juselius (1990) and Engle and Granger (1987) cointegration frameworks along with the Vector Error Correction Model (VECM) to capture both long-term equilibrium relationships and short-term dynamics. More recent studies have shifted towards the Autoregressive Distributed Lag (ARDL) bounds testing approach developed by Pesaran and Shin (1995), combined with an Error Correction Model (ECM) specification. This includes empirical works by Alananga and Mutasa (2021), Okot and Mbabazize (2021), and Twinamatsiko (2022). The ARDL approach is preferred in these more recent studies due to its superior performance in small sample contexts, its flexibility in handling variables with a mixed order of integration, whether integrated of order zero, $I(0)$, or order one, $I(1)$, and its ability to provide unbiased long-run estimates even when explanatory variables are endogenous. This methodological evolution reflects an effort to improve the robustness and validity of empirical findings on the finance-growth nexus in the Ugandan context.

The study by Kasekende and Atingi-Ego (2003) offers empirical insights into the finance-growth nexus in Uganda in the aftermath of financial liberalization and macroeconomic reforms, focusing on the period 1987Q1 to 1995Q3. Utilizing Johansen and Juselius's (1990) cointegration technique and estimating a Vector Error Correction Model (VECM), the authors found that the lending rate, used as a proxy for the cost of working capital sourced from the banking system, was strongly exogenous to real GDP, lending support to Patrick's (1966) supply-leading hypothesis during the period under analysis. Further empirical support for the finance-led growth hypothesis in Uganda is found in Bwire and Musiime (2015) and Odhiambo and Nyasha (2022). Using VAR-based Granger causality tests for the period 1970 to 2005, and ECM-based causality tests for the period 1980 to 2015, respectively, both studies reported a positive causal effect from financial depth (proxied by liquid liabilities and bank deposits) to economic growth. However, the findings are not uniform across all proxies of financial development. In Odhiambo and Nyasha (2019), which employed a broader set of indicators, including the ratio of deposit money bank assets to total bank assets and bank credit to the private sector, the authors identified a bi-directional causal relationship between financial development and economic growth using the former, but found no

evidence of Granger causality when using private sector credit as the measure. These mixed findings underscore the sensitivity of empirical results to the choice of financial development indicator, reflecting a broader pattern in the finance-growth literature across Sub-Saharan Africa.

The empirical findings by Bwire and Musiime (2015), based on a formal growth model employing Johansen and Juselius's (1990) cointegration test and a Vector Error Correction Model (VECM), indicate a long-run cointegrating relationship between real GDP and two measures of financial development, broad money and bank credit, for Uganda over the period 1970 to 2005. While broad money exerted a positive effect on economic growth, the effect of bank credit was found to be negative, suggesting inefficiencies in the intermediation role of the banking sector during that period. In contrast, Nakijoba and Selotlegeng (2019), using Phillips and Hansen's (1990) Fully Modified Ordinary Least Squares (FMOLS) for the period 2000Q1 to 2018Q4, reported a positive relationship between bank credit to the private sector and economic growth, highlighting the possibility of improvements in credit allocation mechanisms or changes in institutional and macroeconomic conditions over time. Further divergence is observed in Alananga and Mutasa (2021), who employed a panel ARDL framework using data for Eastern and Southern African countries (including Uganda) for the period 1980 to 2017. Their country-specific findings for Uganda revealed a negative short-run effect of broad money on economic growth and an insignificant effect in the long run, while domestic credit to the private sector had no statistically significant impact in either the short or long run. Interestingly, despite Uganda recording the highest level of broad money growth among the five East African Community (EAC) member states considered (Burundi, Kenya, Rwanda, Tanzania, and Uganda), the expected growth-enhancing impact was not observed. These conflicting results underscore the sensitivity of the finance-growth relationship to the choice of financial development proxy, estimation method, and period analyzed. They also suggest that the efficacy of financial development in promoting growth may vary depending on the efficiency of financial intermediation, the quality of institutions, and the stage of financial sector development.

Okot and Mbabazize (2021) provide empirical evidence on the finance-growth nexus in Uganda using quarterly data from 2004Q1 to 2019Q4 and incorporating a broader representation of the financial system than many earlier studies. In addition to traditional indicators such as money supply and interest income of the banking sector, the study includes life and non-life insurance penetration as proxies for financial development, thereby capturing the contributions of the insurance sub-sector. Using the Autoregressive Distributed Lag (ARDL) bounds testing approach and an Error Correction Model (ECM), the results indicate that money supply, interest rate margin, and non-life insurance penetration have a short-run effect on real GDP, whereas bank credit to the private sector and bank assets exert a positive and significant effect on economic growth in both the short and long run. These findings highlight the importance of both banking sector assets and credit availability in Uganda's long-term economic performance. Complementing this, Twinamatsiko (2022) investigates the role of the financial market in Uganda's economic growth by analyzing the stock market over the period 2001 to 2020. Employing the ARDL approach, the study uses stock market indicators of size (market capitalization), depth (total value of shares traded), and efficiency (stock market turnover ratio). The results reveal that all three indicators, market size, depth, and efficiency, have a positive and significant long-run impact on economic growth, with stock market efficiency also exerting a short-run positive effect. These findings suggest that the development of Uganda's capital markets, especially improvements in trading efficiency, plays an increasingly important role in supporting long-term economic growth. Together, these studies underscore the relevance of broad-based financial development, spanning the banking, insurance, and capital markets, in fostering economic growth in Uganda. They also emphasize the importance of distinguishing between short- and long-run effects, and of capturing the multifaceted nature of financial systems beyond traditional banking metrics.

Muwanga (2020) emphasizes the importance of accounting for structural breaks when analyzing the finance-growth nexus in Uganda. The study provides evidence of at least one structural break, associated with significant political developments, which may attenuate the strength and stability of the relationship between financial development and economic growth. These findings suggest that ignoring structural breaks may lead to misleading inferences regarding the long-run dynamics

between financial and economic variables. In terms of policy control variables, Kasekende and Atingi-Ego (2003) and Bwire and Musiime (2015) incorporated inflation and the premium on the official exchange rate into their models and found that both variables had a negative and statistically significant effect on real GDP. This underscores the potential adverse impact of macroeconomic instability on growth. In contrast, Nakijoba and Selotlegeng (2019) did not find statistically significant effects of these variables on real GDP, highlighting sensitivity to sample period and estimation technique. Additionally, Bwire and Musiime (2015) identified that exports had a positive effect on real GDP, suggesting the importance of external trade as a growth driver, while the fiscal deficit exerted a negative effect, reflecting the potential crowding-out effects or inefficiencies associated with fiscal imbalances.

A limited number of studies from Uganda have examined the issue of financial inclusion within the broader context of the finance-growth nexus, which has received increased attention in recent empirical work on Sub-Saharan Africa (SSA). Micro-level studies provide evidence that financial inclusion has enabled individuals in Uganda to access financial services tailored to their specific needs (Eton et al., 2019) and that mobile money adopters, particularly those using digital savings and credit, are more likely to engage in entrepreneurial activities (Koomson et al., 2023). Nampewo et al. (2016) investigated the influence of mobile money services on private sector credit growth in Uganda using monthly data from March 2009 to February 2016. Employing Johansen's Vector Error Correction Model (VECM) and Granger causality tests, the study found that mobile money balances held in commercial banks had a positive and significant long-run relationship with private sector credit growth and identified unidirectional causality from mobile money to private sector credit. However, the study focused on aggregate mobile money balances and did not explicitly consider financial inclusion as an outcome of mobile money adoption. This highlights a gap in the empirical literature concerning the role of financial inclusion, proxied by mobile money adoption, in the finance-growth nexus in Uganda. The present study aims to address this gap by employing a broader measure of financial development that incorporates indicators of mobile money-based financial inclusion. Furthermore, and in line with finance-growth theory, which emphasizes the complementarity between financial institutions and financial markets, the study

includes measures that reflect the evolving importance of non-bank financial institutions and the financial market, thereby providing a more comprehensive view of Uganda's financial development landscape.

2.3 Conclusion

The review of recent empirical evidence on the finance-growth nexus reveals that the relationship between financial development and economic growth varies, being negative, positive, or non-existent, depending on the measure of financial development, the estimation method employed, or the period under consideration. These findings are consistent with previous studies conducted in Sub-Saharan Africa (SSA), as well as in Kenya and Uganda. According to the finance-growth theory, the relationship between finance and growth is best understood through a broad view of the financial system, which acknowledges the multi-dimensional and evolving nature of financial development. In this context, while many previous studies have relied on single indicators, typically focusing on either financial institutions, financial markets, or financial innovations such as mobile money, recent empirical studies have increasingly employed broad-based financial development indicators. These indicators aim to reflect the complex nature of financial systems and have adopted Svirydzenka's (2016) multi-dimensional financial index. This index encompasses both financial institutions and financial markets and captures key dimensions such as depth, efficiency, and access (Aluko & Ibrahim, 2020; Aluko et al., 2020; Haini, 2021). However, a limitation of this index is that it does not account for financial inclusion, specifically the role of mobile money, which has emerged as a key aspect of financial development in developing countries, especially in SSA, over the past two decades.

In addition to investigating the individual effect of mobile money, this study constructs a broad-based financial development index that captures the dimensions of access, depth, and efficiency for financial institutions, financial markets, and mobile money. The aim is to analyze the finance-growth nexus within the context of Sub-Saharan Africa (SSA) and case studies of Kenya and Uganda. Specifically, this study extends Svirydzenka's (2016) index by incorporating mobile money and indicators for non-bank financial institutions, including microfinance institutions and

insurance companies. The index was developed using Principal Component Analysis (PCA), a method commonly employed in other empirical studies examining the finance-growth nexus. As a robustness check for the SSA panel analysis, the study adopts the multiplicative interaction model approach to examine non-linearity in the finance-growth nexus, particularly in the context of financial inclusion (proxied by mobile money). This method involves multiplying financial development by the moderating variable (Ehigiamusoe & Samsurijan, 2021), enabling a more nuanced understanding of the potential non-linear effects of financial inclusion on economic growth.

Using the broader measure of financial development, the study utilized Granger causality tests to investigate the direction of causality within the finance-growth nexus. The endogenous growth model was adopted, as it allows finance to exert growth effects through its provision of resources for research and development, thereby enhancing technological effectiveness. This contrasts with the neo-classical growth model, where technology is considered exogenous. To analyze the finance-growth nexus in Sub-Saharan African (SSA) countries, the study employed the Generalized Method of Moments (GMM) dynamic panel estimation method, which has been used in previous studies to address issues of serial correlation and potential endogeneity in the finance-growth relationship. For the country case studies of Kenya and Uganda, the study employed Johansen and Juselius's (1990) cointegration approach and the Vector Error Correction Model (VECM). Additionally, to account for potential structural breaks that may weaken the finance-growth nexus, the study incorporated dummy variables.

Chapter 3

Financial Inclusion and the Finance-Growth Nexus in SSA: The role of mobile money

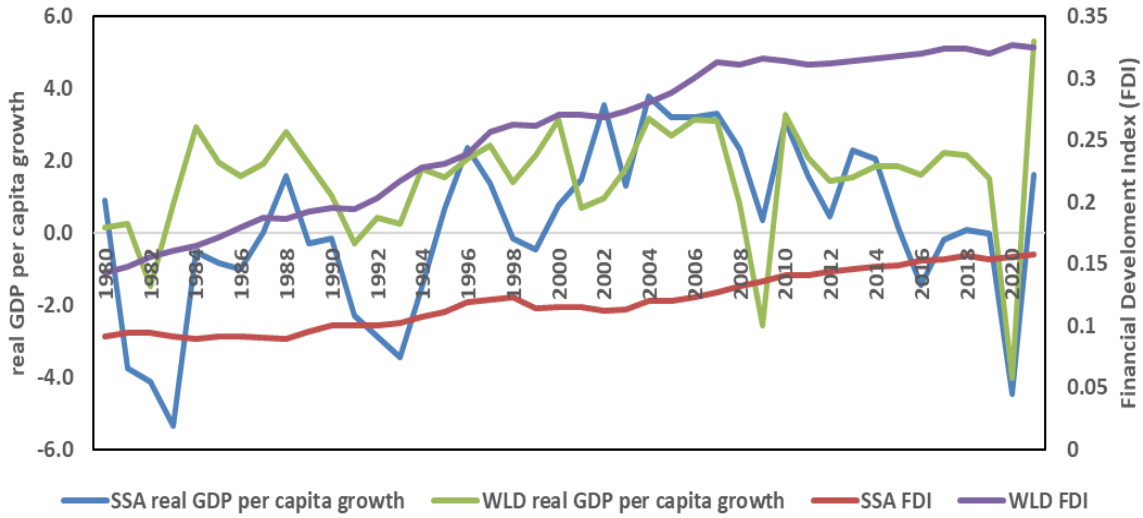
3.1 Economic growth and financial development in Sub-Saharan Africa

In the mid-1990s, following a series of economic and financial reforms, Sub-Saharan African (SSA) countries began to experience positive economic growth, marking a stark contrast to the prolonged period of negative growth observed during the 1980s and early 1990s (Basu et al., 2000). By the 2000s, the region's growth rate had reached approximately 6 percent, exceeding the global average growth rate of around 4 percent (Figures 3.1.1 and 3.1.2). These high growth rates were partly attributed to the economic and financial reforms implemented in the 1990s, with significant support from the International Monetary Fund (IMF) and the World Bank. The objective of these reforms was to address the deteriorating economic and financial conditions of the region while promoting sustained economic growth (Reinhart & Tokatlidis, 2003). Key components of the financial reforms included granting greater autonomy to central banks in monetary policy formulation, liberalizing interest rates and eliminating the administrative allocation of credit, transitioning from direct to indirect monetary policy implementation, restructuring banks to restore solvency, developing financial markets, and enhancing infrastructure, particularly in the areas of bank supervision, accounting, and auditing practices (Hayward et al., 1998).

The Financial Development Index (FDI), as developed by Svirydzenka (2016), which incorporates the dimensions of depth, access, and efficiency of both financial institutions and financial markets, indicates that the level of financial development in Sub-Saharan Africa (SSA) remains substantially lower than the global average. Nevertheless, the region has experienced a sustained upward trajectory in financial development since the 1980s, contrasting with the global trend, which shows a deceleration in growth following the 2008/2009 global financial crisis. The adverse economic effects of the COVID-19 pandemic are clearly reflected in the sharp contraction in real GDP per capita observed in 2020. Moreover, a second commonly employed measure of financial

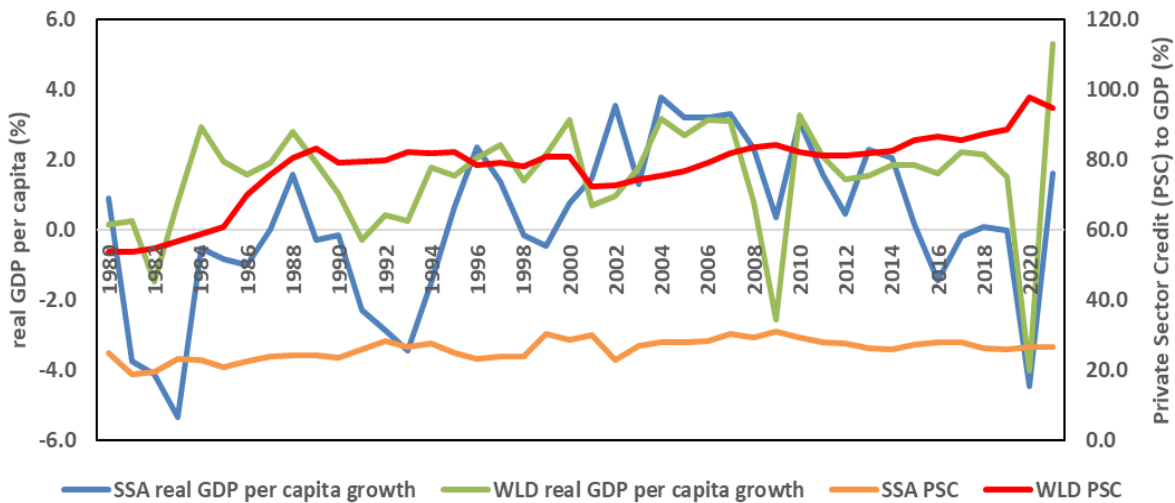
development, bank credit to the private sector as a ratio to GDP, further underscores the pronounced disparity between SSA and the global average (Figure 3.1.2).

Figure 3.1.1: Trend in Real GDP Growth and Financial Development Index (FD) (1980-2021)



Data source: IMF FDI database, 2023; World Bank WDI database, 2023

Figure 3.1.2: Trend in Real GDP Growth and Credit to the Private Sector (PSC) (1980-2021)

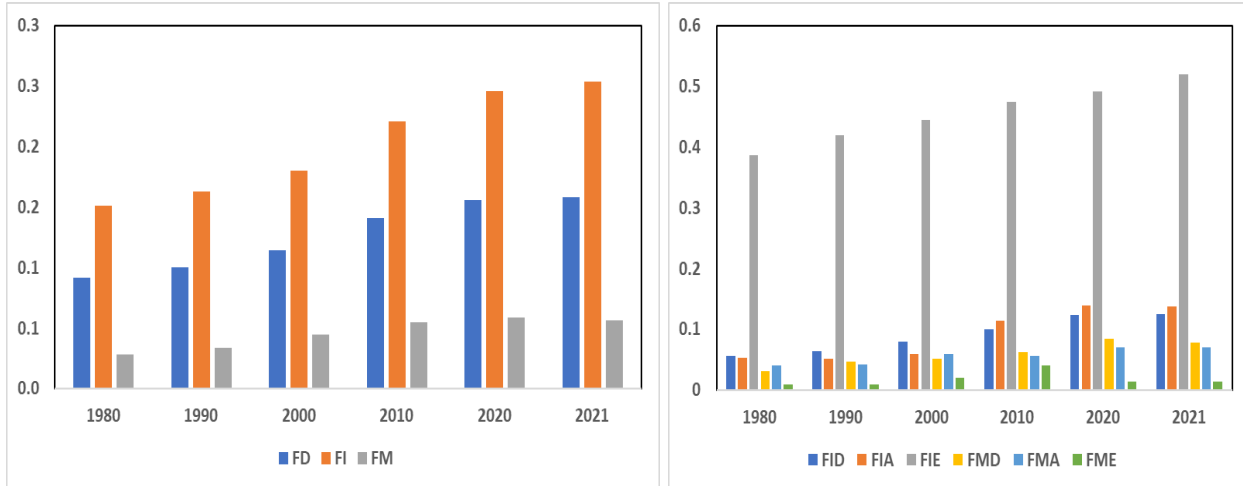


Data source: IMF FDI database, 2023; World Bank WDI database, 2023

The widening gap in the level of financial development between Sub-Saharan Africa (SSA) and the world average is also evident in the components of the financial development index, as shown in Figures 3.1.3 and 3.1.4. Overall, SSA's financial development (FD) lags behind the global average, both in terms of financial institutions and financial markets. Notably, the structure of financial development reveals that financial institutions (FI) are more developed than financial markets (FM) in both SSA and the world. This suggests that, despite significant growth in financial markets—particularly in advanced economies—financial institutions continue to play a dominant role in the global financial system. The Financial Institutions Efficiency (FIE) index is on an upward trajectory, likely reflecting the impact of financial innovations that have enabled financial institutions to reduce operational costs.

The financial access sub-index in Svirydzenka's (2016) financial development index, is based on three indicators: i) the number of ATMs per 1,000 adults; ii) the number of commercial bank branches per 1,000 adults and iii) the percentage of market capitalization outside of top 10 largest companies. On average, financial access in SSA is lower than the world, however, the growing contribution of financial inclusion to financial development in SSA overtime is evident from the Financial Access sub-indices in Figure 3.1.3. The significant growth in financial inclusion in SSA can be observed from the growth in the Financial Institutions Access index (FIA) between 1980 and 1990 and by 2020 it was higher than the Financial Institutions Depth (FID) index, as is the case for the world average.

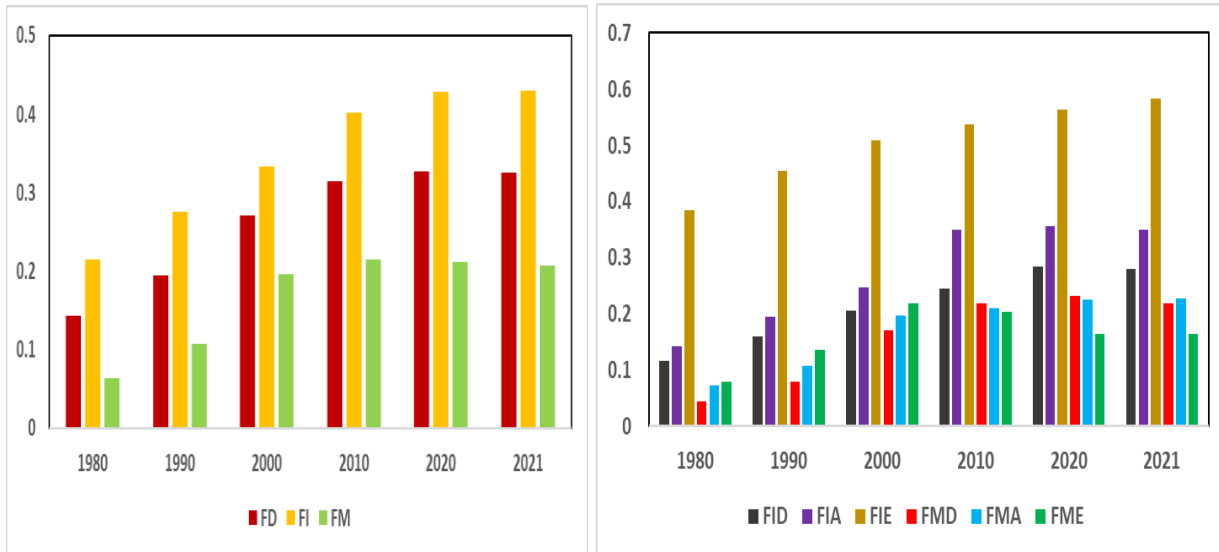
Figure 3.1.3: SSA Financial Development Index and its components



Source: IMF FDI database 2023

Notes: FD (Financial Development); FI (Financial Institutions); FM (Financial Markets); FID (Financial Institutions Depth); FIA (Financial Institutions Access); FIE (Financial Institutions Efficiency); FMD (Financial Markets Depth); FMA (Financial Markets Access); FME (Financial Markets Efficiency)

Figure 3.1.4: World Financial Development Index and its components

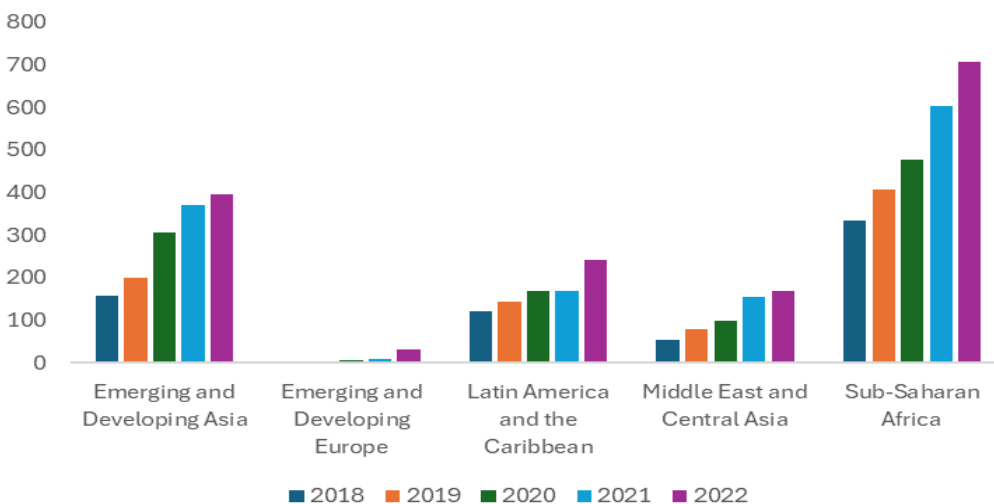


Source: IMF FDI database 2023

Notes: FD (Financial Development); FI (Financial Institutions); FM (Financial Markets); FID (Financial Institutions Depth); FIA (Financial Institutions Access); FIE (Financial Institutions Efficiency); FMD (Financial Markets Depth); FMA (Financial Markets Access); FME (Financial Markets Efficiency)

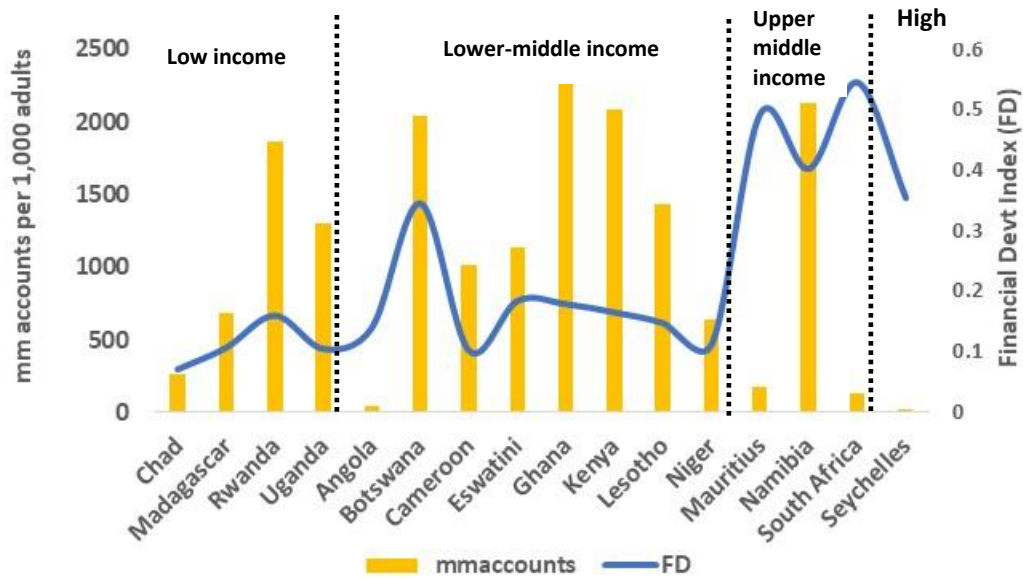
The improvement in financial inclusion across Sub-Saharan African (SSA) countries can be attributed to deliberate efforts aimed at expanding access to formal financial services, such as the proliferation of bank branches and Automated Teller Machines (ATMs), but more significantly, to the transformative impact of mobile money innovation (IMF, 2019). Since its successful launch in Kenya in 2007, mobile money has played a pivotal role in extending financial services to previously unbanked populations, particularly in developing and fragile economies such as Kenya, Uganda, Togo, and Mali (Jobarteh & Kaya, 2019; Idun, 2021; Haini, 2021; Misati et al., 2021). By broadening participation in the financial system, mobile money enhances financial inclusion, which in turn fosters financial development through increased resource mobilization, savings, and risk pooling (Ikhide, 2015; Sethi & Acharya, 2018; Jemiluyi & Jeke, 2023). As depicted in Figure 3.1.5, SSA is the global leader in mobile money usage. Furthermore, Figure 3.1.6 illustrates the resulting expansion in financial access, predominantly in low- and lower-middle-income countries, driven by the widespread adoption of mobile money services.

Figure 3.1.5: Registered MM accounts (Number per 1,000 adults) by region.



Source: IMF Mobile Financial Access Survey (FAS) 2023

Figure 3.1.6: Mobile money growth & financial access in SSA, 2021



Data source: World Bank WDI database and IMF Financial Access Survey, 2023

Notes: FD is the Financial Development Index; bank credit is bank credit to the private sector; mmaccounts denotes mobile money accounts per 1,000 adults; mmtrnsctns denotes mobile money transactions per 100,000 adults.

3.2. Methodology

3.2.1 Model specification

This study adopts a simple endogenous growth model, consistent with the empirical literature (Pagano, 1993; Levine, 2005; Wu, Hou, & Cheng, 2010; Carré & L'Oeillet, 2018), to examine the impact of financial development on economic growth. The model, presented in equation (1), provides a framework for analyzing how improvements in financial intermediation influence capital accumulation, productivity, and long-term growth by facilitating savings mobilization, resource allocation, and technological innovation.

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

In the endogenous growth framework, output (Y_t) is modeled as a linear function of the capital stock (K_t) and the marginal productivity of capital (A). When the model is augmented with financial development, both financial institutions and financial markets enhance economic output by increasing the efficiency of capital allocation. Financial development contributes to higher marginal productivity of capital (A) through mechanisms such as enhanced resource pooling, increased savings mobilization, better risk diversification, and improved allocation of capital toward productive investments, including human capital and research and development (Levine, 2005; Carré & L'Oeillet, 2018). Accordingly, the finance-growth relationship can be expressed as:

$$Y_t = f(K_t, FD_t, Z_t) \quad (2)$$

Where Y_t and K_t are indicators for output and capital stock at time t , respectively, FD_t denotes the level of financial development at time t , capturing the combined effects of financial institutions, financial markets, and financial inclusion, and Z_t denotes a set of control variables commonly considered in the economic growth literature. These controls include population growth, trade openness, and public debt (Aluko & Ibrahim, 2020; Abeka et al., 2021; Mohamed, 2021, inter alia). Gross fixed capital formation is expected to have a positive impact on economic growth, as it expands the productive capacity of the economy (De Long & Summers, 1991; Sala-i-Martin, 1997). Trade openness is generally associated with higher growth due to increased access to manufacturing inputs and enhanced production efficiency through the import of cheaper goods (Beck, 2002; Herwartz & Walle, 2014). Moreover, a well-developed financial system can facilitate the absorption and diffusion of technological innovations that accompany international trade (Mohamed, 2021). Nonetheless, in low- and lower-middle-income countries, a high degree of trade openness can have adverse effects due to increased exposure to macroeconomic volatility and external shocks (Herwartz & Walle, 2014). The impact of population growth on economic growth is theoretically ambiguous. While rapid population growth can exert pressure on available resources and thus constrain growth (Peterson, 2017), it may also contribute positively if it reflects a growing and productive labor force (Heady & Hodge, 2009).

For the empirical analysis, this study adopts a dynamic panel model widely used in the finance-growth literature (Law & Singh, 2014; Arcand et al., 2015; Demetriades & Rousseau, 2016; Demetriades & Rewilak, 2020). The model accounts for the potential endogeneity of financial development and other regressors, as well as unobserved heterogeneity and dynamic adjustment. Rewriting the function in Equation (2), the dynamic panel model to be estimated is specified as follows:

$$Y_{i,t} = \gamma + \sum_{k=1}^k \beta_k Y_{i,t-k} + \omega' Z_{i,t} + \lambda_i + \mu_{i,t} \quad (3)$$

Where Y_{it} is output as measured by real Gross Domestic Product (GDP) per capita for country i at time t ; γ is the intercept; k is the number of lags, β is the estimated coefficient of the lagged Y_{it} ; $Y_{i,t-k}$ is the lagged dependent variable capturing the dynamic nature of growth; Z_{it} is a vector of explanatory variables, including financial development, with ω' as the vector of estimated coefficients; λ_i denotes unobservable individual country effects variables; μ_{it} is the error term and $i=1, \dots, 17$ and $t=2015, \dots, 2022$ represent the country cross-sections and time dimensions of the data set, respectively. To address potential endogeneity and serial correlation, the Generalized Method of Moments (GMM) estimator, particularly the system GMM developed by Arellano and Bover (1995) and Blundell and Bond (1998), is employed. This method uses internal instruments and is particularly suited for datasets with a large number of cross-sectional units and relatively few time periods, as is the case in this study.

3.2.2 Estimation methods

As a first step in empirically investigating the theoretical proposition that financial development promotes economic growth, unit root tests are conducted to examine the time series properties of the variables and to determine the appropriate estimation technique. Given that panel data are often subject to cross-sectional dependence, arising from unobserved common factors or economic linkages among countries, failure to account for such dependence may result in biased and inconsistent estimators, leading to invalid inferences (Chudik & Pesaran, 2013). To address this

concern, this study employs second-generation panel unit root tests, specifically the Pesaran (2007) Cross-sectionally Augmented Im-Pesaran-Shin (CIPS) test and the Bai and Ng (2004) PANIC approach, both of which allow for cross-sectional dependence. The dynamic panel model specified in Equation (3) is estimated using the Generalized Method of Moments (GMM), which is well-suited for handling endogeneity, heterogeneity, and dynamic relationships in panel data. Furthermore, Granger causality tests are conducted to examine the direction of causality between financial development and economic growth.

3.2.2.1 Granger causality

Granger causality tests are conducted as a preliminary step to assess the direction of the relationship between financial development and economic growth. Specifically, these tests evaluate whether past values of financial development indicators improve the prediction of current real GDP, beyond what can be explained by past values of real GDP alone (Granger, 1969). The analysis is based on the empirical model previously outlined in Equation (3), with hypothesis tests specified in Equations (4) and (5). The null hypothesis in Equation (4) posits that financial development, as captured by the relevant indicators in this study, does not Granger-cause real GDP ($Y_{i,t}$), while the null in Equation (5) asserts that real GDP does not Granger-cause financial development. To address the heterogeneity of panel data and potential cross-sectional dependence among countries, the study employs the Granger non-causality test proposed by Juodis, Karavias, and Sarafidis (2021). This test offers robust small sample properties and is valid in the presence of cross-sectional dependence, making it particularly suitable for panel data involving Sub-Saharan African countries.

$$\text{Real GDP per capita}_{i,t} = \alpha_{0,i} + \sum_{k=1}^k \alpha_{k,i} Y_{t-k} + \sum_{k=1}^k \beta_{k,i} \text{FinDev}_{t-k} + u_{i,t} \quad (4)$$

$$\text{FinDev}_{i,t} = \alpha_{0,i} + \sum_{k=1}^k \alpha_{k,i} Z_{t-k} + \sum_{k=1}^k \beta_{k,i} \text{Real GDP per capita}_{t-k} + u_{i,t} \quad (5)$$

3.2.2.2 Empirical model estimation

The dynamic linear panel model specified in Equation (3) may be estimated using a pooled Ordinary Least Squares (OLS) estimator, which treats the dataset as a pure cross-section and

ignores the time dimension. However, this approach yields biased coefficient estimates, as it fails to account for the correlation between the regressors and the unobserved individual (country-specific) effects, denoted by λ_i (Wooldridge, 2010), which become part of the error term (Wooldridge, 2010). Furthermore, the error term in dynamic panels is likely to exhibit serial correlation. Compared to pure time series or cross-sectional data, panel data offers more efficient econometric estimates by increasing degrees of freedom and mitigating problems of omitted variable bias and multicollinearity among explanatory variables (Hsiao, 2003). To address the biases resulting from unobserved heterogeneity, panel data models commonly employ fixed effects or random effects estimators. The fixed effects estimator controls for λ_i by demeaning the variables, effectively removing time-invariant unobserved heterogeneity. In contrast, the random effects estimator treats λ_i as a random variable that is uncorrelated with the regressors, thereby assuming that the composite error term is not serially correlated (Wooldridge, 2010). The Hausman specification test can be used to determine the appropriate model by testing whether λ_i is correlated with the regressors, thereby guiding the choice between fixed and random effects estimators.

However, in dynamic panel models, estimates obtained using the fixed effects estimator are inconsistent when the time dimension remains fixed while the cross-sectional dimension grows, a phenomenon known as the “Nickell bias” (Nickell, 1981). This issue is particularly relevant in this study, which considers a relatively short period (post-mobile money adoption) while maintaining a large cross-sectional sample. Moreover, both fixed and random effects estimators fail to adequately address the potential endogeneity inherent in the finance-growth relationship. To overcome these limitations, the study adopts the System Generalized Method of Moments (S-GMM) estimator proposed by Arellano and Bover (1995) and Blundell and Bond (1998), in line with recent empirical finance-growth literature (Ibrahim & Alagidede, 2018; Demetriades & Rewilak, 2020; Mohamed, 2021; Olaniyi & Oladeji, 2021, *inter alia*). The GMM estimator addresses endogeneity by transforming the model through first-differencing and employing lagged levels of the endogenous regressors as instruments. This method also controls for unobserved country-specific effects and mitigates potential issues of autocorrelation and heteroscedasticity in the panel data (Roodman, 2009). The two-step GMM estimator is preferred over the one-step

version due to its greater efficiency, as it yields estimates with lower asymptotic variance (Hall, 2004; Nielsen, 2005).

To account for the potential macroeconomic disruption caused by the COVID-19 global pandemic, a time dummy variable is included in the analysis. This variable captures the structural break associated with the pandemic during the period under study. In the System Generalized Method of Moments (System GMM) estimation, the key regressors, namely, the financial development indicator, gross fixed capital formation, population growth, and trade openness, are treated as endogenous. This treatment assumes that these variables may be correlated with both past and contemporaneous error terms. Conversely, the time dummy variable is treated as exogenous, reflecting the assumption that it is not influenced by prior economic conditions or shocks captured in the model. The System GMM estimator relies on a system of two simultaneous equations: the original level equation (equation 3) and its corresponding first-differenced form (equation 6). The first-differenced equation removes unobserved individual effects, while lagged levels of the endogenous variables serve as instruments to address potential endogeneity. The level equation, in turn, is instrumented using lagged first differences of the variables. This approach enhances efficiency and robustness, particularly in short panels with large cross-sectional dimensions (Arellano & Bover, 1995; Blundell & Bond, 1998).

$$Y_{i,t} = \gamma + \sum_{k=1}^k \beta_K Y_{i,t-k} + \omega' Z_{i,t} + \lambda_i + \mu_{i,t} \quad (3)$$

$$\Delta Y_{i,t} = \gamma + \sum_{k=1}^k \beta_K \Delta Y_{i,t-k} + \omega' \Delta Z_{i,t} + \mu_{i,t} \quad (6)$$

Where Y_{it} is output as measured by real Gross Domestic Product (GDP) per capita for country i at time t ; γ is the intercept; k is the number of lags, β is the estimated coefficient of the lagged Y_{it} ; $Y_{i,t-k}$ is the lagged dependent variable capturing the dynamic nature of growth; Z_{it} is a vector of explanatory variables, including financial development, with ω' as the vector of estimated coefficients; λ_i denotes unobservable individual country effects variables; μ_{it} is the error term and

$i=1, \dots, 17$ and $t=2015, \dots, 2022$ represent the country cross-sections and time dimensions of the data set, respectively.

Recent empirical studies underscore financial inclusion as a key factor contributing to the observed non-linear relationship between financial development and economic growth (Chami & Yousefi, 2013; Haini, 2021). In line with the empirical literature (Demetriades & Law, 2006; Haini, 2021), this study examines the non-linear relationship between financial development and economic growth by incorporating the interaction between financial development indicators and financial inclusion, proxied by mobile money. Specifically, a positive coefficient of the interaction term would suggest that financial inclusion (as proxied by mobile money) enhances the impact of financial development on economic growth, as predicted by the finance-growth theory. Conversely, a negative coefficient would imply that financial inclusion (proxied by mobile money) weakens the positive relationship between financial development and economic growth, indicating diminishing returns to financial inclusion in the finance-growth nexus.

3.2.2.3 Data

The study utilized a balanced panel dataset comprising 17 Sub-Saharan African countries, selected based on the availability of data (the list of countries is provided in Appendix Table A1). The analysis covers the period from 2015 to 2022, which encompasses the era when most of these countries adopted mobile money as a financial innovation, following the notable success of M-PESA, which was first introduced in Kenya in 2007.

Table A2 in the appendix provides a summary of the variables used in the analysis along with their data sources. Seven distinct measures of financial development are employed: (i) mobile money financial inclusion indicators and an index comprising these indicators; (ii) bank credit to the private sector; (iii) an overall index representing financial institutions indicators; (iv) an overall index representing stock market indicators (excluding mobile money); (v) an overall index representing both financial institutions and stock market indicators; (vi) an overall index that integrates bank, market, and mobile money indicators; and (vii) Svirydzenka's (2016) financial

development index. To investigate the role of mobile money as a key driver of enhanced financial access in Sub-Saharan African (SSA) countries, the study adopts the multiplicative interaction models approach, as outlined in the empirical literature (Ehigiamusoe & Samsurijan, 2021; Haini, 2021). Specifically, the two financial development measures, FD index (excluding mobile money) and private sector credit (PSC), are adjusted by multiplying them with six mobile money indicators: the value of mobile money transactions as a percentage of GDP; the number of mobile money transactions per 1,000 adults; the number of registered mobile money agent outlets per 1,000 km²; the number of registered mobile money agent outlets per 100,000 adults; the number of registered mobile money accounts per 1,000 adults; and mobile cellular subscriptions per 100 people.

The overall financial development indices employed in this study capture the dimensions of access, depth, and efficiency across financial institutions, financial markets, and mobile money, following the methodology of Svirydzenka (2016). However, this study extends Svirydzenka's framework by incorporating six mobile money indicators as well as indicators for non-bank financial institutions, including microfinance institutions, credit unions, and credit cooperatives. The constructed financial development index is normalized on a scale from 0 to 1 and comprises eight sub-indices: (i) Financial Institutions Depth (FID); (ii) Financial Institutions Access (FIA); (iii) Financial Institutions Efficiency (FIE); (iv) Financial Markets Depth (FMD); (v) Financial Markets Access (FMA); (vi) Financial Markets Efficiency (FME); (vii) Mobile Money Depth (MMD); and (viii) Mobile Money Access (MMA). These sub-indices offer a more comprehensive measure of financial development by capturing both traditional and innovative financial services in the Sub-Saharan African context.

The summary statistics are presented in Table 3.2.1. Population growth is expressed as a percentage, while bank credit to the private sector (PSC) and trade openness (Open) are measured as ratios of GDP. Real GDP per capita (RGDPpc) is transformed into logarithmic form to normalize the distribution and reduce heteroskedasticity. In contrast, the Financial Development Index (FD) and the Mobile Money Financial Inclusion Index (MM) are used in their original, untransformed forms due to their already standardized scales. As noted in Appendix Table A2,

most countries in the sample are classified as low- and lower-middle-income economies. Despite this, the summary statistics reveal considerable heterogeneity across the 17 Sub-Saharan African (SSA) countries, particularly in terms of real GDP per capita. For instance, the minimum real GDP per capita of USD 433.8 was recorded by Madagascar in 2020, whereas Seychelles registered the highest real GDP per capita of USD 16,747.4 in 2019. By contrast, the values for the mobile money and financial development indices (MM index, FD, and Svirydzenka's Financial Development Index) display less variability across the sample, reflecting a more uniform trend in these dimensions of financial development.

The mean values of both the constructed Financial Development Index (FD) and Svirydzenka's (2016) Financial Development Index indicate that the countries in the sample exhibit relatively low levels of financial development, which is characteristic of developing economies. Among the countries analyzed, Chad recorded the lowest FD in 2015, whereas South Africa registered the highest FD in 2019. Similarly, the Mobile Money Financial Inclusion Index (MM) reveals generally low levels of financial inclusion across the sample, with most countries exhibiting index values below 0.3, consistent with Sarma's (2008) classification of low financial inclusion. Angola recorded the lowest MM index in 2016, while Uganda achieved the highest MM index in 2022. A comparison of country-specific averages highlights a notable pattern: higher-income countries in the sample, namely Seychelles, South Africa, and Mauritius, exhibit relatively lower mobile money inclusion but higher levels of overall financial development. This finding aligns with the global trend depicted in Figure 3.1.6, suggesting that in higher-income contexts, traditional financial institutions remain the dominant mode of financial intermediation, whereas mobile money plays a more substantial role in financial inclusion among lower-income economies.

Table 3.2.1: Summary Statistics (2015 to 2022)

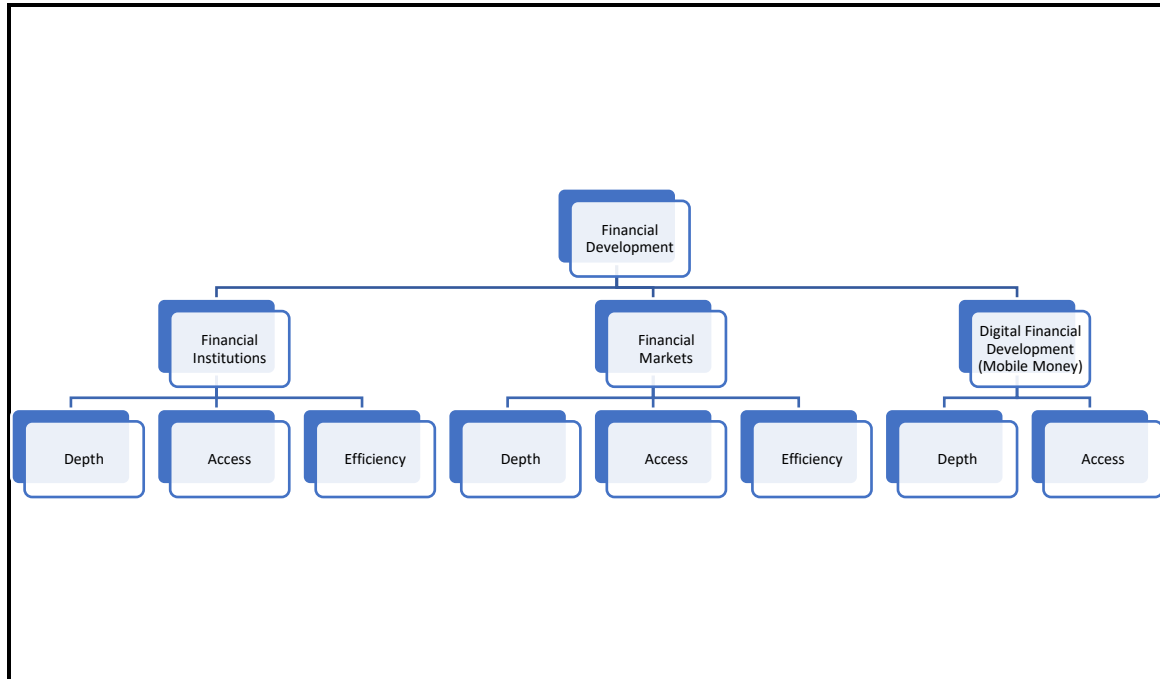
Variables	Mean	Sd	Min	Max
Real GDP per capita (in constant 2015 U.S. dollars)	3,517.9	3,987.6	433.8	16,747.4
Trade openness (exports+imports/GDP) (%)	76.1	43.1	27.2	235.8
Population growth (%)	2.1	1.0	-0.3	3.9
Gross Fixed Capital Formation (% of GDP)	22.5	9.2	9.7	56.5
<i>Financial Development Indicators</i>				
Number of mobile money transactions per 1,000 adults	35,988.2	52,374.7	0.0	23,9972.5
Value of mobile money transactions (% of GDP)	23.0	31.5	0.0	180.6
Registered mobile money agent outlets per 1,000 km ²	559.7	1,088.8	0.1	6,111.4
Registered mobile money agent outlets per 100,000 adults	548.3	615.7	0.9	3,315.8
Registered mobile money accounts per 1,000 adults	853.5	711.2	0.1	2,973.4
Mobile cellular subscriptions (per 100 people).	97.9	41.4	31.4	191.5
Mobile money index	0.3	0.2	0.0	1.0
Financial Development Index (FD)	0.3	0.01	0.27	0.29
Private Sector Credit (PSC)/GDP (%)	22.3	21.6	0.0	100.0
Svirydzienka's (2016) FD index	0.2	0.2	0.0	0.6
No. of Countries	17			
No. of Obs	136			

Data Source: IMF database (2022) and World Bank Databank (2022).

Principal Component Analysis

To address the limitations inherent in using single indicators, a broad-based Financial Development Index (FD) was constructed. Unlike Svirydzienka's (2016) index, which focuses solely on financial institutions and financial markets, this study extends the scope of financial development by incorporating indicators of financial inclusion, proxied by mobile money, as well as other non-bank financial institutions, including microfinance institutions, credit unions, and credit cooperatives. In line with the frameworks proposed by Sarma (2008) and Svirydzienka (2016), the financial indicators were aggregated into three key sub-dimensions: efficiency, access, and depth. These dimensions were subsequently used to compile composite indices that provide a more comprehensive view of financial development across the sample countries, as illustrated in Figure 3.2.1.

Figure 3.2.1: Financial Development Index



Adapted from Svirydenka (2016)

The aggregation of the financial development indices was conducted using Principal Component Analysis (PCA), a widely adopted method in the finance-growth empirical literature for synthesizing correlated financial indicators into a composite index (Jalil et al., 2010; Svirydenka, 2016). PCA is particularly well-suited for cross-country analysis, as it extracts the components that account for the greatest variation across countries, thereby enhancing the comparability of financial development levels (European Commission & Joint Research Centre [EU & JRC], 2008). The constructed Financial Development Index (FD) comprises an aggregation of sub-indices reflecting the three core dimensions of financial systems; access, efficiency, and depth, across financial institutions, financial markets, and mobile money platforms.

Principal Component Analysis (PCA) is a multivariate statistical technique used to examine observations of correlated variables, with the objective of reducing dimensionality while preserving as much variability as possible in the dataset. It does so by transforming the original variables into a new set of uncorrelated variables, principal components, which are linear

combinations of the original variables (Abdi & Williams, 2010). The first principal component captures the greatest possible variance, thereby explaining much of the variation in the data. Table 3.2.2 presents the results of the PCA based on the first principal component. The weights or contributions of the indicators to this component serve to correct for multicollinearity or overlapping information among the variables, rather than reflecting the theoretical relevance of each indicator (European Commission & Joint Research Centre [EU & JRC], 2008). The results indicate that indicators related to depth, access, and efficiency contribute positively to the common variation in the data. At the sub-sectoral level, financial institutions and mobile money exhibit positive contributions, while the financial market dimension contributes negatively. This negative contribution suggests that most countries in the sample fall below the average level of financial market development. The divergence from Svirydzenka's (2016) global Financial Development Index, which reports stronger contributions from financial markets, is likely attributable to differences in sample composition; while Svirydzenka's index is constructed using a global sample that includes both advanced and developing economies, this study focuses exclusively on developing countries in Sub-Saharan Africa.

Table 3.2.2: Principal Component Analysis: Variance Explained by PCA

<u>Principal component</u>	<u>Eigen values</u>	<u>Proportion</u>	<u>Cumulative</u>			
	<u>Depth</u>	<u>Access</u>	<u>Efficiency</u>			
Component 1	1.461	1.338	1.887			
Component 2	0.866	0.989	1.211			
Component 3	0.673	0.674	0.818			
Component 1	<u>Computed indices</u>			<u>Svirydzenka (2016)</u>		
	<u>Depth</u>	<u>Access</u>	<u>Efficiency</u>	<u>Depth</u>	<u>Access</u>	<u>Efficiency</u>
Financial Institutions	0.625	0.596	0.422	0.700	0.882	0.536
Financial Markets	-0.475	-0.701	----	0.590	0.670	----
Mobile Money	0.619	0.391				
	<u>Financial Institutions</u>	<u>Financial Markets</u>	<u>Mobile Money</u>	<u>Financial Institutions</u>	<u>Financial Markets</u>	
Component 1	0.632	-0.562	0.533	0.675	0.769	

Source: Author's computation and Svirydzenka (2016)

Note: A single indicator is used for financial market efficiency thus --- denotes no value computed for the efficiency sub-index.

3.3. Results and Discussion

This study investigates whether financial inclusion, proxied by a composite mobile money index (MM), enhances the relationship between financial development and economic growth. Financial development is measured using both sub-indices and a comprehensive index (FD_MM) that integrates indicators from mobile money, financial markets, and financial institutions. These indices are constructed through Principal Component Analysis (PCA), as elaborated in the data section, to capture the multidimensional nature of financial development. To establish the direction of causality, Granger causality tests are employed, providing preliminary insights into whether lagged values of financial development can predict growth in real GDP per capita. Beyond this, the study utilizes a formal endogenous growth model to explore the finance-growth nexus more rigorously. The model is estimated using the Generalized Method of Moments (GMM), which addresses potential endogeneity and accounts for unobserved heterogeneity, serial correlation, and heteroskedasticity, challenges often present in panel data analysis of this kind.

3.3.1 Unit root tests and cross-sectional dependence

For the Generalized Method of Moments (GMM) estimator to yield valid results, the variables included in the model must be stationary. To determine the stationarity properties of the variables, panel unit root tests that account for cross-sectional dependence, an inherent feature of panel data, were employed. The results, summarized in Table 3.2.3, indicate the presence of cross-sectional dependence in all variables except the Financial Development Index (FD) and population growth. For variables exhibiting cross-sectional dependence, both the Pesaran (2007) Cross-Sectionally Augmented Dickey-Fuller (CADF) test and the Bai and Ng (2004) PANIC test confirm that the variables are stationary in levels, and thus integrated of order zero, $I(0)$. For the two variables without cross-sectional dependence, standard first-generation panel unit root tests were applied. Specifically, the Levin, Lin, and Chu (LLC) test, assuming a common unit root, and the Im, Pesaran, and Shin (IPS) test, assuming individual unit roots, were utilized. The FD variable was found to be stationary across both tests, while the population growth variable exhibited mixed results. However, given the absence of cross-sectional dependence and the theoretical plausibility

of stationarity over the sample period, the conclusion was based on the LLC test, suggesting that population growth is also stationary and integrated of order I(0).

Table 3.2.3: Cross sectional dependence and unit root tests

Variables	Cross Dependence test	CIPS level Null hypothesis: Unit root	Bai and Ng (p-value) Null hypothesis: no cointegration	Integration order
FD_MM	1.969**	-2381***	0.000***	I(0)
FD ^a	4.603	-1.650*	-7.938***	I(0)
Svirydzenka's (2016)	-	-1.685***	0.000***	I(0)
Financial devt index (SV_FD)				
Growth Fixed Capital Formation (GFC)	2.397**	0.000***	0.008***	I(0)
Population growth (POP) ^a	14.343	1.654	-2.167*	I(1) or I(0)
PSC	1.169***	0.000***	0.080*	I(0)
RGDP per capita	4.009***	0.000*	0.000***	I(0)
Openness	6.733***	0.000***	0.001***	I(0)
Mobile money Index (MM)	22.247***	-10.782*	0.016***	I(0)
Financial Institutions Index (FI)	5.779***	-9.732*	0.000***	I(0)
Financial Market Index (FM)	-	-	0.000***	I(0)

Notes: FD is the Financial Development Index. PSC is the ratio of deposit money banks' credit to the private sector to GDP. LR GDP per capita is the logarithm of the real GDP per capita. Openness is the ratio of trade to GDP. GFC is the value of the Gross Fixed Capital formation as ratio of GDP. The unit root tests are based on the model with no intercept or trend. CIPS is a Cross-sectionally augmented Im-Pesaran-Shin (CIPS) Panel Unit Root Test statistics. *** and ** indicate significance at the 1% and 5% levels, respectively. '-' indicates that a statistic was not computed based on the data. ^aFor cross-sectionally independent variables, FD and POP, the Lm Pesaran and Shin (assumes individual unit root) test and Levin, Lin and Chu (assumes common unit root) unit root tests are employed.

3.3.2 Panel Granger causality Results

The results of the Granger non-causality tests, based on the panel Vector Autoregressive (PVAR) model proposed by Juodis et al. (2021), are presented in Table 3.2.4. The null hypothesis of the test posits that financial development indicators do not Granger-cause real GDP per capita, while the alternative suggests that these indicators Granger-cause real GDP per capita in at least one cross-sectional unit within the panel. The findings reveal that real GDP per capita Granger-caused mobile money (MM) in at least one country in the sample, with a test statistic of 9.476 and a p-value of 0.050. Conversely, uni-directional causality was observed from the financial institutions index (FI) and bank credit to the private sector (PSC) to real GDP per capita, with test statistics of

11.944 ($p = 0.018$) and 12.451 ($p = 0.006$), respectively. In the case of financial market development (FM), the results indicate bi-directional causality with real GDP per capita. Furthermore, for the composite financial development index (FD_MM), which integrates financial institutions, financial markets, and mobile money indicators, uni-directional causality was found running from financial development to real GDP per capita in at least one country, with a test statistic of 9.526 and a p-value of 0.049.

Table 3.2.4. Granger causality Test

Null hypothesis	Wald-test statistic (p-value)	Conclusion
FD_MM does not Granger cause LRGDPpc	9.526** (0.049)	FD_MM→LRGDPpc
LRGDPpc does not Granger cause FD_MM	6.552 (0.162)	LRGDPpc ↛FD_MM
FD granger does not Granger cause LRGDPpc	12.540** (0.014)	FD→LRGDPpc
LRGDPpc does not Granger cause FD	10.558** (0.032)	LRGDPpc →FD
MM does not Granger cause LRGDPpc	5.167 (0.251)	MM↛LRGDPpc
LRGDPpc does not Granger cause MM	9.476** (0.050)	LRGDPpc →MM
PSC does not Granger cause LRGDPpc	12.451*** (0.006)	PSC→LRGDPpc
LRGDPpc does not Granger cause PSC	3.024 (0.388)	LRGDPpc ↛PSC
FI does not Granger cause LRGDPpc	11.944** (0.018)	FI→LRGDPpc
LRGDPpc does not Granger cause FI	7.443 (0.114)	LRGDPpc ↛FI
FM does not Granger cause LRGDPpc	12.872** (0.012)	FM→LRGDPpc
FM does not granger cause LRGDPpc	12.153** (0.016)	LRGDPpc →FM

(.) represents the p-values; *p-value<0.10, **p-value<0.05, ***p-value<0.01.

Consistent with prior studies (Agbetsiafa, 2004; Walle, 2014; Acaravci et al., 2009, inter alia), the Granger causality test results varied depending on the specific measure of financial development employed. Notably, the findings based on the overall financial development index (FD_MM),

which integrates indicators from financial institutions, financial markets, and mobile money, align with those of Aluko et al. (2020), who found that financial development, measured using Svirydzenka's (2016) comprehensive index, Granger-caused economic growth in a panel of 33 Sub-Saharan African countries over the period 1990 to 2015. These results lend empirical support to Patrick's (1966) supply-leading hypothesis, suggesting that the deliberate expansion and strengthening of financial services can stimulate real GDP per capita growth.

3.3.3 Generalized Method of Moments (GMM) Results

The growth model was estimated using the system Generalized Method of Moments (GMM) estimator, with data spanning the period from 2015 to 2022 for 17 countries in the sample. This time frame is appropriate as it captures the period during which most Sub-Saharan African countries in the sample adopted mobile money, providing a sufficient number of observations for analysis. The system GMM estimator was preferred over the difference GMM estimator due to its superior efficiency in addressing endogeneity issues, particularly in finite samples. The difference GMM estimator tends to produce weaker instruments in the presence of highly autoregressive variables and moderately small time series data (Blundell et al., 2001; Bond et al., 2001). The p-values for both the Sargan and Hansen tests for instrument validity were not significant at the 1%, 5%, and 10% significance levels, indicating that the null hypothesis of instrument validity could not be rejected. Additionally, the p-values for the AR(2) test suggested that the models were not subject to second-order autocorrelation, further supporting the robustness of the results.

3.3.3.1 Mobile Money and Economic Growth

The results for the mobile money financial inclusion indicators are presented in Table 3.2.5. Among the various indicators, only the number of registered mobile money agent outlets per 1,000 km² and the number of mobile money transactions per 1,000 adults were statistically significant. The estimated coefficient for the number of registered mobile money agent outlets per 1,000 km² was positive, indicating a positive relationship with the dependent variable. In contrast, the coefficient for the number of mobile money transactions per 1,000 adults was negative. However,

both coefficients were found to be of negligible magnitude, suggesting that the impact of these mobile money indicators on the dependent variable is minimal.

Table 3.2.5: SSA Financial Inclusion (Mobile Money) and Economic Growth (2015 – 2022)

Variable	Dependent variable: Real GDP per capita (RGDPpc)					
	MM1	MM2	MM3	MM4	MM5	MM6
RGDPpc ₋₁	0.972*** (0.000)	0.986*** (0.000)	0.966*** (0.000)	0.960*** (0.000)	0.966*** (0.000)	0.958*** (0.000)
FD	-0.000* (0.080)	0.001 (0.118)	-0.000* (0.070)	-0.000 (0.321)	0.000 (0.354)	0.003 (0.207)
FD ₋₁	0.000 (0.119)	-0.000 (0.904)	0.000** (0.042)	0.000 (0.330)	-0.000 (0.268)	-0.002 (0.224)
POP	-0.010 (0.885)	0.014 (0.807)	-0.007 (0.956)	-0.067 (0.489)	-0.025 (0.724)	0.044 (0.612)
POP ₋₁	-0.019 (0.741)	0.040 (0.732)	-0.070 (0.313)	0.034 (0.568)	-0.001 (0.991)	0.017 (0.847)
Open	0.000 (0.820)	0.002 (0.402)	-0.001 (0.581)	0.001 (0.811)	0.001 (0.454)	0.002 (0.117)
Open ₋₁	-0.002 (0.157)	-0.003 (0.133)	-0.001 (0.596)	-0.002 (0.475)	-0.002 (0.356)	-0.004*** (0.004)
GFC	0.003 (0.510)	0.006 (0.260)	0.003 (0.645)	0.002 (0.789)	0.008* (0.088)	0.012*** (0.004)
GFC ₋₁	0.004 (0.347)	0.006 (0.332)	-0.003 (0.506)	0.007 (0.420)	-0.003 (0.231)	-0.006 (0.187)
C	0.249 (0.589)	-0.178 (0.800)	0.537 (0.444)	0.334 (0.473)	0.282 (0.685)	0.348 (0.341)
Covid-19	-0.063*** (0.000)	-0.058*** (0.001)	-0.075*** (0.000)	-0.076** (0.001)	-0.061*** (0.005)	-0.061*** (0.001)
No of obs	119	119	119	119	119	119
Countries	17	17	17	17	17	17
Instruments	17	17	17	17	17	173
AR (2)	0.354	0.390	0.630	0.850	0.832	0.404
Sargan stat	0.598	0.524	0.378	0.110	0.352	0.576
Hansen stat	0.562	0.530	0.546	0.343	0.297	0.478

Notes: In parentheses are p-values which reflect the significance of each correlation value. ***p<0.01, ** p<0.05 and *P<0.10. MM1 denotes Value of mobile money transactions (% of GDP); MM2 denotes Number of mobile money transactions per 1,000 adults; MM3 denotes Number of registered mobile money agent outlets per 1,000 km²; MM4 denotes Number of registered mobile money agent outlets per 100,000 adults; MM5 denotes Number of registered mobile money accounts per 1,000 adults; MM6 denotes Mobile cellular subscriptions (per 100 people).

The positive effect observed for the mobile money financial inclusion indicators is lagged, suggesting that the impact of mobile money on real GDP per capita occurs gradually over time. However, the estimated coefficients for indices that combine the mobile money financial inclusion indicators (MM), including the mobile money access (MMA) and mobile money depth (MMD) dimensions, were not statistically significant (see Table 3.2.6). This finding contrasts with the

results of Ugwuanyi et al. (2022), who identified a positive and significant effect of a digital financial inclusion index (comprising mobile money indicators) for a sample of 29 low- and middle-income Sub-Saharan African countries from 2012 to 2020. The divergence in findings may be attributed to differences in the countries included in the samples and the respective time periods analyzed. In this study, the majority of the 17 countries in the sample are low-income nations, according to the World Bank's country classification by Gross National Income per capita in 2022. Thus, the insignificant coefficient for the mobile money index suggests that, despite notable improvements in financial inclusion facilitated by mobile money innovation, the level of financial inclusion has yet to reach a threshold that significantly drives economic growth. This result aligns with the findings of Asongu and Le Roux (2024), who observed that mobile money services (such as money transfers and bill payments) mitigated the positive impact of income inequality on poverty only at higher levels of mobile money usage. Additionally, it is consistent with Chami and Yousefi (2013), Barajas et al. (2013), and Haini (2021), who found a negative relationship between financial development and economic growth at lower levels of financial access in low-income countries, while the relationship turned positive for higher-income countries at higher levels of financial access.

3.3.3.2 Financial Inclusion and Economic Growth

The estimated coefficients for the overall mobile money index (MM) as well as the mobile money access (MMA) and mobile money depth (MMD) sub-indices were not statistically significant (see Table 3.2.6). Similarly, the coefficients for the financial institutions indices—specifically, the overall financial institutions financial inclusion index (FII), the financial institutions access index (FIA), and the financial institutions depth index (FID) were also found to be insignificant. However, the estimated coefficients for certain indicators, such as the number of ATMs per 1,000 km², the number of credit union and credit cooperative branches per 1,000 km², and the number of credit union and credit cooperative branches per 100,000 adults, were found to be positive, significant, and larger in magnitude than those for the mobile money indicators (refer to Appendix Table A3a). In contrast, the estimated coefficients for the number of loan accounts with all microfinance institutions per 1,000 adults, as well as the number of loan accounts with credit

unions and credit cooperatives per 1,000 adults, were negative and statistically significant (see Appendix Table A3b).

Table 3.2.6: System-GMM – SSA Financial Inclusion and Economic Growth (2015 – 2022)

Variable	Dependent variable: Real GDP per capita (RGDPpc)					
	MM	MMA	MMD	FII	FIA	FID
RGDPpc ₋₁	0.948*** (0.000)	0.934*** (0.000)	0.975*** (0.000)	0.921*** (0.000)	0.942*** (0.000)	0.943*** (0.000)
FD	0.119 (0.538)	-0.046 (0.876)	0.142 (0.751)	0.701 (0.422)	0.026 (0.950)	-0.091 (0.572)
FD ₋₁	-0.156 (0.269)	-0.037 (0.902)	-0.103 (0.462)	-1.100 (0.488)	-0.318 (0.564)	-0.063 (0.715)
POP	-0.023 (0.825)	-0.037 (0.973)	0.016 (0.814)	-0.146 (0.436)	-0.001 (0.981)	-0.037 (0.563)
POP ₋₁	-0.099 (0.519)	-0.097 (0.398)	0.011 (0.917)	0.046 (0.181)	-0.026 (0.786)	0.028 (0.682)
Open	0.001 (0.416)	0.002 (0.485)	0.001 (0.534)	-0.001 (0.839)	0.001 (0.652)	0.001 (0.669)
Open ₋₁	-0.003 (0.109)	-0.004* (0.052)	-0.003 (0.157)	-0.003 (0.249)	-0.003 (0.442)	-0.004 (0.147)
GFC	0.008** (0.015)	0.007 (0.421)	0.006 (0.305)	0.011 (0.215)	0.001 (0.891)	0.006 (0.398)
GFC ₋₁	-0.005 (0.301)	-0.005 (0.337)	0.005 (0.415)	-0.005 (0.527)	0.004 (0.676)	0.008 (0.332)
C	0.714 (0.492)	0.867* (0.088)	0.007 (0.992)	0.965 (0.574)	0.598* (0.079)	0.346 (0.284)
Covid-19	-0.055* (0.010)	-0.052** (0.009)	-0.060*** (0.002)	-0.072*** (0.000)	-0.067*** (0.000)	-0.055*** (0.001)
No of obs	119	119	119	119	119	119
Countries	17	17	17	17	17	17
Instruments	17	17	17	17	17	17
AR (2)	0.529	0.681	0.515	0.421	0.775	0.205
Sargan statistic	0.160	0.470	0.322	0.346	0.252	0.814
Hansen statistic	0.572	0.550	0.387	0.684	0.500	0.648

Notes: In parentheses are p-values which reflect the significance of each correlation value. ***p<0.01, ** p<0.05 and *P<0.10. MM denotes the overall mobile money financial inclusion index; MMA denotes the mobile money access index; MMD denotes the mobile money depth index; FII denotes the financial institutions financial inclusion index; FIA denotes the financial institutions access index; FID denotes the financial institutions depth index.

The finding of positive and statistically significant coefficients for the number of ATMs per 1,000 km², the number of credit union and credit cooperative branches per 1,000 km², and the number of credit union and credit cooperative branches per 100,000 adults aligns with the results of previous studies by Ikhide (2015), Sarpong & Nketiah-Amponsah (2022), and Ugwuanyi et al. (2022).

These studies similarly found that traditional financial inclusion, such as the presence of commercial banks and other financial institutions, has a positive and significant effect on economic growth. Furthermore, Ugwuanyi et al. (2022) highlighted that traditional financial inclusion had a greater impact on economic growth than digital financial inclusion, as proxied by mobile money. In contrast, the negative and statistically insignificant coefficients for the number of loan accounts with all microfinance institutions per 1,000 adults, as well as the number of loan accounts with credit unions and credit cooperatives per 1,000 adults, suggest that financial inclusion, whether measured by mobile money or traditional financial indicators, remains at a relatively low level. This finding is consistent with Haini (2021), who observed that the impact of financial development on economic growth is negative at low levels of financial access and positive at higher levels of financial access. However, the negative coefficients may also indicate potential risks and adverse effects, such as the entry of unsophisticated borrowers with limited financial literacy, as noted by Carré and L'oeillet (2018)

3.3.3.3 Financial Development and Economic Growth

The overall financial institutions index (FI), which incorporates the efficiency dimension of financial institutions, was not statistically significant, as were the other overall indices, including the financial markets index (FM), and both the overall financial development indices excluding and including mobile money (FD and FD_MM) (Table 3.2.7). As a robustness check, Svirydzhenka's (2016) financial development index (SK_FD) was employed, yielding similar results. In contrast, bank credit to the private sector (PSC) exhibited a negative and statistically significant relationship with real GDP per capita. The estimated coefficient suggests that a 1 percent increase in PSC corresponds to a 0.6 percent decrease in real GDP per capita. The coefficient for Gross Fixed Capital Formation (GFC) was positive and significant, indicating a positive relationship with economic growth. Conversely, the coefficient for trade openness was negative and significant, suggesting that increased openness could have an adverse effect on growth in this context. As anticipated, the dummy variable capturing the effect of the COVID-19 pandemic was negative and significant, reflecting the detrimental impact of the pandemic on economic performance.

Table 3.2.7: System-GMM – SSA Financial Development^a and Economic Growth (2015 – 2022)

	Dependent variable: Real GDP per capita (RGDPpc)					
	FI	FM	PSC	FD	SK_FD	FD_MM
RGDPpc ₋₁	0.977*** (0.000)	0.934*** (0.000)	0.982*** (0.000)	0.970*** (0.000)	0.998*** (0.000)	0.920*** (0.000)
FD	0.183 (0.819)	-0.206 (0.512)	-0.006*** (0.007)	0.220 (0.505)	0.633 (0.241)	-0.867 (0.143)
FD ₋₁	-0.239 (0.781)	0.621 (0.125)	0.004 (0.392)	-0.275 (0.695)	-0.688 (0.251)	0.732 (0.228)
POP	-0.053 (0.270)	-0.177 (0.250)	0.183 (0.348)	0.007 (0.951)	-0.024 (0.615)	0.019 (0.904)
POP ₋₁	0.033 (0.372)	0.244 (0.144)	-0.301 (0.235)	0.037 (0.785)	-0.030 (0.420)	-0.095 (0.342)
Open	0.001 (0.604)	-0.002 (0.400)	0.002 (0.466)	0.002 (0.679)	0.001 (0.603)	0.002 (0.532)
Open ₋₁	-0.002* (0.069)	-0.000 (0.881)	-0.002 (0.197)	-0.004 (0.275)	-0.002* (0.098)	-0.005*** (0.006)
GFC	0.011 (0.124)	-0.005 (0.651)	0.013* (0.057)	0.007 (0.272)	0.005 (0.332)	0.009 (0.263)
GFC ₋₁	-0.005 (0.108)	0.024* (0.098)	-0.018 (0.355)	-0.001 (0.934)	-0.004 (0.371)	-0.003 (0.717)
C	0.221 (0.272)	-0.081 (0.881)	0.592 (0.174)	0.325 (0.464)	0.222 (0.420)	0.966 (0.148)
Covid-19	-0.065*** (0.000)	-0.089*** (0.004)	-0.057*** (0.004)	-0.058** (0.016)	-0.064*** (0.000)	-0.063*** (0.001)
No of obs	119	119	119	119	119	119
Countries	17	17	17	17	17	17
Instruments	17	17	17	17	17	17
AR (2)	0.818	0.170	0.332	0.525	0.955	0.187
Sargan statistic	0.117	0.922	0.606	0.477	0.338	0.672
Hansen statistic	0.547	0.838	0.286	0.541	0.551	0.770

Notes: In parentheses are p-values which reflect the significance of each correlation value. ***p<0.01, ** p<0.05 and *P<0.10. ^aFI denotes Financial Institutions index; FM denotes Financial Markets Index; PSC denotes Bank credit to the private sector; FD denotes the overall Financial Development index (excluding mobile money indicators); SV_FD denotes Svirydzenka's (2016) index and FD_MM denotes the overall Financial Development Index including mobile money indicators.

The finding that the overall financial development indices, both excluding and including mobile money, as well as Svirydzenka's (2016) index, were not statistically significant, contrasts with the results of Aluko et al. (2020) and Aluko & Ibrahim (2020), who also utilized Svirydzenka's (2016) index to examine the finance-growth nexus for Sub-Saharan Africa (SSA) over the periods 1990 to 2015 and 1996 to 2015, respectively. These studies found positive and significant relationships. The discrepancy in results may be attributed to differences in the periods analyzed and the country samples. Aluko et al. (2020) used a sample of 33 SSA countries, while Aluko & Ibrahim (2020)

used 28 SSA countries. In contrast, the present study focused on a sample of 17 countries, most of which are low- and lower-middle-income countries with relatively low levels of financial development. This may explain the lack of significance for the overall financial development index, including mobile money indicators (FD_MM), which aligns with the findings for mobile money financial inclusion indicators, which also did not exhibit a significant effect on real GDP per capita. On the other hand, the result that bank credit to the private sector (PSC) is negatively associated with real GDP per capita may suggest non-linearity in the relationship between bank credit and economic growth, a phenomenon previously identified by Ibrahim & Alagidede (2018), who examined a panel of 29 SSA countries from 1980 to 2014.

The estimated positive effect of Gross Fixed Capital Formation (GFC) aligns with both theoretical expectations and empirical findings in the literature (De Long & Summers, 1991; Sala-i-Martin, 1997; Herwartz & Walle, 2014; Hagan & Amoah, 2019; Aluko & Ibrahim, 2020). This result underscores the importance of investment in physical capital as a driver of economic growth. Conversely, the estimated negative effect of trade openness on real GDP per capita is consistent with the argument that a high degree of trade openness may reduce economic growth in low-income economies due to their vulnerability to macroeconomic shocks (Herwartz & Walle, 2014).

3.3.3.4 Financial Development (Mobile money adjusted Financial Development index) and Economic Growth

The results presented in Table 3.2.8 indicate that the mobile-money-adjusted financial development indicator (FD), which represents the interaction between mobile money indicators and the financial development index, was not statistically significant. This finding reinforces the earlier result that mobile money financial inclusion does not have a significant impact on real GDP per capita in the sample under study.

Table 3.2.8: System-GMM – SSA Financial Development (Mobile money adjusted Financial Development index) and Economic Growth (2015-2022)

Variable	Dependent variable: Real GDP per capita (RGDPpc)							
	FD*MM1	FD*MM2	FD*MM3	FD*MM4	FD*MM5	FD*MM6	PSC*MM	FD*MM
RGDPpc ₋₁	0.987*** (0.000)	0.980*** (0.000)	0.952*** (0.000)	0.930*** (0.000)	0.988*** (0.000)	0.991*** (0.000)	0.969*** (0.000)	0.952*** (0.000)
FD*MM	-0.000 (0.142)	0.001 (0.228)	-0.008 (0.933)	0.000 (0.896)	0.000 (0.371)	0.007 (0.423)	-0.008 (0.509)	0.050 (0.911)
FD*MM ₋₁	0.000 (0.125)	0.000 (0.899)	-0.023 (0.815)	-0.000 (0.432)	-0.000 (0.495)	-0.008 (0.374)	0.008 (0.570)	-0.187 (0.526)
POP	0.006 (0.938)	0.002 (0.967)	-0.112 (0.376)	-0.071 (0.464)	0.018 (0.878)	-0.169 (0.200)	0.054 (0.491)	-0.050 (0.623)
POP ₋₁	0.004 (0.935)	0.036 (0.754)	-0.050 (0.772)	-0.098 (0.180)	0.012 (0.919)	0.114 (0.386)	-0.086 (0.336)	-0.069 (0.320)
Open	-0.000 (0.950)	0.001 (0.614)	0.003 (0.468)	0.003 (0.256)	0.007 (0.173)	0.003 (0.107)	0.001 (0.704)	0.001 (0.390)
Open ₋₁	-0.001 (0.456)	-0.002 (0.313)	-0.005 (0.164)	-0.005** (0.032)	-0.000 (0.964)	-0.006** (0.015)	-0.002 (0.335)	-0.003* (0.074)
GFC	0.003 (0.581)	0.003 (0.656)	0.014*** (0.000)	0.007 (0.384)	0.007 (0.157)	0.018 (0.180)	0.001 (0.858)	0.006 (0.191)
GFC ₋₁	0.005 (0.352)	0.007 (0.287)	-0.006 (0.143)	-0.006 (0.203)	-0.003 (0.383)	-0.004 (0.606)	0.004 (0.447)	-0.005 (0.288)
C	-0.008 (0.998)	-0.057 (0.925)	0.734 (0.302)	1.012** (0.043)	0.024 (0.947)	0.190 (0.831)	0.300 (0.332)	0.711 (0.272)
Covid-19	-0.067*** (0.000)	-0.063*** (0.000)	-0.041 (0.209)	-0.049** (0.024)	-0.060** (0.017)	-0.058* (0.013)	-0.075*** (0.000)	-0.056*** (0.001)
No of obs	119	119	119	119	119	119	119	119
No of countries	17	17	17	17	17	17	17	17
Instruments	17	17	17	17	17	17	17	17
AR (2)	0.734	0.319	0.668	0.553	0.574	0.990	0.774	0.773
Sargan statistic	0.398	0.360	0.413	0.330	0.144	0.836	0.480	0.116
Hansen statistic	0.398	0.525	0.757	0.565	0.180	0.590	0.408	0.665

Notes: In parentheses are p-values which reflect the significance of each correlation value. ***p<0.01, ** p<0.05 and *P<0.10. MM1 denotes Value of mobile money transactions (% of GDP); MM2 denotes Number of mobile money transactions per 1,000 adults; MM3 denotes Number of registered mobile money agent outlets per 1,000 km²; MM4 denotes Number of registered mobile money agent outlets per 100,000 adults; MM5 denotes Number of registered mobile money accounts per 1,000 adults; MM6 denotes Mobile cellular subscriptions (per 100 people); MM denotes the mobile money index; PSC denotes bank credit to the private sector; FD denotes the overall Financial Development index (excluding mobile money indicators);

The results for the mobile-money-adjusted financial development indicators suggest that, although mobile money has played a crucial role in driving financial inclusion across the SSA countries in the sample, the overall level of financial inclusion remains relatively low. This finding aligns with empirical studies that indicate the effect of financial development on real GDP per capita becomes

positive and statistically significant only at higher levels of financial inclusion (Chami & Yousefi, 2013; Haini, 2021).

3.4. Conclusion

This study sought to address a gap in the literature by focusing on the critical relationship between financial development and economic growth in Sub-Saharan Africa (SSA), a region predominantly comprised of low-income countries. Beyond the traditional financial indicators such as bank credit to the private sector and the financial development index commonly utilized in previous research, this study constructed a comprehensive financial development index that incorporates mobile money financial inclusion indicators. Furthermore, the study also employed mobile-money-adjusted financial development variables to explore the role of mobile money in the finance-growth nexus within the SSA context.

For the empirical analysis, the study utilized the system Generalized Method of Moments (GMM) estimator, with data spanning from 2015 to 2022, a period when most Sub-Saharan African (SSA) countries adopted mobile money as a financial innovation. Seven financial development indicators were considered to examine the relationship between financial development and economic growth in the SSA context: (i) mobile money financial inclusion indicators and an index of mobile money financial inclusion; (ii) bank credit to the private sector; (iii) an overall index comprising financial institutions indicators; (iv) an overall index encompassing stock market indicators; (v) an overall index combining financial institutions and stock market indicators; (vi) an overall index integrating bank, market, and mobile money indicators; and (vii) Svirydzenka's (2016) financial development index. These overall financial development indices captured the dimensions of access, depth, and efficiency for financial institutions, financial markets, and mobile money. To further analyze the effect of financial inclusion, proxied by mobile money, the financial development index and bank credit to the private sector (PSC) were interacted with six mobile money-based financial inclusion indicators.

The study found that only the number of registered mobile money agent outlets per 1,000 km² and the Financial Development Index (FDI) had a positive and statistically significant effect on real GDP per capita, though the magnitude of this effect was negligible. The overall mobile money index, however, was not significant. Regarding financial institutions, only the number of ATMs per 1,000 km², as well as the number of credit union and credit cooperative branches per 1,000 km² and per 100,000 adults, exhibited positive and significant effects. The estimated coefficients for these financial institutions' financial inclusion indicators were of larger magnitude, which aligns with the findings of Ugwuanyi et al. (2022), who reported that traditional financial inclusion had a more substantial positive impact on real GDP per capita than mobile money financial inclusion. The overall financial development indices, including those incorporating both mobile money and financial institutions, were not significant, echoing the results from the mobile money and financial institutions indicators. However, the Granger causality results suggest that both mobile money financial inclusion and overall financial development Granger-cause real GDP per capita in at least one country in the sample. This implies that the findings cannot be generalized across all the countries in the sample.

Indeed, cross-country and panel empirical studies often mask the heterogeneity among countries within the sample. While this study addressed potential biases arising from cross-sectional dependence, autocorrelation, and endogeneity, leading to robust results, it also highlighted significant country-specific differences. As suggested by the Granger causality results, the impact of mobile money financial innovation varies across countries in Sub-Saharan Africa (SSA), and therefore, the findings cannot be generalized to all countries within the sample. The literature also points to substantial heterogeneity among developing countries in terms of mobile money adoption (Lashitew et al., 2019). Consequently, country-specific case studies could offer more detailed insights into the role of mobile money in the finance-growth nexus within these countries. To further explore this dynamic, in addition to the panel analysis, this study examines the experiences of Kenya and Uganda, selected for their status as pioneering adopters and leading users of mobile money in SSA.

Chapter 4

Financial Inclusion and the Finance-Growth Nexus - Empirical evidence from Kenya and Uganda

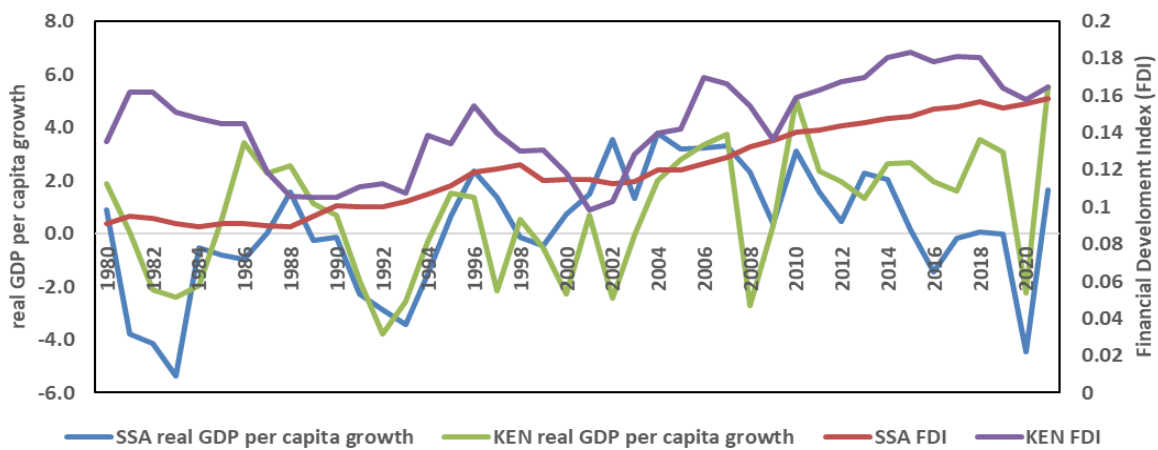
4.1 Economic growth and financial development in Kenya

Kenya, like many other Sub-Saharan African (SSA) countries, embarked on economic and financial reforms starting in the early 1980s, with the full liberalization of interest rates occurring in 1991 (Odhiambo, 2005). As illustrated in Figure 4.1.1, Kenya's economic growth has exhibited considerable volatility over the years. Notably, following the 2008/2009 global financial crisis, Kenya's per capita growth outpaced the average growth rate for the SSA region.

The trends depicted in Figures 4.1.1 and 4.1.2 suggest that financial liberalization in 1991 led to improvements in both Foreign Direct Investment (FDI) and Private Sector Credit (PSC), signaling positive developments in financial growth. However, the impact of the 2008/2009 global financial crisis is clearly observable, marked by a sharp decline in both financial development indicators and economic growth. In September 2016, Kenya introduced a cap on the lending interest rates charged by banks, aiming to stimulate credit growth. However, the cap was lifted in November 2019. The observed decline in PSC in 2016 indicates that the interest rate cap did not achieve its intended effect of enhancing private credit. This finding aligns with the results of Misati et al. (2021), who found a negative effect from the introduction of the interest rate cap. Furthermore, Alper et al. (2020) showed that the cap contributed to a reduction in financial intermediation, especially to Micro, Small, and Medium Enterprises (MSMEs). Similarly, Safavian & Zia (2018) highlighted that the interest rate cap not only reduced lending but also led to an increase in non-performing loans and a shift away from offering interest on current account deposits to maintain interest margins.

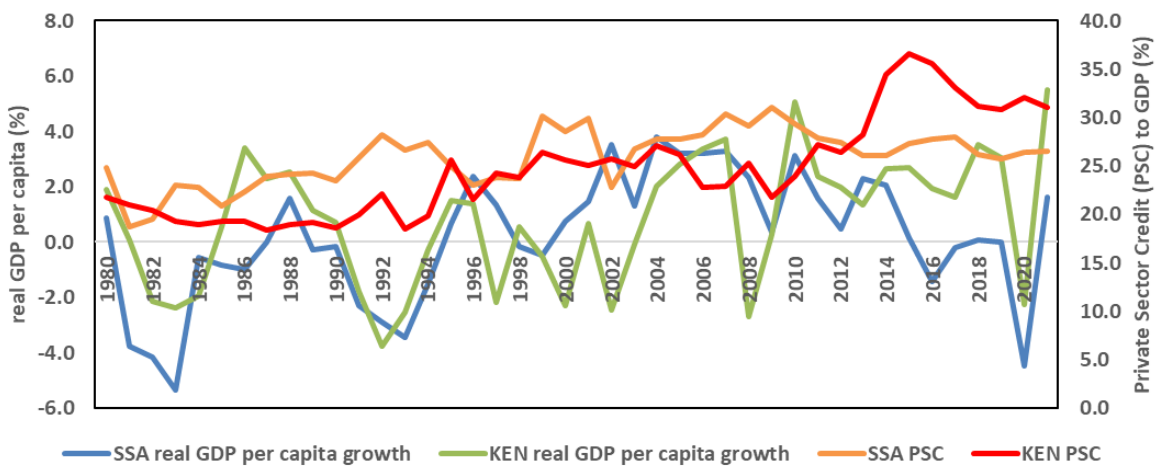
As illustrated in Figures 4.1.1 and 4.1.2, Kenya's overall financial development, as measured by the Financial Development Index (FD) and Private Sector Credit (PSC), has consistently surpassed the Sub-Saharan Africa (SSA) average, particularly in the past decade. This higher level of financial development can be attributed to Kenya's relatively more advanced financial market compared to other SSA countries.

Figure 4.1.1: Trend in Real GDP Growth and Financial Development: FD (1980-2021)



Data source: World Bank WDI database, 2023

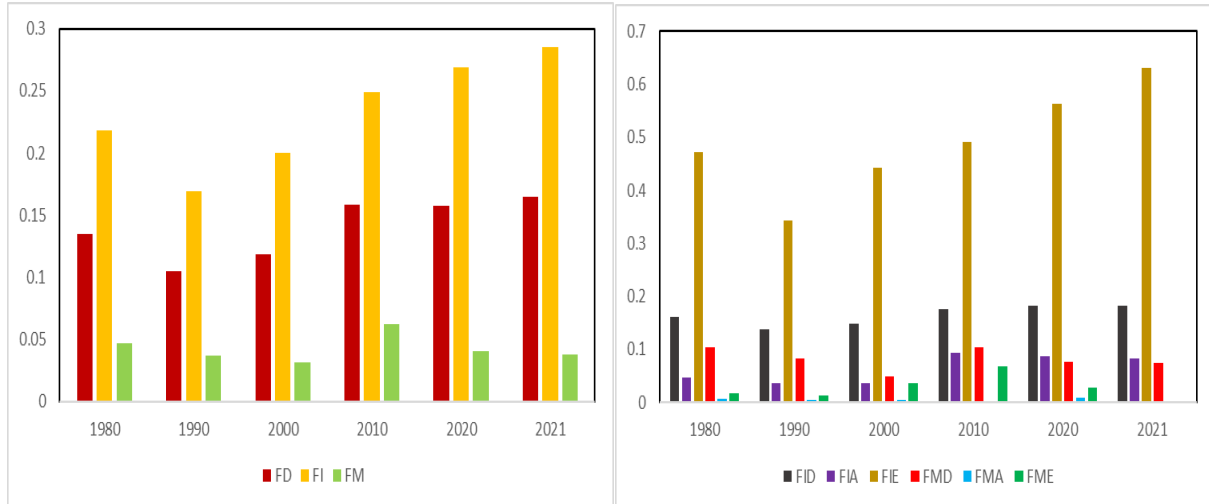
Figure 4.1.2: Trend in Real GDP Growth and Financial Development: PSC (1980-2021)



Data source: World Bank WDI database, 2023

The higher overall financial development level in Kenya, relative to the Sub-Saharan Africa (SSA) average, is also reflected in the components of the Financial Development Index, as shown in Figure 4.1.3. Specifically, Kenya's financial institutions development outpaced that of SSA, while its financial market development was slightly below the SSA average. In terms of structure, both Kenya and SSA exhibited more developed financial institutions than financial markets. Kenya leads the SSA region in financial depth and efficiency, and its financial access index was comparable to the SSA average. Notably, Kenya's Financial Institutions Efficiency Index (FIE) showed a consistent upward trend, likely driven by financial innovation. The remarkable growth in financial inclusion in Kenya is particularly evident from the increase in the Financial Institutions Access Index (FIA) between 1980 and 1990. However, the Financial Institutions Depth Index (FID) remained dominant over the FIA during this period.

Figure 4.1.3: Kenya Financial Development Index and its components (1980-2021)



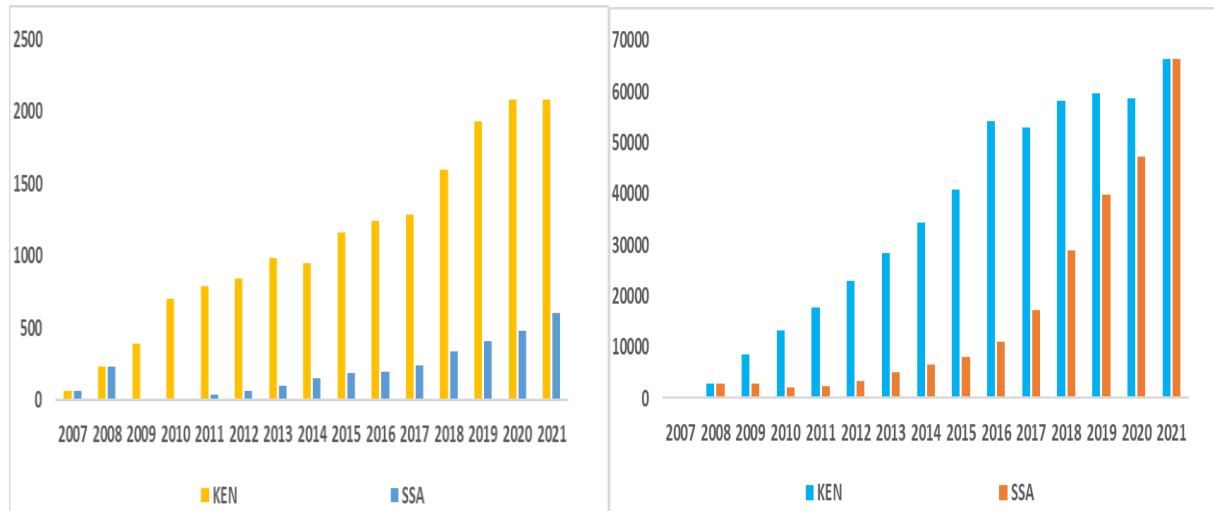
Source: IMF FDI database 2023

Note: FD (Financial Development); FI(Financial Institutions); FM (Financial Markets); FID (Financial Institutions Depth); FIA (Financial Institutions Access); FIE (Financial Insitutions Efficiency); FMD (Financial Markets Depth); FMA (Financial Markets Access); FME (Financial Markets Efficiency)

The improvement in financial inclusion in Kenya is largely attributed to efforts aimed at increasing access to formal financial institutions, such as the expansion of bank branches and Automated Teller Machines (ATMs). However, the most significant contributor has been the mobile money

financial innovation. Following its successful adoption in 2007, mobile money has facilitated the inclusion of previously excluded individuals in the financial system (Suri & Stoker, 2012; FinAccess Household Survey Report, 2021; Financial Sector Deepening [FSD], 2023). The latest financial access survey indicates that the usage of mobile money services provided by financial service providers has significantly outpaced the usage of traditional bank services, with 81.4 percent of the population utilizing mobile money compared to just 44.1 percent using bank services (FSD, 2023). Evidence from Kenya's M-Pesa demonstrates that mobile money has greatly enhanced financial inclusion by increasing the number of participants in the financial sector, which in turn has stimulated financial development through higher levels of savings and financial intermediation (Burns, 2015). As shown in Figures 4.1.4 and 4.1.5, Kenya continues to be a dominant user of mobile money in the SSA region.

Figure 4.1.4: MM accounts per 1,000 adults **Figure 4.1.5: MM transactions per 1,000 adults**



Source: IMF Financial Access Survey, 2023

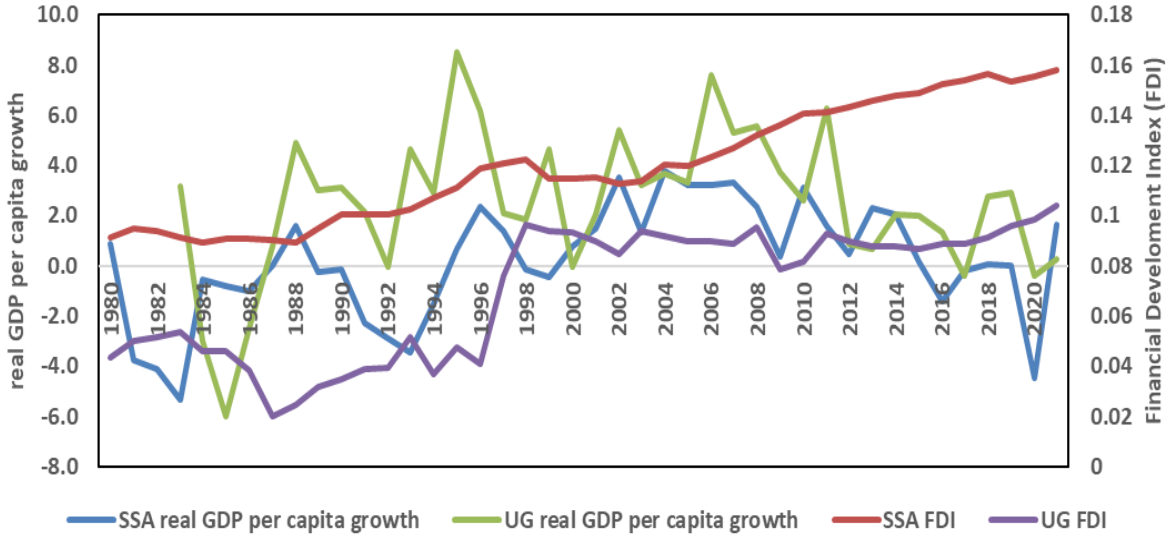
4.2 Economic growth and financial development in Uganda

Uganda's economic and financial performance has been shaped by a series of economic and financial reforms initiated in 1987. The process of financial liberalization began in 1992 and was completed by 1994 with the full liberalization of interest rates (Dijkstra & Van Donge, 2001;

Kasekende & Atingi-Ego, 2003). These reforms were aimed at strengthening the supervisory and regulatory functions of the central bank, deepening the financial market, broadening the range of financial instruments available, and restructuring and recapitalizing weak commercial banks to enhance their efficiency and viability (Kasekende & Atingi-Ego, 2003). As depicted in Figure 4.2.1, Uganda's economic growth has mirrored the trends observed in Sub-Saharan Africa (SSA), though it has consistently trended above the SSA average. The trajectory of GDP per capita was initially characterized by negative growth during the early to mid-1980s, largely due to the civil conflict between 1978 and 1986. However, following the implementation of economic and financial reforms, Uganda experienced sustained growth (Dijkstra & Van Donge, 2001). Another pivotal moment in Uganda's economic development was the substantial donor aid and debt relief it received between 1989 and 2001. Notably, Uganda became the first country to qualify for debt relief under the Heavily Indebted Poor Countries (HIPC) initiative, having met the conditions of strong adjustment and reform in collaboration with the International Monetary Fund (IMF) (Muwanga-Zake & Ndhaye, 2001; Kuteesa & Nabbumba, 2004). In Figure 4.2.1, the impacts of global events, particularly the 2008/2009 global financial crisis and the COVID-19 pandemic, are evident, with a notable decline in real GDP per capita in 2008 and a more pronounced decline in 2020.

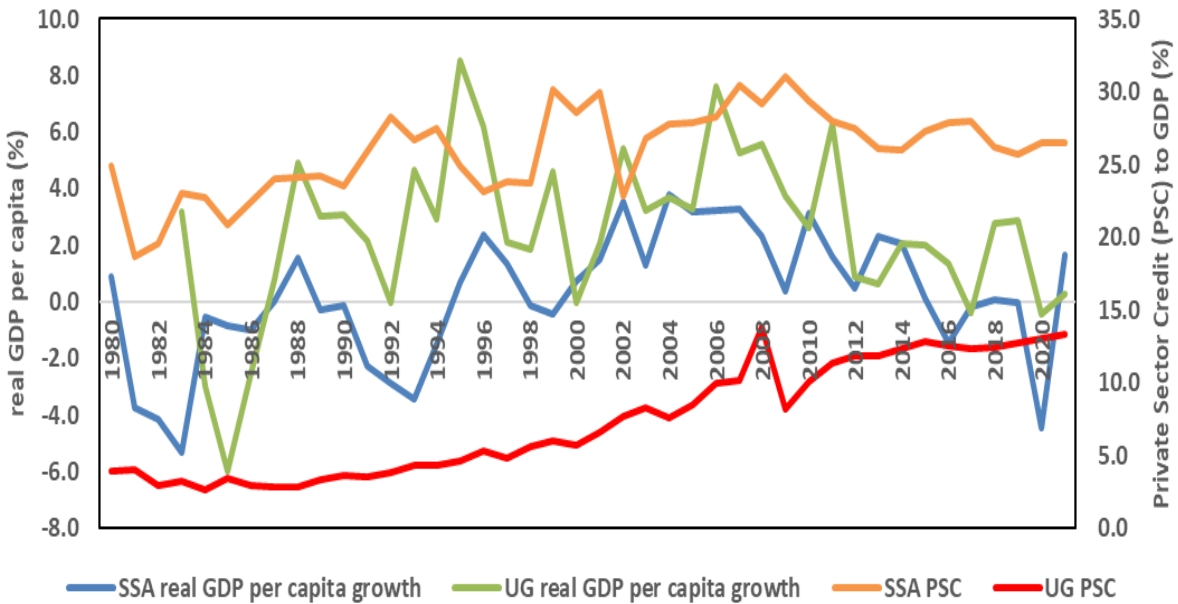
The trends observed in Figures 4.2.1 and 4.2.2 reveal that the financial sector reforms implemented in the mid-1990s contributed to improvements in financial development, as indicated by the evolution of both the Financial Development Index (FDI) and Private Sector Credit (PSC). The impact of the 2008/2009 global financial crisis is evident in a decline in both financial development indicators; however, the decline was more pronounced in the PSC. As shown in Figures 4.7 and 4.8, Uganda's overall financial development, as measured by both the FDI and PSC, remained lower than the SSA average. Nevertheless, the gap between Uganda and the SSA average narrowed over time. This convergence can be attributed to strong growth in financial access, as evidenced by the components of the FDI presented in Figures 4.2.3 and 4.2.4.

Figure 4.2.1: Trend in Real GDP Growth and Financial Development Index (FD) (1980-2021)



Data source: World Bank WDI database, 2023

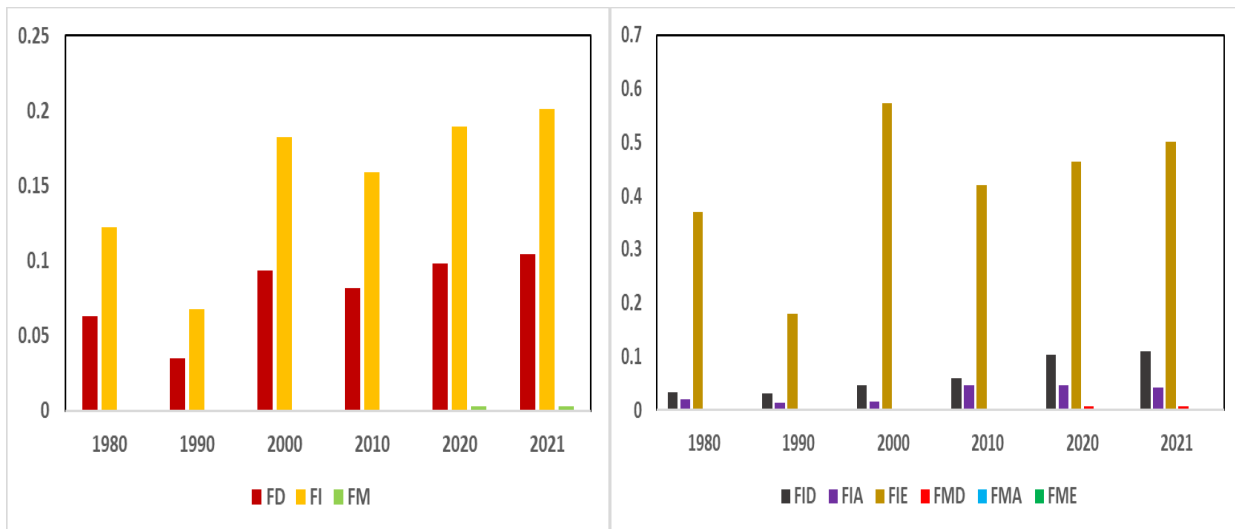
Figure 4.2.2: Trend in Real GDP Growth and Credit to the Private Sector (PSC) (1980-2021)



Data source: World Bank WDI database, 2023

The components of the financial development index, as presented in Figure 4.2.3, reveal that Financial Markets (FM) development in Uganda was significantly lower than the Sub-Saharan African (SSA) average. However, the development of financial institutions in Uganda was only slightly below the SSA average. In terms of structure, financial institutions were more developed than financial markets in both Uganda and SSA. Additionally, similar to the SSA trend, the Financial Institutions’ Efficiency Index (FIE) for Uganda exhibited an upward trajectory over the period, likely driven by financial innovation. The substantial growth in financial inclusion for both Uganda and SSA is evident in the increase in the Financial Institutions Access Index (FIA) between 1980 and 1990. However, a slight decline in the FIA is observed in 2020 for both Uganda and SSA. Moreover, while the FIA for SSA exceeded the Financial Institutions Depth (FID) index by 2019, the FID has remained dominant over the FIA in Uganda. This suggests that despite the considerable contribution of mobile money financial innovation, there remains significant room to further enhance financial inclusion in Uganda.

Figure 4.2.3: Uganda Financial Development Index and its components



Source: IMF FDI database 2023

Note: FD (Financial Development); FI(Financial Institutions); FM (Financial Markets); FID (Financial Institutions Depth); FIA (Financial Institutions Access); FIE (Financial Institutions Efficiency); FMD (Financial Markets Depth); FMA (Financial Markets Access); FME (Financial Markets Efficiency)

Similar to Kenya, mobile money has been the primary driver of financial inclusion improvement in Uganda (Akileng et al., 2018; Ministry of Finance and Planning and Economic Development & Bank of Uganda [MoFPED & BoU], 2023; Huang, 2023). Uganda conducted its first FinScope survey in 2006 to monitor progress in financial inclusion, following government efforts initiated in 2001 to enhance access to financial services (FSDU, 2013). The 2018 FinScope survey revealed that mobile money usage was the principal factor behind the increase in financial inclusion observed since 2006, with the inclusion rate rising from 57 percent in 2006 to 78 percent in 2018 (FSDU, 2018). Formal financial inclusion increased from 28 percent in 2006 to 58 percent in 2018, while the use of informal financial services declined from 42 percent in 2009 to 20 percent in 2018. Mobile money-based financial products have since expanded to include micro-savings and micro-insurance, with commercial banks increasingly partnering with mobile money service providers to offer credit to Small and Medium Enterprises (SMEs).

As illustrated in Figures 4.2.4 and 4.2.5, Uganda remains one of the leading users of mobile money in the Sub-Saharan African (SSA) region. Following substantial growth in mobile money adoption and usage, Uganda implemented a tax on mobile money transactions in July 2018, aiming to increase tax revenue. However, studies examining the impact of this tax indicate that it resulted in a contraction of the mobile money sector and disproportionately affected the poor (Ssonko & Kawooya, 2020; UN Capital Development Fund [UNCDF], 2021; Katusiime, 2021). In response to these adverse effects, the mobile money tax rate was subsequently reduced.

Figure 4.2.4: MM accounts per 1,000 adults

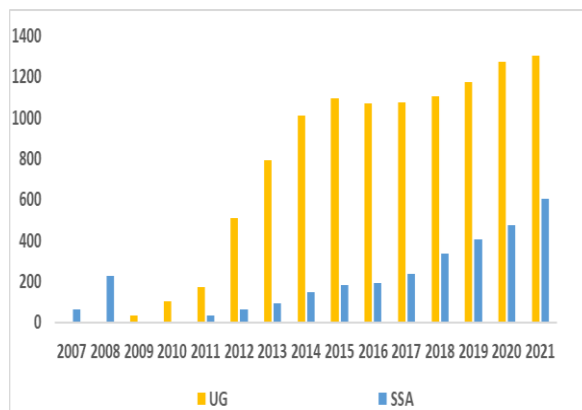
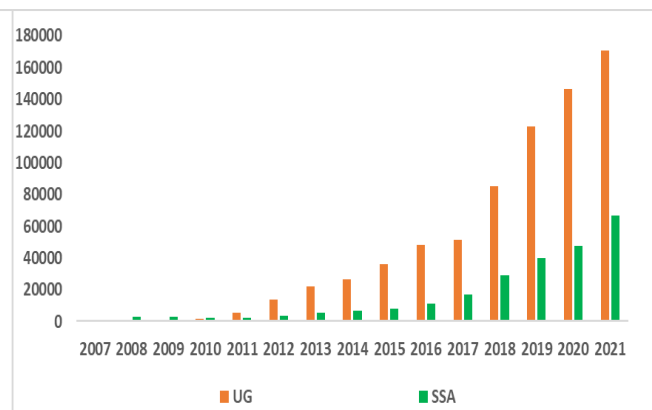


Figure 4.2.5: MM transactions per 1,000 adults



Source: IMF Financial Access Survey, 2023

Empirical evidence from Nampewo et al. (2016) suggests that mobile money balances held by banks contribute to an increase in the deposits available for bank credit to the private sector in Uganda. Data observations in this study reveal an upward trend in both the Financial Development Index (FDI) and bank credit to the private sector (PSC). The contribution of financial inclusion to financial development is further evidenced by the Financial Access sub-index in the FDI, as shown in Figure 4.2.4. The empirical evidence in conjunction with the observed data trends, provide a strong basis for testing the hypothesis that financial inclusion, as proxied by mobile money, influences the relationship between financial development and economic growth in Uganda.

4.3 Methodology

4.3.1 Model specification

To analyze the relationship between financial development and economic growth in the two country cases, Kenya and Uganda, the study employs the endogenous growth model $Y_t = Ak_t$, which is augmented with financial development, as presented and discussed in Chapter 3. The relationship between financial development and economic growth is summarized in the following function:

$$Y_t = f(K_t, FD_t, Z_t) \quad (2)$$

Where Y_t is the output or real GDP per capita at time t , K_t represents the capital stock at time t , FD_t represents the financial development at time t , and Z_t is a set of control variables. In this model, financial development (FD_t) plays a critical role in determining the output through its influence on investment, capital accumulation, and overall economic efficiency. The model incorporates both physical and human capital, as well as the potential for financial development to affect the productive capacity of an economy, particularly in the context of the mobile money financial inclusion indicators that are central to this study. The study employed five key financial development indicators to examine the relationship between financial development and economic

growth in Kenya and Uganda: (i) Mobile Money Financial Inclusion Indicators and the Mobile Money Financial Inclusion Index (MM): This includes mobile money indicators that capture the depth and access to mobile money services, which have been a significant driver of financial inclusion in both countries; (ii) Bank Credit to the Private Sector (PSC): A traditional measure of financial development, PSC reflects the role of financial institutions in providing credit to the private sector, which is crucial for investment and economic growth; (iii) An Overall Index of Bank and Market Indicators (FD): This index encompasses traditional financial institutions (banks) and markets, capturing the depth, efficiency, and access within these sectors; (iv) An Overall Index of Bank, Market, and Mobile Money Indicators (FD_MM): This expanded index includes both traditional financial institutions and markets along with mobile money indicators, reflecting the growing importance of digital financial services in Sub-Saharan Africa (SSA); and (v) Svirydzenka's (2016) Financial Development Index (SK_FD): A comprehensive index that captures financial development through multiple dimensions, providing an alternative measure of financial development.

In addition to these financial development indicators, the study incorporates several control variables drawn from the empirical literature to account for other factors that may influence economic growth: Trade Openness (Openness): The degree to which a country is integrated into the global economy, influencing growth through international trade and investment. Inflation (CPI): Consumer price inflation, which can have a direct impact on economic stability and growth. External Debt: The level of external debt, which can affect a country's ability to invest in growth-promoting sectors or cause economic stress if debt servicing becomes burdensome. Population Growth: Population growth is an important demographic factor influencing both labor supply and demand, as well as the overall size of the economy.

Increased trade openness allows countries to import manufacturing inputs and access capital markets, which in turn can be financed via the financial system. The expectation is that trade liberalization boosts productivity and growth by providing cheaper inputs and opening new markets. Beck (2002) emphasized the positive link between trade and economic growth through

access to international markets and efficient resource allocation. The effect of inflation on economic growth is complex. In moderate amounts, inflation might have a positive impact by encouraging spending and investment, but high inflation tends to reduce confidence in the currency, erodes the value of savings, and can make long-term planning difficult. The relationship with financial development can become negative at higher inflation rates because the positive effects of financial development are undermined by the inflationary environment (Boyd et al., 2001; Rousseau & Wachtel, 2002). Public debt can have both positive and negative effects. On the positive side, public debt can serve as collateral in the financial markets, providing the government with the necessary financing for investments and development projects, which can indirectly spur growth. However, high debt burdens can lead to financial repression, where the government uses mechanisms like capital controls or direct lending to finance debt, limiting the overall effectiveness of financial markets (Hauner, 2009). Time-specific dummies are included to account for major events that affected the countries (Kenya and Uganda) during the study period. The inclusion of dummy variables helps to isolate the impact of specific events that may have disrupted the economy or financial system. These include: (i) Global Financial Crisis (2008/2009): This was a significant global event that may have had widespread economic impacts; (ii) COVID-19 pandemic (2020): The global pandemic also had profound economic effects on many countries, including those in SS; and (iii) Policy Shifts: Key policy changes (such as interest rate caps in Kenya or financial reforms in Uganda) that have specifically influenced the financial systems and overall growth. Re-writing the function in equation 2 in linear form, the model to be estimated is:

$$\ln Y_t = \alpha_0 + \beta_1 \ln FD_t + \beta_2 \ln Openness_t + \beta_3 \ln Debt_t + \beta_4 \ln CPI_t + \beta_5 \ln GFC_t + \beta_6 POPg_t + \epsilon_t \quad (3)$$

4.3.2 Estimation methods

Prior to estimating the model, preliminary tests were conducted to assess the integration properties of the variables and to select the appropriate estimation technique. Specifically, unit root tests were employed to determine the order of integration of the variables, while structural break tests were

conducted to account for potential disruptions in the data that could affect inference. To ensure the stationarity of the variables, unit root tests were performed. Non-stationarity can result in spurious regression results, and thus it is essential to identify the order of integration of each series before proceeding with any further analysis. Common tests employed include: (i) Augmented Dickey-Fuller (ADF) Test, which is used to test for the presence of a unit root in the series; (ii) Phillips-Perron (PP) Test, an alternative to the ADF test, adjusting for serial correlation in the error terms and (iii) Kwiatkowski-Phillips-Schmidt-Shin (KPSS) Test, which is employed to test for stationarity, where the null hypothesis is stationarity. These tests help identify whether the variables are stationary at levels or require differencing to achieve stationarity. Given the possibility of structural shifts over time (e.g., due to external shocks such as the global financial crisis), structural break tests were conducted to identify any significant changes in the relationship between financial development and economic growth. Ignoring such breaks could lead to misleading inferences. Tests include: (i) Chow Test, which is applied to check if there is a structural break in the data across different time periods; (ii) Zivot-Andrews Test, which is designed to detect unit roots with allowance for structural breaks in the time series; and (iii) Perron Test, used to detect structural breaks while testing for stationarity. These tests help ensure that the results reflect the underlying relationships between the variables, accounting for any shifts in the data.

Once the unit root properties of the variables were established, the next step was to test cointegration using the Johansen & Juselius (1990) cointegration test. This method determines whether a long-run equilibrium relationship exists between the variables. The Johansen test is particularly useful for multivariate systems and can identify multiple cointegrating relationships, which helps to capture the long-term dynamics among financial development indicators and economic growth. The cointegration test consists of two key tests: (i) Trace Test, which tests the null hypothesis that there are r cointegrating relationships in the data; and (ii) Maximum Eigenvalue Test, which tests the null hypothesis that the number of cointegrating relationships is r versus $r+1$. The presence of cointegration would suggest that the variables share a long-run equilibrium relationship and that deviations from this equilibrium are temporary. If cointegration is confirmed, a Vector Error Correction Model (VECM) is estimated to capture both short-term

and long-term relationships between financial development and economic growth. The VECM is an extension of the Vector Autoregressive (VAR) model and is particularly useful when the variables are cointegrated. The long-run equilibrium relationship between the variables is captured by the cointegrating equation, providing insight into the persistent effects of financial development on economic growth. The VECM also includes an error correction term, which reflects the speed at which the system adjusts to deviations from equilibrium, providing an understanding of how financial development shocks affect economic growth in the short run.

In addition, Granger causality tests were conducted to assess the direction of causality between financial development and economic growth. These tests served as a preliminary step to explore the dynamic relationship between the two variables. Specifically, the Granger causality test examines whether past values of the explanatory variables, in conjunction with past values of the dependent variable, significantly improve the prediction of the dependent variable beyond what can be explained by its own lagged values alone. In this context, the null hypothesis tested was that financial development does not Granger cause real GDP (Y_t). The test was based on the estimated empirical models, and rejection of the null hypothesis would imply that financial development contains predictive information for real GDP (Y_t), suggesting a causal relationship in the Granger sense.

4.3.2.1 Vector Error Correction Model (VECM)

In the analysis of economic and financial time series, the assumption of stationarity is often violated, as many such series exhibit deterministic or stochastic trends. Consequently, the application of estimators that assume stationarity, such as Ordinary Least Squares (OLS), may yield spurious regression results, leading to misleading inferences (Hamilton, 1989; Kirchgässner et al., 2012). To address this issue, the present study employs the cointegration framework developed by Engle and Granger (1987), which is extensively utilized in the empirical finance–growth literature. The Engle–Granger methodology enables the investigation of long-run relationships between non-stationary variables that are integrated of order one, $I(1)$. If a linear combination of these variables is found to be stationary, the series are said to be cointegrated. This

cointegration implies the existence of a long-run equilibrium relationship among the variables, despite their individual non-stationarity. Upon establishing cointegration, an error correction model (ECM) can be specified, capturing both the short-run dynamics and the speed of adjustment towards the long-run equilibrium by incorporating the lagged residuals of the cointegrating equation. In addition to the Engle–Granger approach, other robust methodologies for testing cointegration in multivariate settings include the Johansen maximum likelihood procedures. These involve the trace and maximum eigenvalue tests (Johansen, 1988; Johansen & Juselius, 1990), which allow for the identification of multiple cointegrating vectors. Furthermore, the autoregressive distributed lag (ARDL) bounds testing approach, as proposed by Pesaran and Smith (2001), provides an alternative framework that accommodates variables of mixed integration orders (I(0) and I(1)) without requiring pre-testing for unit roots.

The study adopted the Johansen (1988) approach, which involves the maximum likelihood estimation of a vector autoregressive (VAR) model of order p to examine the linear relationships among k non-stationary variables.

$$Y_t = \sum_{j=1}^p A_j Y_{t-j} + D_t + U_t \quad (1)$$

Where, U_t denotes a k -dimensional white noise process that is normally distributed, D represents the deterministic components of the system, and A_j , $j = 1, 2, \dots, p$, are $k \times k$ dimensional parameter matrices. Assuming initially that the system excludes deterministic terms, the Johansen (1988) procedure estimates a vector autoregressive (VAR) model of order p to investigate the linear interdependencies among k non-stationary variables. The absence of deterministic elements simplifies the model, allowing focus on the stochastic dynamics and cointegration structure among the variables as presented in equation (2).

$$\Delta Y_t + \Gamma B' Y_{t-1} = A_1^* \Delta Y_{t-1} + \dots + A_{p-1}^* \Delta Y_{t-p+1} + U_t \quad (2)$$

The maximum likelihood estimation of the coefficient matrices A_j^* $j = 1, \dots, p-1$ is obtained by applying Ordinary Least Squares (OLS) to equation (2), conditional on given values of Γ and B .

To isolate the long-run relationships and eliminate the influence of short-run dynamics on both ΔY_t and Y_{t-1} , the variables ΔY_t and Y_{t-1} are regressed on their lagged differences. The residuals, denoted as R_{0t} (R_{1t}) for which (3) holds, are then obtained.

$$R_{0t} = -\Gamma B' R_{1,t} + \hat{U}_t \quad (3)$$

R_0 is a vector of stationary processes, while R_1 is a vector of nonstationary processes. The core idea of the Johansen approach is to identify linear combinations, $B'R_1$, that exhibit the highest correlations with R_0 . Reparametrizing equation (1) as a vector error correction model (VECM) leads to the following formulation:

$$Y_t = -\Pi Y_{t-1} + \sum_{j=1}^p A_j^* \Delta Y_{t-j} + D_t + U_t \quad (4), \text{ with}$$

$$\Pi = A(1) = 1 - \sum_{j=1}^p A_j \quad \text{and} \quad A_j^* = -\sum_{j=1}^p A_j, j = 1, 2, \dots, p-1$$

The matrix Π represents the long-run relationships between the variables. Since all components of Y_t are variables integrated of order one, $I(1)$, each component of $\Delta Y_t, \dots, \Delta Y_{t-p+1}$ is stationary, and each component of Y_{t-1} is also integrated of order one. This makes the relationship in equation (4) unbalanced if Π has a full rank of k . In such a case, the inverse matrix Π^{-1} exists, and equation (4) can be solved for Y_{t-1} as a linear combination of stationary variables. However, to avoid any contradiction, Π must have a reduced rank of $r < k$. Therefore, equation (4) must satisfy the restriction in equation (5).

$$\Pi = \begin{matrix} \Gamma & B' \\ (k \times k) & (k \times r)(r \times k) \end{matrix} \quad (5)$$

Where all matrices are assumed to have rank r . The term $B'Y_{t-1}$ represents r stationary linear combinations, which ensure that the equations in system (6.12) are balanced. The columns of matrix B contain the r linearly independent cointegration vectors, while the matrix Γ contains the so-called loading coefficients, which quantify the contributions of the r long-run relationships in the various equations of the system. The adjustment processes toward equilibrium can be derived from these coefficients.

If there is no cointegration, i.e., if $r = 0$, then Π is the zero matrix, and equation (4) reduces to a Vector Autoregressive (VAR) model of order $p-1$ in ΔY . This system possesses k unit roots, corresponding to k stochastic trends. If $r = k - 1$, the system contains exactly one common stochastic trend, and all the variables in the system are pairwise cointegrated. In general, system (4) contains $k - r$ common stochastic trends and r linearly independent cointegration vectors, where the cointegration rank r satisfies $0 < r < k$.

One of the key differences between approaches for testing cointegration is that the method proposed by Pesaran and Smith (2001) accommodates the analysis of a mixed order of integration, i.e., variables that are $I(1)$ and $I(0)$. In contrast, the approaches developed by Engle and Granger (1987) and Johansen and Juselius (1990) require all variables to be integrated of the same order, specifically $I(1)$. Additionally, Pesaran and Smith (2001) assume that there is only one cointegrating relationship among the variables. If more than one cointegrating relationship is identified, the method by Johansen and Juselius (1990) should be used (Nkoro & Uko, 2016)

4.3.3 Data

Kenya

This study employs annual data spanning the period 1980 to 2022 to examine the relationship between financial development and economic growth in Kenya. This timeframe encompasses key milestones in Kenya's financial sector, including the liberalization of interest rates in 1991 and the introduction of mobile money services in 2007. The variables utilized in the analysis, along with their respective data sources, are detailed in Appendix Table A2. Summary statistics for the variables are presented in Table 4.3.3.1

Table 4.3.3.1: Kenya Summary Statistics (1980 to 2022)

Variables	Mean	Sd	Min	Max
Real GDP per capita (in constant 2015 U.S. dollars)	1,324.6	159.6	1,165.2	1,754.6
Trade openness (exports+imports/GDP) (%)	51.9	11.1	27.2	72.9
Population growth (%)	2.9	0.5	1.9	3.7
Gross Fixed Capital Formation (% of GDP)	18.8	2.0	15.4	23.9
<i>Financial Development Indicators</i>				
MM index	0.2	0.3	0.0	1.0
Overall index excluding mobile money (FD)	0.5	0.4	0.0	1.0
Overall index including mobile money (FD_MM)	0.4	0.3	0.0	1.0
Private Sector Credit (PSC)/GDP (%)	32.7	2.2	30.8	36.6
Svirydzenka's (2016) FD index	0.1	0.0	0.1	0.2

Data Sources: IMF database (2022) and World Bank Databank (2022), Central Bank of Kenya and Kenya Securities Exchange

Seven measures of financial development were employed in the analysis. First, mobile money financial inclusion indicators were used, which also served as the basis for constructing a mobile money financial inclusion index. Second, bank credit to the private sector (PSC) was included, as it is widely regarded in the empirical finance–growth literature as a suitable proxy for the financial intermediation role of finance (Arcand et al., 2015; Ibrahim & Alagidede, 2018; Demetriades & Rewilak, 2020). Third, a financial institutions indicators index was used. Fourth, a financial markets indicators index was considered. Fifth, a combined index incorporating both financial institutions and financial markets indicators was constructed. Sixth, an overall index was developed, comprising financial institutions, financial markets, and mobile money indicators. Seventh, the financial development index (FDI) developed by Svirydzenka (2016) was employed as a robustness check. This index provides a comprehensive measure of financial development by capturing the dimensions of depth, access, and efficiency across both financial institutions and financial markets. It has been used in recent empirical finance–growth studies (Aluko et al., 2020; Aluko & Ibrahim, 2020; Boukraine, 2020; Haini, 2021). Time dummy variables were incorporated into the analysis to control for major structural and macroeconomic events, including the financial

liberalization of 1991, the global financial crisis of 2008/2009, the introduction of mobile money in 2007, and the COVID-19 pandemic.

Annual data on financial development indicators, selected based on empirical literature and data availability, were utilized to construct a comprehensive financial development index that incorporates mobile money indicators. The mobile money indicators exhibited a very high degree of correlation, with coefficients approaching unity (Table 4.3.3.2). Consequently, Principal Component Analysis (PCA) was employed to aggregate these indicators into a single composite index.

Table 4.3.3.2: Kenya Correlation Matrix

	<i>MM1</i>	<i>M2</i>	<i>M3</i>	<i>M4</i>	<i>M5</i>	<i>M6</i>
<i>MM1</i>	1					
<i>MM2</i>	0.974	1				
<i>MM3</i>	0.984	0.954	1			
<i>MM4</i>	0.993	0.974	0.996	1		
<i>MM5</i>	0.984	0.975	0.985	0.991	1	
<i>MM6</i>	0.955	0.978	0.940	0.956	0.976	1

Note: Values reported are pair-wise correlation coefficients. *MM1* denotes Value of mobile money transactions (% of GDP); *MM2* denotes Number of mobile money transactions per 1,000 adults; *MM3* denotes Number of registered mobile money agent outlets per 1,000 km²; *MM4* denotes Number of registered mobile money agent outlets per 100,000 adults; *MM5* denotes Number of registered mobile money accounts per 1,000 adults; *MM6* denotes Mobile cellular subscriptions (per 100 people).

The results of the Principal Component Analysis (PCA), based on the first principal component, are presented in Table 4.3.3.3. The findings indicate that all three dimensions of financial development; depth, access, and efficiency, contributed positively to the common variation in the data. Among these, the access dimension had the largest contribution, particularly within the financial institutions sub-sector, which recorded a loading of 0.676, compared to 0.661 for mobile money and 0.325 for financial markets. Furthermore, the sub-index loadings reveal that financial institutions, financial markets, and mobile money all contributed positively to the overall variation, with loadings of 0.642, 0.521, and 0.563, respectively. Financial institutions exhibited the highest contribution, followed by mobile money. A comparison between the computed indices and the Financial Development Index by Svirydzenka (2016) suggests that Kenya's level of financial

development was relatively lower than the average observed in the global cross-country sample used by Svirydzenka, which includes both advanced and developing economies.

Table 4.3.3.3: Kenya Principal Component Analysis: Variance Explained by PCA

<u>Principal component</u>	<u>Eigen values</u>	<u>Proportion</u>	<u>Cumulative</u>			
	<u>Depth</u>	<u>Access</u>	<u>Efficiency</u>			
Component 1	2.282	2.036	1.887			
Component 2	0.575	0.883	1.211			
Component 3	0.143	0.082	0.818			
Component 1	<u>Weights for Computed indices</u>			<u>Weights -Svirydzenka (2016)</u>		
	<u>Depth</u>	<u>Access</u>	<u>Efficiency</u>	<u>Depth</u>	<u>Access</u>	<u>Efficiency</u>
Financial Institutions	0.628	0.676	0.537	0.700	0.882	0.536
Financial Markets	0.513	0.325	----	0.590	0.670	---
Mobile Money	0.585	0.661				
	<u>Financial</u>	<u>Financial</u>	<u>Mobile</u>	<u>Financial</u>	<u>Financial</u>	
	<u>Institutions</u>	<u>Markets</u>	<u>Money</u>	<u>Institutions</u>	<u>Markets</u>	
Component 1	0.642	0.521	0.563	0.675	0.769	

Source: Author's computation and Svirydzenka (2016).

Note: A single indicator is used for financial market efficiency thus --- denotes no value computed for the efficiency sub-index.

Uganda

The study for Uganda utilized annual data spanning the period 1982 to 2022 to capture key phases in the country's financial and economic development. Notable milestones during this period include the liberalization of interest rates between 1992 and 1994, as well as the introduction of mobile money services in 2009. The variables used in the analysis, along with their respective data sources, are provided in Appendix Table A2, while summary statistics are presented in Table 4.3.3.4. As shown in Table 4.3.3.5, the mobile money indicators exhibit high pairwise correlations, suggesting the presence of a common underlying factor. Consequently, the Principal Component Analysis (PCA) method was employed to aggregate these indicators into a single mobile money index. In addition, PCA was also used to combine the financial institutions and financial markets indicators into an overall financial development index, reflecting their complementary nature and intercorrelations.

Table 4.3.3.4: Uganda Summary Statistics (1982 – 2022)

Variables	Mean	Sd	Min	Max
Real GDP per capita (in constant 2015 U.S. dollars)	900.4	26.9	864.2	934.3
Trade openness (exports+imports/GDP) (%)	36.9	3.1	31.2	41.7
Population growth (%)	3.28	0.17	3.00	3.50
Gross Fixed Capital Formation (% of GDP)	23.9	0.7	23.3	24.9
<i>Financial Development Indicators</i>				
MM index	0.6	0.3	0.3	1.0
Private Sector Credit (PSC)/GDP (%)	12.8	0.4	12.3	13.4
Svirydzhenka's (2016) FD index	0.1	0.0	0.1	0.1

Data Source: IMF database (2022) and World Bank Databank (2022), Bank of Uganda, Uganda Securities Exchange

Table 4.3.3.5: Uganda Correlation Matrix

	<i>MM1</i>	<i>MM2</i>	<i>MM3</i>	<i>MM4</i>	<i>MM5</i>	<i>MM6</i>
<i>MM1</i>	1					
<i>MM2</i>	0.967	1				
<i>MM3</i>	0.990	0.976	1			
<i>MM4</i>	0.976	0.981	0.996	1		
<i>MM5</i>	0.846	0.752	0.808	0.763	1	
<i>MM6</i>	0.955	0.877	0.915	0.878	0.916	1

Note: Values reported are pair-wise correlation coefficients. MM1 denotes Value of mobile money transactions (% of GDP); MM2 denotes Number of mobile money transactions per 1,000 adults; MM3 denotes Number of registered mobile money agent outlets per 100,000 adults; MM4 denotes Number of registered mobile money agent outlets per 1,000 km²; MM5 denotes Mobile cellular subscriptions (per 100 people); MM6 denotes Number of registered mobile money accounts per 1,000 adults.

Table 4.3.3.6 presents the results of the Principal Component Analysis (PCA) based on the first principal component. The findings indicate that all three dimensions; depth, access, and efficiency, contributed positively to the common variation in the data. Among these, the access dimension exhibited the highest contribution, with loadings of 0.684 for financial institutions, 0.664 for mobile money, and 0.301 for the financial market. The sub-index results further demonstrate that financial institutions, mobile money, and financial markets all contributed positively to the variation in the data, with respective loadings of 0.672, 0.525, and 0.523. Financial institutions contributed the most to the overall financial development index, while mobile money and the financial market had nearly equal influence. A comparative analysis against Svirydzhenka's (2016) Financial Development Index reveals that Uganda exhibited a lower level of financial development

than the average recorded in the global cross-country sample, which includes both advanced and developing economies. This discrepancy may be attributed, in part, to the relatively greater weight of the financial market in Svirydzenka's index (0.769), compared to a lower corresponding weight of 0.523 observed for Uganda.

Table 4.3.3.6: Uganda Principal Component Analysis: Variance Explained by PCA

<u>Principal component</u>	<u>Eigen values</u>	<u>Proportion</u>	<u>Cumulative</u>			
	<u>Depth</u>	<u>Access</u>	<u>Efficiency</u>			
Component 1	1.927	1.943	1.887			
Component 2	0.842	0.915	1.211			
Component 3	0.232	0.142	0.818			
<hr/>						
Component 1	<u>Weights for computed indices</u>			<u>Weights - Svirydzenka (2016)</u>		
	<u>Depth</u>	<u>Access</u>	<u>Efficiency</u>	<u>Depth</u>	<u>Access</u>	<u>Efficiency</u>
Financial Institutions	0.672	0.684	0.543	0.700	0.882	0.536
Financial Markets	0.462	0.301	----	0.590	0.670	---
Mobile Money	0.579	0.664				
<hr/>						
Component 1	<u>Financial Institutions</u>	<u>Financial Markets</u>	<u>Mobile Money</u>	<u>Financial Institutions</u>	<u>Financial Markets</u>	
	0.672	0.523	0.525	0.675	0.769	

Source: Author's computation and Svirydzenka (2016).

Note: A single indicator is used for financial market efficiency thus --- denotes no value computed for the efficiency sub-index.

4.4. Results and Discussion

Building on the preceding panel analysis of 17 Sub-Saharan African countries, the country-specific case studies of Kenya and Uganda aim to further explore whether financial inclusion, proxied by mobile money, enhances the relationship between financial development and economic growth. These country-level analyses allow for the consideration of context-specific dynamics that may be masked in a panel framework. Financial inclusion is represented by a mobile money index (MM), constructed from a combination of mobile money indicators. Financial development is measured using both sub-indices and an overall index (FD_MM), which integrates mobile money, financial

market, and financial institution indicators. The analysis employed Granger causality tests to provide an initial assessment of the directionality of the relationship; specifically, whether past values of financial development help explain variations in economic growth, measured by growth in real GDP per capita. Furthermore, the relationship was examined within a formal growth model estimated using the Johansen and Juselius (1990) Vector Error Correction Model (VECM), which accounts for both short-run dynamics and long-run equilibrium relationships between the variables.

4.4.1. Unit root and structural break tests

To determine the order of integration of the variables, unit root tests were conducted using the Augmented Dickey-Fuller (ADF) test, the Phillips–Perron (PP) test, and the Zivot-Andrews test, which accounts for potential structural breaks. The Zivot-Andrews test identified structural breaks in several key variables: bank credit to the private sector (2013), the financial market index (1992), and the financial institutions index (2010). Accordingly, dummy variables representing these structural break years were included in the analysis to control for their potential effects. Additional dummy variables were incorporated to account for other significant structural events, including the liberalization of interest rates in Kenya in 1991, the global financial crisis of 2008/09, and the COVID-19 pandemic. The results of the unit root tests, presented in Appendix Tables A4 and A5, indicate that all variables are integrated of order one, i.e., $I(1)$.

The results of the Augmented Dickey-Fuller (ADF), Phillips–Perron (PP), and Zivot-Andrews unit root tests for Uganda are presented in Appendix Tables A8 and A9. The findings indicated that, except for bank credit to the private sector, all variables were integrated of order one, i.e., $I(1)$. The Zivot-Andrews test identified several potential structural breaks in key variables: the overall financial development index (2005), openness (2005), gross fixed capital formation (2014), and public external debt (2005). While dummy variables were initially included to account for these breaks, the estimated coefficients were not statistically significant. To avoid overfitting and the proliferation of dummy variables, these were subsequently excluded from the final model

specification. Instead, only major and well-documented structural events were accounted for in the analysis through dummy variables. These included financial liberalization in 1994, the provision of debt relief in 2000, the global financial crisis of 2008/09, the introduction of mobile money (2009 onward), and the COVID-19 pandemic. Overall, the unit root test results confirmed that, aside from bank credit to the private sector, all variables exhibit integration of order one.

The unit root tests conducted on data for both Kenya and Uganda indicated that the variables in the model were integrated of order one, $I(1)$. This suggests that the variables may be cointegrated, implying the existence of a long-run equilibrium relationship, as posited by Engle and Granger (1987). The next step in the analysis was to determine the appropriate lag structure to test for cointegration among the variables and to examine both the short-run and long-run relationships.

4.4.2. Lag selection

For the data on Kenya, the optimal number of lags was determined based on the lowest values of several information criteria, including the Likelihood Ratio (LR), Final Prediction Error (FPE), Schwarz Bayesian Criterion (SBC), and Hannan-Quinn Information Criterion (HQIC), all of which selected 1 lag as the optimal choice (see Appendix Table A6). In contrast, the Akaike Information Criterion (AIC), which also had the lowest value, indicated 4 lags as the optimal number. However, the results obtained using the 4 lags suggested by the AIC exhibited serial correlation. Consequently, the 1 lag specification, recommended by most of the information criteria, was adopted as the optimal lag length for the analysis. Additionally, it is worth noting that the SBC tends to be more accurate when the sample size is smaller than 120, as noted by Ivanov and Kilian (2005).

As shown in Appendix Tables A10, for the data on Uganda, the selection of the optimal number of lags varied across the different information criteria. The Likelihood Ratio (LR) test selected 3 lags, while the Schwarz Information Criterion (SC) suggested 1 lag. In contrast, the Akaike Information Criterion (AIC) selected 4 lags as optimal for most of the models. The Likelihood

Ratio test is typically considered the most reliable for determining the optimal number of lags, especially when other criteria yield differing results (Hatemi-J & Hacker, 2009). However, the models using 4, 3, and 2 lags exhibited serial correlation. Consequently, 1 lag, as recommended by the SC in most models, was adopted as the optimal lag length for the analysis.

4.4.3. Cointegration

The Johansen and Juselius (1990) trace and maximum eigenvalue cointegration tests, based on data for Kenya, indicated the presence of more than one cointegrating relationship among the variables in all models, except for the model based on the mobile money index (MM) (see Appendix Table A7). The results from the two cointegration tests were consistent when applied to the data for Uganda (see Appendix Tables A11). Given that the Autoregressive Distributed Lag (ARDL) model, as proposed by Pesaran and Smith (2001), assumes a single cointegrating relationship among the variables, the Johansen and Juselius (1990) approach was deemed more appropriate. Consequently, a Vector Error Correction Model (VECM), based on this approach, was estimated to analyze the long-run relationships among the variables.

4.4.4. Granger causality Results

Kenya

Before estimating the formal growth model, Granger causality analysis was conducted to assess the potential effects of mobile money and other measures of financial development on real GDP per capita in Kenya. The results of the Granger causality tests are presented in Table 4.4.4.1. The analysis revealed that real GDP Granger-caused bank credit to the private sector (PSC) (statistic = 5.581, p-value = 0.018), while the mobile money index (MM) Granger-caused real GDP per capita (statistic = 6.841, p-value = 0.009). Furthermore, bi-directional causality was found between real GDP per capita and financial development, as measured by the financial institutions' development index (FI), the overall financial development index excluding mobile money (FD), and the overall financial development index including mobile money (FD_MM). Specifically, the estimated statistics and p-values for the overall financial development index excluding mobile money (FD)

were 2.961 and p-value = 0.085 for the Granger causality from real GDP to FD, and 6.425 with p-value = 0.011 for the reverse Granger causality. For the overall financial development index including mobile money (FD_MM), the respective statistics were 7.599 (p-value = 0.006) for real GDP Granger causing FD_MM, and 2.992 (p-value = 0.084) for FD_MM Granger causing real GDP.

Table 4.4.4.1: Kenya VAR Granger Causality/Block Exogeneity Wald Tests

Null hypothesis	Chi-sq statistic (p-value)	Conclusion
FD_MM does not Granger cause LRGDPPc	7.599*** (0.006)	FD_MM→LRGDPPc
LRGDPPc does not Granger cause FD_MM	2.992* (0.084)	LRGDPPc →FD_MM
FD granger does not Granger cause LRGDPPc	2.961* (0.085)	FD→LRGDPPc
LRGDPPc does not Granger cause FD	6.425** (0.011)	LRGDPPc →FD
MM does not Granger cause LRGDPPc	6.841*** (0.009)	MM→LRGDPPc
LRGDPPc does not Granger cause MM	0.117 (0.732)	LRGDPPc ↯MM
PSC does not Granger cause LRGDPPc	0.001 (0.972)	PSC↯LRGDPPc
LRGDPPc does not Granger cause PSC	5.581** (0.018)	LRGDPPc →PSC
FI does not Granger cause LRGDPPc	15.560*** (0.000)	FI → LRGDPPc
LRGDPPc does not Granger cause FI	7.860*** (0.005)	LRGDPPc →FI
FM does not Granger cause LRGDPPc	0.112 (0.738)	FM ↯ LRGDPPc
LRGDPPc does not Granger cause FM	2.166 (0.141)	LRGDPPc ↯FM

(.) represents the p-values; *p-value<0.10, **p-value<0.05, ***p-value<0.01.

The results of the Granger causality tests align with findings from previous studies, which report varying causality results depending on the measure of financial development (Odhiambo, 2008a; Wolde-Rufael, 2009; Nyasha & Odhiambo, 2015; Maturu, 2022). Notably, similar results were obtained when using the financial institutions index and the overall financial development index, which supports the findings from the Principal Component Analysis (PCA). The PCA revealed

that the financial institutions index contributed most significantly to the variation in the overall financial development index. The observed bi-directional Granger causality between the overall financial development index and real GDP per capita is consistent with Patrick's (1966) stage of development hypothesis. This finding suggests that, over the analyzed period, Kenya transitioned from a supply-led financial development model to a demand-following model. Such a shift is typically observed as countries advance to higher stages of economic development.

Uganda

The results of the Granger causality test using data for Uganda are presented in Table 4.4.4.2. The null hypothesis of no Granger causality was rejected for all financial development variables. A bi-directional relationship was found between financial development and real GDP per capita for the mobile money financial inclusion index (MM) (statistic = 5.078, p-value = 0.024 and statistic = 8.184, p-value = 0.001) and the financial markets index (FM) (statistic = 3.354, p-value = 0.067 and statistic = 9.303, p-value = 0.002). Additionally, causality from real GDP per capita to financial development was observed for bank credit to the private sector (PSC) (statistic = 5.403, p-value = 0.020) and the financial institutions index (FI) (statistic = 11.179, p-value = 0.001). Finally, the overall financial development index, including mobile money (FD_MM), was found to Granger cause real GDP per capita (statistic = 3.877, p-value = 0.049).

Table 4.4.4.2: Uganda VAR Granger Causality/Block Exogeneity Wald Tests

Null hypothesis	Chi-sq statistic (p-value)	Conclusion
FD_MM does not Granger cause LRGDPpc	3.877** (0.049)	FD_MM→LRGDPpc
LRGDPpc does not Granger cause FD_MM	0.972 (0.324)	LRGDPpc ↯FD_MM
FD granger does not Granger cause LRGDPpc	4.661** (0.031)	FD→LRGDPpc
LRGDPpc does not Granger cause FD	22.841*** (0.000)	LRGDPpc →FD
MM does not Granger cause LRGDPpc	5.078** (0.024)	MM→LRGDPpc
LRGDPpc does not Granger cause MM	8.184*** (0.001)	LRGDPpc →MM
PSC does not Granger cause LRGDPpc	0.015 (0.901)	PSC↯LRGDPpc
LRGDPpc does not Granger cause PSC	5.403** (0.020)	LRGDPpc →PSC
FI does not Granger cause LRGDPpc	1.508 (0.219)	FI ↯ LRGDPpc
LRGDPpc does not Granger cause FI	11.179*** (0.001)	LRGDPpc →FI
FM does not Granger cause LRGDPpc	3.354* (0.067)	FM → LRGDPpc
LRGDPpc does not Granger cause FM	9.303*** (0.002)	LRGDPpc →FM

Notes: In parentheses are T-statistics which reflect the significance of each correlation value. ***T>2.576, ** T>1.96 and * T>1.282.

As observed in previous studies (Kasekende & Atingi-Ego, 2003; Bwire & Musiime, 2015; Odhiambo & Nyasha, 2022), the results of the Granger causality tests revealed variation in the direction of causality depending on the measure of financial development. The finding that the overall financial development index, including mobile money (FD_MM), Granger caused real GDP per capita supports Patrick's (1966) supply-leading hypothesis. This suggests that, during the period analyzed, the growth in real GDP per capita in Uganda was driven by the deliberate creation of financial services, notably mobile money innovations, as well as developments in financial institutions and the financial market.

4.4.5. Vector Error Correction Model Results

Kenya

The study employed Johansen and Juselius's (1990) Vector Error Correction Model (VECM) to estimate both the short- and long-run relationships between real GDP per capita, financial development, trade openness, and external debt for Kenya and Uganda. This section presents and discusses the results for Kenya. Tables 4.4.5.1a and 4.4.5.1b provide the short-run and long-run results for the individual mobile money indicators and the mobile money index, while Tables 4.4.5.2 (a and b) and 4.4.5.3 (a and b) present the short-run and long-run results for the access and depth sub-indices and the overall financial development indices, respectively. For all models, the p-values from the Portmanteau test for autocorrelations and the heteroscedasticity test indicated that the null hypothesis of serial correlation and heteroscedasticity was rejected at the 1 percent, 5 percent, and 10 percent significance levels.

Mobile Money and Economic Growth

The results from estimating the Vector Error Correction Model (VECM) revealed a long-run equilibrium relationship among the five variables in the model: real GDP per capita (RGDPPC), Gross Fixed Capital Formation (GFC), external debt (ExtDebt), trade openness (open), and mobile money. However, the long-run equilibrium relationship was found only for two mobile money indicators: the value of mobile money transactions (% of GDP) (MM1) and the number of mobile money transactions per 1,000 adults (MM2). The coefficients of the error correction term (ECT) were negative and significant, indicating a stable long-run relationship (Table 4.4.5.1a). The estimated effect of mobile money transactions (% of GDP) was positive in the long run (2.844, t-statistic 2.058), though it was not significant in the short run (Table 4.4.5.1b). Conversely, the effect of the number of mobile money transactions per 1,000 adults was negative both in the short run (-0.310, t-statistic 1.816) and in the long run (-0.679, t-statistic 3.191). Additionally, the coefficients for the number of registered mobile money agent outlets per 100,000 adults, the number of registered mobile money agent outlets per 1,000 km², and mobile cellular subscriptions (per 100 people) were positive and significant in the short run, with estimated coefficients of 0.679 (t-statistic 1.764), 1.812 (t-statistic 2.166), and 0.287 (t-statistic 1.334), respectively.

A long-run equilibrium relationship among the variables was not found when the overall mobile money index (MM) was used (Table 4.4.5.1b). Additionally, the estimated coefficient for the mobile money index was not significant in the short run. However, the dummy variable representing the period of mobile money adoption (2007 to 2022) was found to be positive and significant in the cases of the number of mobile money transactions per 1,000 adults, the number of registered mobile money agent outlets per 1,000 km², and mobile cellular subscriptions (per 100 people) (Table 4.4.5.1b)

Table 4.4.5.1a: Kenya Financial Inclusion (Mobile Money) and Economic Growth - LR(1980 - 2022)

Cointegrating Eq:	MM1	MM2	MM3	MM4	MM5	MM6	MM
RGDPPC	1.000	1.000	1.000	1.000	1.000	1.000	1.000
GFC	0.042*	-0.037***	-0.052***	-0.062***	-0.072***	-0.036***	-0.051***
	[1.311]	[8.753]	[5.908]	[6.300]	[5.438]	[6.988]	[6.521]
ExtDebt	-0.654***	-0.023	-0.061	-0.111**	-0.057	-0.013	-0.004
	[4.071]	[0.977]	[1.213]	[1.993]	[0.818]	[0.479]	[0.081]
Open	0.006	0.004***	0.006	0.006***	0.007**	0.004***	0.005
	[0.841]	[3.705]	[2.943]	[2.661]	[2.393]	[2.968]	[2.936]
Mobile money	2.844**	-0.679***	-0.656*	-2.445**	-0.515*	-0.355***	-0.245**
	[2.058]	[3.191]	[1.407]	[1.398]	[1.409]	[3.332]	[1.911]
C	6.490	-6.103	-5.079	-3.782	-4.816	-6.336	-6.374
Multiple R-Squared	0.668	0.681	0.635	0.648	0.626	0.600	0.630
Adjusted R-squared:	0.557	0.575	0.513	0.530	0.501	0.466	0.507
Akaike AIC	-5.253	-6.527	-5.159	-5.195	-5.135	-5.067	-5.146
Schwarz SC	-4.793	-6.068	-4.699	-4.735	-4.676	-4.607	-4.686
Portmanteau Tests	0.869	0.999	0.898	0.984	0.9972	0.9949	0.9922
Heteroscedasticity	0.9661	0.982	0.678	0.648	0.711	0.7012	0.919

Notes: In parentheses are T-statistics which reflect the significance of each correlation value. ***T>2.576, ** T>1.96 and * T>1.282. MM1 denotes Value of mobile money transactions (% of GDP); MM2 denotes Number of mobile money transactions per 1,000 adults; MM3 denotes Number of registered mobile money agent outlets per 100,000 adults; MM4 denotes Number of registered mobile money agent outlets per 1,000 km²; MM5 denotes Mobile cellular subscriptions (per 100 people); MM6 denotes Number of registered mobile money accounts per 1,000 adults.

Table 4.4.5.1b: Kenya Financial Inclusion (Mobile Money) and Economic Growth – SR(1980 -2022)

Error Correction:	MM1	MM2	MM3	MM4	MM5	MM6	MM
Ect	-0.035*** [2.617]	-0.100** [2.493]	0.063 [1.375]	0.054 [1.522]	0.033 [1.019]	0.062 [0.784]	0.086 [1.657]
ΔRGDPPC ₋₁	0.202* [1.527]	-0.084 [1.131]	0.294** [1.954]	0.303** [2.057]	0.219* [1.527]	0.185 [1.273]	0.220* [1.554]
ΔGFC ₋₁	0.005** [2.413]	-0.001 [1.194]	0.004** [2.032]	0.004* [1.846]	0.004* [1.862]	0.005* [1.927]	0.005** [2.368]
ΔExtDebt ₋₁	0.085** [2.392]	-0.002 [0.081]	0.090** [2.252]	0.092** [2.361]	0.097** [2.399]	0.085** [2.033]	0.104** [2.532]
ΔOpen ₋₁	-0.000 [0.336]	0.000 [0.738]	-0.000 [0.031]	0.000 [0.346]	-0.000 [0.360]	-0.000 [0.313]	-0.000 [0.492]
Δ FinDevt ₋₁	0.232 [0.892]	-0.310* [1.816]	0.679* [1.764]	1.812** [2.166]	0.287* [1.334]	0.069 [0.519]	0.171 [1.167]
C	-0.001 [0.187]	0.003* [1.400]	-0.005 [1.014]	-0.006 [1.168]	-0.006 [1.041]	-0.003 [0.596]	-0.006 [1.240]
D_mobile money	0.009 [0.984]	0.019*** [4.123]	0.010 [0.960]	0.014* [1.484]	0.015 [1.041]	0.017* [1.608]	0.013 [1.054]
GFcrisis	-0.059*** [3.466]	-0.007 [0.696]	-0.056*** [3.010]	-0.059*** [3.296]	-0.073*** [3.846]	-0.063*** [3.299]	-0.061*** [3.226]
Covid-19	-0.057*** [3.233]	-0.023** [2.511]	-0.046*** [2.684]	-0.039* [2.248]	-0.053*** [3.056]	-0.056** [2.801]	-0.048 [2.595]
Liberalization_1991	-0.037** [2.181]	-0.002 [0.208]	-0.035 [1.948]	-0.034* [1.945]	-0.035* [1.916]	-0.037* [1.954]	-0.036** [2.000]

Notes: In parentheses are T-statistics which reflect the significance of each correlation value. ***T>2.576, ** T>1.96 and * T>1.282. MM1 denotes Value of mobile money transactions (% of GDP); MM2 denotes Number of mobile money transactions per 1,000 adults; MM3 denotes Number of registered mobile money agent outlets per 100,000 adults; MM4 denotes Number of registered mobile money agent outlets per 1,000 km²; MM5 denotes Mobile cellular subscriptions (per 100 people); MM6 denotes Number of registered mobile money accounts per 1,000 adults.

The significant results obtained suggest that mobile money transactions, agent outlets, and mobile cellular subscriptions serve as crucial channels for mobile money financial inclusion in Kenya. Specifically, the positive and significant effect of mobile money transactions (% of GDP) aligns with the findings of Suri and Jack (2016), who reported that households' usage of M-PESA had a positive and significant impact on poverty reduction. Conversely, the negative effect associated with the number of mobile money transactions per 1,000 adults, along with the insignificant coefficient for the overall mobile money index, reflects concerns raised by Bateman et al. (2019), who highlighted the negative aspects of M-PESA, such as increased household indebtedness and the crowding out of viable micro-businesses, which undermine its potential for economic development. Additionally, the latest financial access survey pointed to risks associated with mobile money providers, including loss of funds and fraud (FSD, 2023). These findings are also consistent with Bharadwaj and Suri (2020), who noted that mobile money financial inclusion in

Kenya remains at a relatively low level, with considerable room for improvement, particularly in the areas of savings and credit.

Financial Access, Financial Depth and Economic Growth

As indicated by the negative and significant coefficients of the error correction term (ECT), the variables were found to exhibit a cointegrating long-run relationship when using financial market access and financial institutions' depth as measures of financial development (Table 4.4.5.2b). The results revealed that, in the long run, the effect of the access sub-index was positively significant only in the case of financial market access (FM_Access), with a coefficient of 0.073 and a t-statistic of 12.697 (Table 4.4.5.2a). Furthermore, the financial institutions' depth index (FI_Depth) was found to positively affect real GDP per capita in the long run, with a coefficient of 0.035 and a t-statistic of 4.360. However, in the short run, only mobile money access was found to significantly influence real GDP per capita. The estimated coefficient for this variable was both positive and significant, at -0.060 with a t-statistic of 2.614.

Table 4.4.5.2a: Kenya Financial Access, Financial Depth and Economic Growth - LR(1980– 2022)

Cointegrating Eq:	MM_Access	MM_Depth	FI_Access	FI_Depth	FM_Access	FM_Depth
RGDPPC	1.000	1.000	1.000	1.000	1.000	1.000
GFC	-0.058*** [5.701]	-0.061*** [5.999]	-0.000 [0.004]	-0.012** [2.516]	0.001 [0.601]	0.051*** [4.617]
ExtDebt	-0.060 [1.027]	0.072* [1.302]	0.166 [2.645]	-0.214*** [7.965]	-0.186*** [16.919]	-0.422*** [7.270]
Open	0.007*** [2.851]	0.006 [2.458]	-0.006** [2.276]	0.003*** [2.710]	-0.001* [1.520]	-0.011*** [3.822]
FinDevt	-0.043* [1.326]	-0.068* [1.946]	-0.052** [1.970]	0.035*** [4.360]	0.073*** [12.697]	0.196*** [9.241]
C	-5.073	-7.988	-10.639	-2.213	-2.985	2.094
R-squared	0.671	0.642	0.649	0.721	0.766	0.672
Adj. R-squared	0.562	0.523	0.516	0.615	0.677	0.547
Akaike AIC	-5.265	-5.180	-5.150	-5.380	-5.556	-5.216
Schwarz SC	-4.805	-4.720	-4.648	-4.878	-5.055	-4.715
Autocorrelation Test	0.998	0.992	0.956	0.959	0.852	0.976
Heteroscedasticity	0.929	0.944	0.998	0.999	0.680	0.972

Notes: In parentheses are T-statistics which reflect the significance of each correlation value. ***T>2.576, **T>1.96 and * T>1.282.

Table 4.4.5.2b: Kenya Financial Access, Financial Depth and Economic Growth – SR(1980 - 2022)

Error Correction:	MM_Access	MM_Depth	FI_Access	FI_Depth	FM_Access	FM_Depth
Ect	0.068 [1.776]	0.083 [2.088]	0.032 [1.200]	-0.196*** [2.722]	-0.304*** [3.881]	0.022 [0.778]
Δ RGDPPC ₋₁	0.330*** [2.320]	0.219* [1.568]	0.184* [1.295]	0.151 [1.183]	0.248** [2.133]	0.139 [1.007]
Δ GFC ₋₁	0.004 [1.957]	0.005** [2.498]	0.004 [1.801]	0.004** [1.995]	0.004** [2.391]	0.001 [0.593]
Δ ExtDebt ₋₁	0.101 [2.639]	0.102** [2.556]	0.069 [1.891]	0.042 [1.231]	0.019 [0.577]	0.095** [2.255]
Δ open ₋₁	0.000 [0.147]	-0.000 [0.622]	0.000 [0.429]	-0.000 [0.019]	-0.000 [0.994]	0.000 [0.526]
Δ FinDevt ₋₁	0.060*** [2.614]	0.002 [0.087]	0.011 [1.045]	-0.006 [0.850]	-0.000 [0.035]	0.003 [0.902]
C	-0.007* [1.453]	-0.005* [1.197]	0.001 [0.300]	0.003 [0.787]	0.000 [0.112]	0.002 [0.589]
D_mobile money	0.005 [0.503]	0.021 [2.065]	0.006 [0.746]	0.013** [1.984]	0.023*** [3.737]	0.009 [0.867]
GFcrisis	-0.060 [3.477]	-0.067*** [3.626]	-0.059*** [3.320]	-0.054*** [3.501]	-0.049*** [3.470]	-0.062*** [3.411]
Covid-19	-0.042 [2.507]	-0.060*** [3.246]	-0.054 [2.978]	-0.056*** [3.635]	-0.057*** [4.067]	-0.0569*** [3.336]
Liberalization_1991	-0.035 [2.052]	-0.035** [1.988]	-0.040 [2.196]	-0.020 [0.981]	-0.038** [2.567]	-0.037** [2.139]
D_break			0.035* [1.893]	0.019 [1.101]	-0.050*** [3.500]	-0.034** [2.012]

Notes: In parentheses are T-statistics which reflect the significance of each correlation value. ***T>2.576, **T>1.96 and * T>1.282.

The absence of a long-run cointegrating relationship in the case of mobile money access and depth is consistent with the findings based on the overall mobile money index, which was found to have no significant effect on real GDP per capita. However, the results indicate that mobile money access provides a short-term benefit to real GDP per capita in Kenya. These findings align with the observation that mobile money in Kenya is primarily used for facilitating payments, rather than for savings and credit (Bharadwaj & Suri, 2020). Moreover, the results suggest that the traditional financial system, financial institutions and financial markets, contributes more significantly to real GDP per capita compared to mobile money, both in terms of depth and access. This underscores the continued importance of the traditional financial system for driving economic growth in Kenya.

Financial Development and Economic Growth

A long-run cointegrating relationship was also identified among the variables in the model when using the overall financial development index excluding mobile money (FD), the overall index including mobile money (FD_MM), bank credit to the private sector (PSC), and the financial market index (FM). However, no long-run cointegrating relationship was found when the financial institutions index (FI) and Svirydzenka's (2016) financial development index (SV_FD) were employed as measures of financial development (Table 4.4.5.3b). The estimated coefficients for all measures of financial development i.e., FD, FD_MM, PSC, and FM, were positive and significant in the long run. Notably, the overall financial development index including mobile money (FD_MM) exhibited the highest estimated coefficient at 0.443, with a t-statistic of 2.873 (Table 4.4.5.3a). In contrast, in the short run, only the estimated coefficient for the financial market index (FM) was significant, at 0.04 with a t-statistic of 1.679 (Table 4.4.5.3b).

The results indicate that Gross Fixed Capital Formation (GFC) had a positive and significant effect on real GDP per capita in the long run when the overall financial development index was used, with coefficients of 0.010 (t-statistic 1.669) and 0.048 (t-statistic 3.357). However, the estimated coefficient for GFC was not significant when the financial market index (FM) was used and was negative in the case of bank credit to the private sector (PSC), with a coefficient of -0.008 (t-statistic 1.475). External debt was found to have a positive effect on real GDP per capita in the short run but a negative effect in the long run. The effect of openness was not significant in the short run but was positive in the long run. The estimated coefficient for the dummy variable representing the mobile money adoption period was positive and significant, while the coefficients for the dummy variables representing the 2008/2009 global financial crisis and the COVID-19 pandemic were negative. Additionally, the estimated coefficient for the dummy variable representing financial liberalization through fully liberalized interest rates in 1991 was negative and significant. This finding may help explain the negative coefficient associated with the structural break in 1992, which corresponds to the financial market index.

Table 4.4.5.3a: Kenya Financial Development and Economic Growth – LR (1980 – 2022)

Cointegrating Eq:	FI	FM	PSC	FD	SK_FD	FD_MM
RGDPPC	1.000	1.000	1.000	1.000	1.000	1.000
GFC	-0.023***	0.000	-0.008*	0.010*	-0.046***	0.048***
	[5.339]	[0.074]	[1.475]	[1.669]	[2.792]	[3.357]
ExtDebt	-0.120***	-0.144***	-0.1786	-0.096***	0.056	-0.084
	[5.830]	[9.595]	[7.669]	[3.201]	[0.844]	[0.979]
Open	0.005***	0.002**	0.004***	0.008***	0.024***	0.018***
	[5.396]	[2.493]	[3.325]	[5.153]	[6.196]	[5.097]
FinDevt	0.074*	0.159***	0.009***	0.176***	2.782**	0.443***
	[1.822]	[7.739]	[3.783]	[4.128]	[2.047]	[2.873]
C	-4.265	-4.067	-3.355	-5.703	-9.252	-7.296
Multiple R-Squared	0.646	0.710	0.684	0.632	0.592	0.628
Adjusted R-squared:	0.512	0.600	0.564	0.510	0.456	0.503
Akaike AIC	-5.142	-5.341	-5.255	-5.152	-5.049	-5.140
Schwarz SC	-4.641	-4.840	-4.753	-4.692	-4.589	-4.680
Portmanteau Test	0.693	0.985	0.959	0.986	0.989	0.967
Heteroscedasticity	0.996	0.800	0.970	0.697	0.983	0.606

Table 4.4.5.3b: Kenya Financial Development and Economic Growth – SR (1980 – 2022)

Error Correction:	FI	FM	PSC	FD	SK_FD	FD_MM
Ect	-0.086	-0.197**	-0.152**	-0.088*	0.005	-0.035*
	[0.942]	[2.422]	[2.278]	[1.849]	[0.213]	[1.726]
Δ RGDPPC ₋₁	0.193*	0.233*	0.165	0.227*	0.205*	0.224*
	[1.347]	[1.774]	[1.235]	[1.607]	[1.330]	[1.580]
Δ LFC ₋₁	0.003*	0.004**	0.004**	0.004**	0.003*	0.004**
	[1.499]	[2.094]	[2.304]	[2.023]	[1.676]	[2.045]
Δ ExtDebt ₋₁	0.050	0.036	0.056*	0.058*	0.068*	0.070*
	[1.206]	[0.968]	[1.580]	[1.560]	[1.730]	[1.891]
Δ open ₋₁	0.000	-0.000	-0.000	-0.000	-0.000	-0.000
	[0.647]	[0.801]	[0.155]	[0.096]	[0.163]	[0.037]
Δ FinDevt ₋₁	-0.053	0.041*	-0.001	0.052	-0.138	0.079
	[0.846]	[1.679]	[0.878]	[1.121]	[0.526]	[1.063]
C	0.002	-0.003	0.002	-0.004	-0.000	-0.005
	[0.545]	[0.795]	[0.457]	[1.030]	[0.089]	[1.059]
D ₋₁ mobile money	0.013*	0.025***	0.016**	0.024***	0.016**	0.021**
	[1.816]	[3.256]	[2.393]	[2.884]	[2.172]	[2.539]
GFcrisis	-0.055***	-0.043**	-0.059***	-0.052***	-0.062***	-0.054***
	[3.172]	[2.571]	[3.656]	[2.898]	[3.303]	[2.942]
Covid-19	-0.0488***	-0.050***	-0.057***	-0.051***	-0.053***	-0.050***
	[2.830]	[3.170]	[3.492]	[2.884]	[2.849]	[2.781]
Liberalization ₋₁₉₉₁	-0.029*	-0.033**	-0.038**	-0.034*	-0.035*	-0.036**
	[1.471]	[2.011]	[2.256]	[1.870]	[1.821]	[1.978]
D ₋₁ break	0.031*	-0.040***	-0.022*			
	[1.693]	[2.583]	[1.303]			

Notes: In parentheses are T-statistics which reflect the significance of each correlation value. ***T>2.576, ** T>1.96 and * T>1.282. FI denotes the financial institutions index; FM denotes the financial markets index; PSC denotes bank credit to the private sector; FD denotes the overall financial development index (excluding mobile money indicators); SV_FD denotes Svirydenka's (2016) Financial Development Index (FDI) and FD_MM denotes the overall financial development index (including mobile money indicators).

The finding of a positive effect from the overall financial development index excluding mobile money (FD), the overall index including mobile money (FD_MM), bank credit to the private sector (PSC), and the financial market index (FM) on real GDP per capita in the long run aligns with the theoretical proposition that financial development fosters economic growth. This result is also consistent with empirical studies. For instance, Nyasha and Odhiambo (2017), Misati et al. (2021), and Maturu (2022) found evidence of a positive relationship between bank credit and economic growth in the long run. Similarly, Aduda et al. (2013) and Nyasha and Odhiambo (2017) reported a positive relationship between market-based financial development and economic growth in Kenya.

The absence of cointegration among the variables when Svirydzenka's (2016) financial development index is used as a measure of financial development may be attributed to the fact that Svirydzenka's (2016) index has a smaller magnitude compared to the index constructed in this study, as it is based on a broader sample of both developed and developing countries. The inclusion of both developed and developing countries in the sample results in a smaller weight for the developing countries in the construction of the index, due to the low level of financial development. A notable finding is that the estimated coefficient for the overall financial development index including mobile money (0.443) is higher than that for the index excluding mobile money (0.176). This suggests that mobile money financial inclusion plays a positive role in enhancing the relationship between financial development and economic growth in Kenya. These findings point to a non-linear relationship between financial development and real GDP in Kenya, with the degree of financial inclusion influencing the strength of this relationship.

The negative estimated coefficient for Gross Fixed Capital formation (GFC) in the case of bank credit to the private sector (PSC), compared to the positive coefficient for the overall financial development index, suggests that a broader index is more representative and a better measure of financial development than narrower, sector-specific measures. However, the negative coefficient for GFC in the context of PSC may also reflect factors that constrain capital productivity in developing countries, such as institutional quality and the quality of labor or human capital per

worker (Lucas, 1990; Alfaro et al., 2008). The positive short-run effect of external debt and its negative long-run effect illustrate the non-linear relationship between debt and economic growth (Hauner, 2009; Reinhart & Rogoff, 2010). The negative estimated coefficient for the dummy variable representing financial liberalization likely reflects the adverse effects of high borrowing costs associated with liberalization in the context of high inflation (Brownbridge & Gockel, 1998). Finally, the negative coefficients for the 2008/2009 global financial crisis and COVID-19 pandemic dummy variables highlight the detrimental impacts of these global shocks on Kenya's economy.

Uganda

This section presents and discusses the short-run and long-run results for Uganda using Johansen and Juselius's (1990) Vector Error Correction Model (VECM). Tables 4.4.5.4(a) and 4.4.5.4(b) provide the VECM results for the mobile money indicators, while Tables 4.4.5.5(a), 4.4.5.5(b), 4.4.5.6(a), and 4.4.5.6(b) present the results for the various financial development indices. The p-values from the Portmanteau test for autocorrelation and the heteroscedasticity test indicated that the null hypothesis of serial correlation and heteroscedasticity was rejected at the 1 percent, 5 percent, and 10 percent significance levels for all models.

Mobile Money and Economic Growth

The results from estimating the Vector Error Correction Model (VECM) revealed a long-run cointegrating relationship among the five variables in the model: real GDP per capita, Gross Fixed Capital formation (GFC), public external debt, openness, and mobile money (proxied by the mobile money index). The coefficient of the error correction term (ECT) was negative and significant, with a value of -0.005 (t-statistic 2.133), indicating the presence of a long-run equilibrium relationship (Table 4.4.5.4b). In the long run, the coefficient for the mobile money financial inclusion index (MM) was found to be positive and significant (20.742, t-statistic 4.224). Furthermore, the dummy variable representing the period of mobile money adoption (2009 to 2022) was also positive and significant in the model based on the mobile money financial inclusion index. A long-run cointegrating relationship was also found using individual mobile money

indicators, such as the number of mobile money transactions per 1,000 adults (MM2), the number of registered mobile money agent outlets per 100,000 adults (MM3), and the number of registered mobile money agent outlets per 1,000 km² (MM4). The estimated effect in the long run was positive and significant for the number of mobile money transactions per 1,000 adults (MM2) (1.044, t-statistic 2.270) and the number of registered mobile money agent outlets per 100,000 adults (MM3) (0.004, t-statistic 3.740) (Table 4.4.5.4a). However, the coefficient for the number of registered mobile money agent outlets per 1,000 km² (MM4) was negative (-0.117, t-statistic 4.739), suggesting that an increase in agent outlets density at the regional level might have a detrimental effect on mobile money usage in the long run.

In the short run, the estimated coefficient for the mobile money financial inclusion index (MM) was found to be not significant, indicating that the overall mobile money financial inclusion index does not have an immediate impact on real GDP per capita. However, a negative estimated effect was found for the number of registered mobile money agent outlets per 1,000 km², with a coefficient of -0.024 (t-statistic 3.740), suggesting that the density of mobile money agents at the regional level has a detrimental effect on real GDP per capita in the short run. On the other hand, the value of mobile money transactions (% of GDP), the number of registered mobile money agent outlets per 100,000 adults, and the mobile money financial inclusion index were found to have a positive effect on real GDP per capita, with estimated coefficients of 0.433 (t-statistic 1.643), 0.000 (t-statistic 1.612), and the mobile money index showing positive, albeit marginal, results in the short run (Table 4.4.5.4b). These findings suggest that while the mobile money sector's presence and its ability to facilitate transactions contribute positively to economic activity, the short-term effects may be more muted and context-dependent.

Table 4.4.5.4a: Uganda Financial Inclusion (Mobile money) and Economic Growth -LR(1982–2022)

Cointegrating Eq:	MM1	MM2	MM3	MM4	MM5	MM6	MM
RGDPPC	1.000	1.000	1.000	1.000	1.000	1.000	1.000
GFC	-0.736***	0.049***	0.302***	-9.375***	0.047*	-0.046***	0.859***
	[8.215]	[2.756]	[5.817]	[6.556]	[1.943]	[7.046]	[6.352]
ExtDebt	4.927***	-0.501***	-2.228***	58.727***	-0.373**	0.257***	-6.158***
	[6.684]	[3.993]	[5.200]	[5.227]	[2.268]	[5.324]	[5.453]
Open	0.182***	-0.052***	-0.136***	3.607***	-0.070***	-0.029***	-0.293***
	[4.218]	[6.623]	[5.531]	[5.781]	[3.201]	[6.802]	[4.503]
FinDevt	-32.075***	1.044**	0.004***	-0.117***	0.025*	-0.001***	20.742***
	[6.714]	[2.270]	[3.740]	[4.739]	[1.656]	[8.367]	[4.224]
C	-103.897	5.379	40.458	-1208.158	2.869	-9.836	119.156
R-squared	0.564	0.563	0.537	0.613	0.469	0.444	0.526
Adj. R-squared	0.363	0.361	0.323	0.434	0.224	0.187	0.316
Akaike AIC	-4.368	-4.491	-4.433	5.445	-4.297	-4.251	-4.453
Schwarz SC	-3.814	-3.936	-3.879	5.999	-3.743	-3.697	-3.904
Portmanteau Test	0.997	0.950	0.998	0.999	0.927	0.944	0.996
Heteroscedasticity	0.791	0.712	0.467	0.434	0.979	0.868	0.365

Table 4.4.5.4b: Uganda Financial Inclusion (Mobile money) and Economic Growth -SR(1982–2022)

Error Correction:	MM1	MM2	MM3	MM4	MM5	MM6	MM
Ect	0.001	-0.058***	-0.014**	-0.126***	-0.014	-0.009	-0.005**
	[0.393]	[2.663]	[2.277]	[3.910]	[1.128]	[0.204]	[2.133]
Δ RGDPPC ₋₁	-0.035	0.349**	0.337**	34.614*	0.432**	0.469***	0.334**
	[0.199]	[2.226]	[2.023]	[1.487]	[2.521]	[2.601]	[1.961]
Δ GFC ₋₁	-0.003	0.002	0.003	-0.640*	0.002	0.002	0.003*
	[1.190]	[0.731]	[1.256]	[1.952]	[0.741]	[0.849]	[1.311]
Δ ExtDebt ₋₁	0.019	-0.018	-0.017	-1.671	-0.001	-0.008	-0.018
	[0.976]	[1.006]	[0.964]	[-0.664]	[0.029]	[0.382]	[0.966]
Δ Open ₋₁	-0.001	-0.002*	-0.001*	-0.001	-0.001	-0.000	-0.001
	[0.632]	[1.713]	[1.310]	[0.005]	[0.713]	[0.379]	[1.230]
Δ FinDevt ₋₁	0.433*	0.120	0.000*	-0.024***	-0.000	-0.000	0.210*
	[1.643]	[0.760]	[1.612]	[3.740]	[0.194]	[0.169]	[1.333]
C	-0.003	0.006	0.001	5.179***	0.006	0.015*	-0.003
	[0.286]	[0.801]	[0.071]	[4.009]	[0.632]	[1.418]	[0.266]
D_mobile money	0.027*	0.022*	0.030*	-9.902***	0.019	-0.005	0.034*
	[1.333]	[1.661]	[1.738]	[4.265]	[0.881]	[0.233]	[1.651]
GFcrisis	0.004	0.039*	0.045*	4.428	0.024	0.015	0.050*
	[0.127]	[1.541]	[1.638]	[1.164]	[0.832]	[0.452]	[1.700]
Covid-19	0.061*	-0.028	-0.019	-3.594	-0.026	-0.030	-0.017
	[1.923]	[0.952]	[0.763]	[1.016]	[0.980]	[1.118]	[0.675]
Liberalization_1994	-0.006	-0.012	-0.007	-3.657	-0.006	-0.006	-0.007
	[0.226]	[0.506]	[0.279]	[1.056]	[0.245]	[0.208]	[0.267]
Debt relief	0.018	-0.031	-0.034*	-4.459	-0.036*	-0.041*	-0.033*
	[0.681]	[1.252]	[1.314]	[1.252]	[1.323]	[1.497]	[1.282]

Notes: In parentheses are T-statistics which reflect the significance of each correlation value. ***T>2.576, ** T>1.96 and * T>1.282. MM1 denotes Value of mobile money transactions (% of GDP); MM2 denotes Number of mobile money transactions per 1,000 adults; MM3 denotes Number of registered mobile money agent outlets per 100,000 adults; MM4 denotes Number of registered mobile money agent outlets per 1,000 km²; MM5 denotes Mobile cellular subscriptions (per 100 people); MM6 denotes Number of registered mobile money accounts per 1,000 adults.

The significant results obtained indicate that the value of mobile money transactions (% of GDP) (MM1), the number of mobile money transactions per 1,000 adults (MM2), the number of registered mobile money agent outlets per 100,000 adults (MM3), and the number of registered mobile money agent outlets per 1,000 km² (MM4) are crucial channels for mobile money financial inclusion in Uganda. However, the effects of mobile money on real GDP per capita vary, with both positive and negative effects being observed. While macro-level empirical evidence on the broader effect of mobile money on Uganda's economy is limited, the positive and significant result obtained for the mobile money index aligns with micro-level studies. Specifically, it supports findings that mobile money adoption, particularly in terms of digital savings and access to digital credit, enhances entrepreneurship opportunities (Koomson et al., 2023). Moreover, this finding is consistent with cross-country evidence from Sub-Saharan Africa (SSA), as observed by Ugwuanyi et al. (2022), who found that digital financial inclusion, as measured by mobile money indicators, positively impacts economic growth, especially in low-income SSA countries.

On the other hand, the finding of a negative effect for some of the mobile money indicators aligns with the work of Bateman et al. (2019), who, based on evidence from M-Pesa, highlighted the potential downsides of mobile money. Specifically, they pointed to the increase in household indebtedness as one of the negative consequences, which can counterbalance its positive contribution to economic development. Moreover, the risks of over-indebtedness faced by financially excluded individuals, often due to limited financial literacy, as well as issues related to fraud and other risks associated with cash-in-transit for mobile money agents, are also highlighted in the government's report on financial inclusion (MoFPED & BoU, 2023:69). This negative relationship is further supported by studies that point to the challenges posed by underdeveloped financial systems and barriers to accessing financial services (Sulong & Bakar, 2018). These results suggest that, despite significant progress in financial inclusion through mobile money in Uganda, its full potential may still be limited. Furthermore, the findings underscore the potential risks and unintended negative side effects of mobile money in the country.

Financial Access, Financial Depth and Economic Growth

The results from the Vector Error Correction Model (VECM) estimation revealed a long-run cointegrating relationship among the variables based on the access and depth sub-indices. In the long run, the effect of the access sub-index was found to be significant only in the case of the financial institutions access index (FI_Access), with an estimated coefficient of 22.571 and a t-statistic of 6.860 (Table 4.4.5.5a). This suggests that, in the long run, access to financial institutions plays a crucial role in influencing real GDP per capita. Additionally, the results showed a positive effect from the depth sub-index for financial institutions (FI_Depth) on real GDP per capita, with a coefficient of 1.534 and a t-statistic of 5.949. This indicates that deeper financial institutions positively contribute to economic growth over time. However, the effect of the mobile money depth sub-index (MM_Depth) was negative, with a coefficient of -5.210 and a t-statistic of -6.633. This suggests that, in the long run, deeper mobile money penetration may not necessarily lead to economic growth, possibly due to factors such as the risks associated with over-indebtedness or limited financial literacy in the population. In the short run, only the financial market depth sub-index (FM_Depth) was found to have a positive and significant effect on real GDP per capita, with an estimated coefficient of 0.109 and a t-statistic of 2.413 (Table 4.4.5.5b). This indicates that, in the short run, the depth of financial markets has a positive impact on the economy, likely due to better access to financial products and services, which can foster investment and growth. These findings suggest that, while access to and depth of financial institutions and markets are important drivers of economic growth, the effects of mobile money may be more complex, with potential negative side effects that warrant further investigation.

The finding of a negative effect from the mobile money depth index (MM_Depth) on real GDP per capita is consistent with earlier results from the individual mobile money indicators, especially the number of registered mobile money agent outlets per 1,000 km², which also revealed a negative impact. This suggests that, while mobile money has significantly contributed to financial inclusion, its deeper penetration may not always lead to immediate positive outcomes for economic growth. The negative effect may stem from potential drawbacks associated with mobile money, such as the risks of over-indebtedness, fraud, and the crowding-out of traditional micro-businesses

(Bateman et al., 2019), or from the limited use of mobile money for productive activities like savings and credit (Bharadwaj & Suri, 2020). Additionally, the results from the Vector Error Correction Model (VECM) also highlight that the financial access dimension tends to have a higher positive contribution to real GDP per capita compared to the financial depth dimension. This could indicate that, in the short term, increasing access to financial services (e.g., through mobile money agent outlets, financial institutions, or financial markets) has a more direct and tangible impact on economic growth than increasing the depth of these services. Furthermore, the findings show that financial institutions (e.g., banks) contribute more to real GDP per capita than mobile money and financial markets. This is likely because traditional financial institutions play a central role in the economy by facilitating investment, savings, and credit, all of which are essential for long-term economic growth. In contrast, mobile money and financial markets may not yet have the same level of depth or reach in terms of promoting productive economic activities in Uganda.

Table 4.4.5a: Uganda Financial Inclusion (Mobile Money, Financial institutions and Financial market) and Economic Growth -LR(1982 – 2022)

Cointegrating Eq:	MM_Access	MM_Depth	FI_Access	FI_Depth	FM_Access	FM_Depth
RGDPPC	1.000	1.000	1.000	1.000	1.000	1.000
GFC	0.026**	-0.188***	0.199**	-0.133***	0.003	0.005
	[2.208]	[7.751]	[2.294]	[8.885]	[0.402]	[0.517]
ExtDebt	-0.407***	0.733***	-2.953***	-0.274***	-0.152***	-0.193***
	[3.749]	[4.022]	[5.120]	[3.469]	[3.855]	[4.105]
Open	-0.038***	0.052***	0.029	0.056***	-0.024***	-0.040***
	[5.166]	[5.008]	[0.452]	[6.944]	[4.706]	[6.242]
FinDevt	0.584	-5.210***	22.571***	1.534***	-0.046	0.236
	[1.272]	[6.633]	[6.860]	[5.949]	[1.138]	[1.029]
C	3.294	-20.002	45.936	-0.507	-2.199	-0.890
R-squared	0.618	0.863	0.470	0.479	0.500	0.588
Adj. R-squared	0.411	0.800	0.225	0.239	0.269	0.397
Akaike AIC	-3.531	-4.677	-4.298	-4.316	-4.357	-4.550
Schwarz SC	-2.928	-4.122	-3.744	-3.761	-3.802	-3.995
Portmanteau Tests	0.312	1.000	0.940	1.000	0.996	0.972
Heteroscedasticity	0.650	0.7107	0.874	0.929	0.914	0.953

Notes: In parentheses are T-statistics which reflect the significance of each correlation value. ***T>2.576, **T>1.96 and * T>1.282.

Table 4.4.5b: Uganda Financial Inclusion -Short run (1982 – 2022)

Error Correction:	MM_Access	MM_Depth	FI_Access	FI_Depth	FM_Access	FM_Depth
Ect	-0.067*** [2.718]	-0.032*** [2.691]	-0.001 [0.498]	-0.027* [1.323]	-0.073* [1.716]	-0.081*** [2.713]
Δ RGDPPC ₋₁	0.350** [2.232]	0.058 [0.406]	0.399** [2.250]	0.420** [2.509]	0.425** [2.556]	0.570*** [3.606]
Δ GFC ₋₁	0.001 [0.475]	-0.006*** [3.012]	0.002 [0.773]	0.000 [0.122]	0.001 [0.459]	-0.002 [0.624]
Δ Debt ₋₁	-0.014 [0.785]	0.043*** [2.657]	-0.008 [0.391]	-0.008 [0.406]	-0.007 [0.409]	0.022 [0.973]
Δ Open ₋₁	-0.002* [1.585]	0.002* [1.731]	-0.000 [0.349]	0.001 [0.588]	-0.001 [1.049]	-0.001 [1.311]
Δ FinDevt ₋₁	0.039 [0.378]	0.006 [0.025]	0.111 [1.106]	-0.019 [0.377]	-0.005 [0.127]	0.109*** [2.413]
C	0.004 [0.569]	0.018** [1.973]	0.002 [0.109]	0.011* [1.447]	0.005 [0.646]	0.001 [0.166]
D_mobile money	0.028* [1.813]	0.011 [0.855]	0.021 [0.424]	0.008 [0.728]	0.0219* [1.351]	0.020* [1.810]
GFcrisis	0.042* [1.614]	-0.024 [1.038]	0.038 [0.842]	0.036 [1.203]	0.033 [1.219]	0.044* [1.740]
Covid-19	-0.023 [0.951]	0.021 [0.883]	-0.022 [0.797]	-0.031 [1.183]	-0.023 [0.885]	-0.021 [0.924]
Liberalization_1994	-0.014 [0.572]	-0.004 [0.182]	-0.004 [0.138]	-0.009 [0.339]	-0.008 [0.128]	-0.038* [1.439]
Debt relief	-0.030 [1.229]	0.011 [0.477]	-0.037* [1.337]	-0.038* [1.404]	-0.034 [1.277]	-0.023 [0.925]

Notes: In parentheses are T-statistics which reflect the significance of each correlation value. ***T>2.576, **T>1.96 and * T>1.282.

Financial Development and Economic Growth

A long-run cointegrating relationship was identified among the variables in the model when all financial development indicators were considered, including the financial institutions index (FI), financial markets index (FM), bank credit to the private sector (PSC), the overall financial development index excluding mobile money (FD), and the overall index including mobile money (FD_MM). The estimated long-run coefficients for FI, FM, PSC, and the overall financial development indices were all negative and statistically significant: -0.030 (t-statistic = 7.542), -0.441 (t-statistic = 2.749), and -0.236 (t-statistic = 1.833), respectively (Table 4.4.5.6a). These findings suggest that while a long-run equilibrium relationship exists, the current structure or utilization of financial development in Uganda may not be translating into sustained economic growth. Notably, a positive and statistically significant short-run effect was observed for the financial markets index, with an estimated coefficient of 0.109 (t-statistic = 2.332) (Table

4.4.5.6b), indicating that capital market activity may have immediate, albeit transitory, positive effects on real GDP per capita.

To assess the robustness of the constructed financial development index (FD), Svirydzenka's (2016) Financial Development Index (SK_FD) was employed as a benchmark. The long-run estimated coefficients for both the constructed index including mobile money (FD_MM) and SK_FD were negative and statistically significant, at -0.607 (t-statistic = 4.604) and -6.932 (t-statistic = 10.023), respectively. These findings suggest that, in the context of Uganda, the current configuration of financial development, despite increased financial inclusion, may not be sufficiently structured to support long-term economic growth. In the short run, both FD_MM and FD exhibited positive and statistically significant effects on real GDP per capita. Notably, the coefficient for FD_MM (0.155, t-statistic = 1.981) was slightly higher than that of FD (0.152, t-statistic = 2.685), indicating that the inclusion of mobile money modestly enhances the short-run growth effects of financial development. Furthermore, the dummy variables for financial liberalization and debt relief were associated with negative and statistically significant coefficients, potentially reflecting the adverse effects of premature or poorly sequenced reforms. The dummy variable for the COVID-19 pandemic, although negative, was statistically insignificant. Conversely, the coefficients for the 2008/2009 global financial crisis and the period of mobile money adoption were positive and significant, implying a short-run stimulative effect on economic activity.

Table 4.4.5.6a: Uganda Financial Development and Economic Growth – LR (1982 – 2022)

Cointegrating Eq:	FI	FM	PSC	FD	SK_FD	FD MM
RGDPPC	1.000	1.000	1.000	1.000	1.000	1.000
GFC	0.006	0.003	0.008	0.022**	-0.002	-0.002
	[0.712]	[0.374]	[1.161]	[2.532]	[0.346]	[0.400]
ExtDebt	-0.118***	-0.197***	-0.082**	-0.181***	-0.034*	-0.053*
	[3.296]	[5.489]	[2.254]	[6.042]	[1.684]	[1.661]
Open	-0.024***	-0.024***	-0.030***	-0.022***	0.003*	-0.017***
	[6.748]	[4.855]	[7.542]	[5.903]	[1.373]	[5.854]
FinDevt	-0.441***	-0.236*	-0.025***	-0.509***	-6.932***	-0.607***
	[2.749]	[1.833]	[3.910]	[4.170]	[10.023]	[4.604]
C	-2.810	-1.181	-3.024	-1.751	-5.181	-4.260
R-squared	0.571	0.675	0.498	0.687	0.453	0.659
Adj. R-squared	0.373	0.525	0.266	0.543	0.201	0.502
Akaike AIC	-4.510	-4.788	-4.352	-4.826	-4.268	-4.741
Schwarz SC	-3.955	-4.233	-3.798	-4.272	-3.713	-4.186
Autocorrelation Test	0.863	0.990	0.972	0.935	0.994	0.820
Heteroscedasticity	0.990	0.992	0.871	0.974	0.712	0.992

Table 4.4.5.6b: Uganda Financial Development and Economic Growth – SR (1982 – 2022)

Error Correction:	FI	FM	PSC	FD	SK_FD	FD MM
Ect	-0.125***	-0.160***	-0.074*	-0.177***	0.053	-0.218***
	[2.672]	[4.176]	[1.615]	[4.194]	[0.688]	[3.763]
Δ RGDPPC ₋₁	0.431***	0.365***	0.444***	0.427***	0.377*	0.489***
	[2.896]	[2.732]	[2.691]	[3.316]	[1.790]	[3.640]
Δ GFC ₋₁	0.001	-0.001	0.002	0.000	0.002	-0.001
	[0.223]	[0.567]	[0.958]	[0.246]	[0.929]	[0.451]
Δ ExtDebt ₋₁	-0.010	0.022	-0.010	0.025*	-0.017	0.021
	[0.589]	[1.185]	[0.531]	[1.487]	[0.747]	[1.220]
Δ Open ₋₁	-0.002	-0.002**	-0.002	-0.003***	-0.000	-0.003***
	[1.806]	[2.449]	[1.252]	[2.854]	[0.410]	[2.669]
Δ FinDevt ₋₁	0.017	0.109**	0.000	0.152***	0.072	0.155*
	[0.242]	[2.332]	[0.087]	[2.685]	[0.141]	[1.981]
C	0.009	-0.001	0.008	-0.007	0.025*	0.004
	[1.346]	[0.153]	[1.002]	[1.016]	[1.349]	[0.580]
D_mobile money	0.012*	0.037***	0.013	0.043***	-0.025	0.012*
	[1.293]	[3.230]	[1.057]	[3.443]	[0.715]	[1.379]
GFCcrisis	0.026	0.053**	0.028	0.049**	0.007	0.023
	[1.079]	[2.319]	[1.057]	[2.215]	[0.228]	[1.018]
Covid-19	-0.019	0.015	-0.022	0.017	-0.031	0.010
	[0.784]	[0.632]	[0.838]	[0.744]	[1.167]	[0.433]
Liberalization_1994	-0.015	-0.063**	-0.005	-0.055**	-0.002	-0.051**
	[0.595]	[2.304]	[0.171]	[2.273]	[0.064]	[2.043]
Debt relief	-0.022	-0.015	-0.040*	-0.007	-0.037	-0.012
	[0.869]	[0.693]	[1.484]	[0.332]	[1.276]	[0.503]

Notes: In parentheses are T-statistics which reflect the significance of each correlation value. ***T>2.576, ** T>1.96 and * T>1.282.

The negative coefficient for bank credit to the private sector (PSC) aligns with the findings of Bwire and Musiime (2015), who reported a negative effect of bank credit on economic growth using Johansen and Juselius's (1990) Vector Error Correction Model (VECM). Similarly, Nakijoba and Selotlegeng (2019), employing the Fully Modified Ordinary Least Squares (FMOLS) method developed by Phillips and Hansen (1990), also identified a cointegrating relationship between bank credit to the private sector and economic growth, with a negative long-run effect. Furthermore, the finding that the estimated short-run coefficient for the overall financial development index including mobile money (FD_MM) (0.155) is slightly higher than that for the index excluding mobile money (FD) (0.152) suggests that mobile money financial inclusion enhances the relationship between financial development and real GDP per capita. This result is consistent with Nampewo et al. (2016), who found that mobile money balances held by banks contributed to an increase in bank deposits, thereby expanding the volume of credit extended to the private sector in Uganda.

The results indicate that financial liberalization in 1994 had a negative effect on real GDP per capita, which can likely be attributed to the high borrowing costs that emerged due to elevated inflation levels during the liberalization process (Brownbridge & Gockel, 1998). Furthermore, the estimated coefficient for the dummy variable representing Heavily Indebted Poor Countries (HIPC) debt relief for Uganda in 2000 suggests a negative impact on real GDP per capita. This finding aligns with the work of Romero-Barrutieta et al. (2015), who, in their analysis of the period from 1982 to 2006, concluded that Uganda's debt-to-GDP ratio was higher and its investment-to-GDP ratio lower when debt relief was available. Consequently, the country's GDP was, on average, more than 20 percent lower during periods when debt relief was expected compared to periods without such expectations. In contrast, the positive and significant coefficient for the dummy variable representing the 2008/2009 global financial crisis (GFcrisis) suggests that the global financial crisis did not significantly harm the Ugandan economy. This finding is consistent with studies indicating that the crisis had a modest impact on Uganda's financial sector and overall economy, largely due to prudent economic management and limited exposure to international financial markets (IMF, 2009; Marsha, 2009). Moreover, the positive coefficient could also reflect

the beneficial effects of concurrent events, such as the adoption of mobile money in 2009, which contributed to economic resilience during the crisis.

The control variables in the model exhibit signs consistent with theoretical expectations and empirical evidence. Public debt, in line with Hauner (2009) and Reinhart and Rogoff (2010), demonstrates both positive and negative effects on real GDP per capita, depending on the specific context and period. Similarly, the global financial crisis (GFC) is found to have a positive effect on economic growth, as suggested by De Long and Summers (1991) and Sala-i-Martin (1997). The estimated positive effect of openness on real GDP per capita aligns with the theoretical notion that increased openness facilitates financial inflows, thereby stimulating economic activity and fostering growth (Herwartz and Walle, 2014). Additionally, the finding is consistent with Bwire and Musiime (2015), who observed that exports exert a positive impact on real GDP, reinforcing the argument that openness to trade can enhance economic performance.

4.5 A comparative analysis of financial inclusion (proxied by mobile money) and the finance-growth nexus in Sub-Saharan Africa (SSA), Kenya and Uganda

The Sub-Saharan Africa (SSA) panel Granger causality analysis revealed a unidirectional causality from the financial development index to real GDP per capita in at least one country within the sample, confirming the presence of heterogeneity across the countries. Based on these findings, a focused comparative analysis was conducted between Kenya and Uganda to explore any similarities or differences in the impact of mobile money financial innovation on the finance-growth nexus. Furthermore, the short-run results for both Kenya and Uganda, derived using Johansen and Juselius's (1990) Vector Error Correction Model (VECM), are compared with the findings from the SSA panel to assess whether the country-specific dynamics align with or diverge from regional trends.

4.5.1 Financial development and economic growth in SSA, Kenya and Uganda

The summary statistics presented in Table 4.5.1.1 indicate that the average real GDP per capita for the sample of 20 Sub-Saharan African (SSA) countries from 2015 to 2022 was US\$ 3,517.9. This figure exhibited considerable variation, as reflected by the standard deviation of US\$ 3,987.6, highlighting the significant heterogeneity across the countries in the panel. Both Kenya and Uganda reported lower real GDP per capita compared to the SSA average, with Kenya's figure standing at US\$ 1,613.5, higher than Uganda's US\$ 900.4. These per capita levels align with the World Bank's country classification, where Kenya is categorized as a lower-middle-income country and Uganda as a low-income country. Despite Kenya's higher real GDP per capita, Uganda outperformed Kenya in terms of Gross Fixed Capital Formation, with Uganda's rate at 23.9 percent, surpassing both Kenya's rate of 22.5 percent and the SSA average of 19.6 percent. This suggests a higher level of investment activity in Uganda. Conversely, the levels of openness for Kenya and Uganda, at 33.6 percent and 36.9 percent, respectively, were substantially lower than the SSA average of 76.1 percent.

Uganda's financial development, as measured by both Svirydzenka's (2016) Financial Development Index and bank credit to the private sector (PSC), was lower than that of Kenya and

the SSA average. However, both Uganda and Kenya reported higher mobile money financial inclusion indices, with values of 0.6 and 0.4, respectively, compared to the SSA average of 0.3. This indicates the significant role of mobile money in the financial landscapes of both Uganda and Kenya

Table 4.5.1.1: Summary Statistics (SSA, Kenya and Uganda)

Variables	Mean	Sd	Min	Max
	SSA			
Real GDP per capita (in constant 2015 U.S. dollars)	3,517.9	3,987.6	433.8	16,747.4
Trade openness (exports+imports/GDP) (%)	76.1	43.1	27.2	235.8
Population growth (%)	2.1	1.0	-0.3	3.9
Gross Fixed Capital Formation (% of GDP)	22.5	9.2	9.7	56.5
<i>Financial Development Indicators</i>				
MM index	0.3	0.2	0.0	1.0
Private Sector Credit (PSC)/GDP (%)	22.3	21.6	0.0	100.0
Svirydzhenka's (2016) FD index	0.2	0.2	0	0.6
No. of Countries	17			
No. of Obs	136			
	Kenya			
Real GDP per capita (in constant 2015 U.S. dollars)	1,613.5	89.0	1,496.7	1754.6
Trade openness (exports+imports/GDP) (%)	33.6	3.9	27.2	40.3
Population growth (%)	2.06	0.12	1.91	2.20
Gross Fixed Capital Formation (% of GDP)	19.6	1.1	18.7	22.1
<i>Financial Development Indicators</i>				
MM index	0.4	0.1	0.3	0.5
Private Sector Credit (PSC)/GDP (%)	32.7	2.2	30.8	36.6
Svirydzhenka's (2016) FD index	0.2	0.0	0.2	0.2
	Uganda			
Real GDP per capita (in constant 2015 U.S. dollars)	900.4	26.9	864.2	934.3
Trade openness (exports+imports/GDP) (%)	36.9	3.1	31.2	41.7
Population growth (%)	3.28	0.17	3.00	3.50
Gross Fixed Capital Formation (% of GDP)	23.9	0.7	23.3	24.9
<i>Financial Development Indicators</i>				
MM index	0.6	0.3	0.3	1.0
Private Sector Credit (PSC)/GDP (%)	12.8	0.4	12.3	13.4
Svirydzhenka's (2016) FD index	0.1	0.0	0.1	0.1

Data Source: IMF database (2022) and World Bank Databank (2022).

4.5.2 Empirical findings for Sub-Saharan Africa (SSA), Kenya and Uganda

Granger causality results

The results of the Granger causality test for the Sub-Saharan Africa (SSA) panel, Kenya, and Uganda are summarized in Table 4.5.2.1. The panel Granger causality test for the 17 SSA countries revealed that real GDP per capita Granger caused mobile money (MM) in at least one country within the sample (6.841, p-value 0.009), supporting Patrick's (1966) demand-following hypothesis, which posits that mobile money development is driven by economic growth. Conversely, in Kenya, the results indicated that mobile money financial inclusion stimulates real GDP per capita growth (6.841, p-value 0.009), aligning with Patrick's (1996) supply-leading hypothesis. For Uganda, bi-directional causality between mobile money financial inclusion and real GDP per capita growth was identified (5.078, p-value 0.024 and 8.814, p-value 0.001), suggesting a feedback relationship. The Granger causality results for Kenya and Uganda contrast with those for the broader SSA panel, confirming the heterogeneity within the SSA sample. Moreover, these findings are consistent with Uganda's higher mobile money index (0.6) compared to Kenya (0.4) and the SSA average (0.3), highlighting the importance of mobile money in Uganda's economic structure.

The panel Granger causality results further revealed that the overall financial development index, including mobile money, Granger caused economic growth in at least one country in the sample (9.256, p-value 0.049). This finding aligns with Patrick's (1966) supply-leading hypothesis, which posits that, in the early stages of development, countries intentionally advance their financial systems to facilitate economic activity and growth. A similar result was obtained for Uganda, where financial development was found to Granger cause real GDP per capita (3.877, p-value 0.049). In contrast, a bi-directional relationship between financial development and real GDP per capita was observed in Kenya (7.599, p-value 0.006 and 2.992, p-value 0.084), supporting Patrick's (1966) stage-of-development hypothesis. These findings align with Kenya's higher real GDP per capita relative to Uganda, which is consistent with Patrick's hypothesis that as economies grow, they transition from supply-led to demand-led financial development.

Table 4.5.2.1 Granger causality tests

Null hypothesis	SSA	Conclusion	Kenya	Conclusion	Uganda	Conclusion
FD_MM does not Granger cause LRGDPpc	9.526** (0.049)	FD_MM→L RGDPpc	7.599*** (0.006)	FD_MM→ LRGDPpc	3.877** (0.049)	FD_MM→ LRGDPpc
LRGDPpc does not Granger cause FD_MM	6.552 (0.162)	LRGDPpc →FD_MM	2.992* (0.084)	LRGDPpc →FD_MM	0.972 (0.324)	LRGDPpc ↔FD_MM
FD Granger does not Granger cause LRGDPpc	12.540** (0.014)	FD→LRGDP pc	2.961* (0.085)	FD→ LRGDPpc	4.661** (0.031)	FD→ LRGDPpc
LRGDPpc does not Granger cause FD	10.558** (0.032)	LRGDPpc →FD	6.425** (0.011)	LRGDPpc →FD	22.841*** (0.000)	LRGDPpc →FD
MM does not Granger cause LRGDPpc	5.167 (0.251)	MM↔LRGD Ppc	6.841*** (0.009)	MM→ LRGDPpc	5.078** (0.024)	MM→ LRGDPpc
LRGDPpc does not Granger cause MM	9.476** (0.050)	LRGDPpc →MM	0.117 (0.732)	LRGDPpc ↔MM	8.184*** (0.001)	LRGDPpc →MM

(.) represents the p-values; *p-value<0.10, **p-value<0.05, ***p-value<0.01.

4.5.2.2 System GMM and VECM results

The results obtained from a formal growth model, estimated using the system Generalized Method of Moments (GMM) estimator and data spanning the period from 2015 to 2022 for a panel of 17 Sub-Saharan African countries, revealed that the mobile money index and the overall financial development index (including mobile money) were not statistically significant (Table 4.5.2.2). However, individual financial inclusion indicators, such as the number of ATMs per 1,000 km², the number of credit union and credit cooperative branches per 1,000 km², and the number of credit union and credit cooperative branches per 100,000 adults, were found to have positive and significant effects on economic growth. These findings align with previous empirical studies which suggest that traditional financial inclusion indicators (e.g., commercial banks) have a positive and significant effect on economic growth, often exerting a larger impact than digital financial inclusion (proxied by mobile money) (Ikhide, 2015; Sarpong and Nketiah-Amponsah, 2022; Ugwuanyi et al., 2022).

Furthermore, the estimated coefficients for the number of loan accounts with microfinance institutions per 1,000 adults and the number of loan accounts with credit unions and credit cooperatives per 1,000 adults were not statistically significant. This suggests that financial inclusion, as represented by both mobile money and traditional financial indicators, remains at

relatively low levels across the panel. This finding is consistent with Haini (2021), who posited that the impact of financial development on economic growth is negative at low levels of financial access but becomes positive as financial access increases. The negative coefficients observed in the case of microfinance and credit unions may also indicate potential risks and negative effects, such as the inclusion of unsophisticated borrowers with limited financial literacy, as discussed by Carré and L'oeillet (2018).

Table 4.5.2.2. SSA System-GMM - Financial Inclusion and Economic Growth (2015-2022)

Variable	Dependent variable: Real GDP per capita (RGDPpc)				
	MM	FI	FM	PSC	FD_MM
RGDPpc ₋₁	0.948*** (0.000)	0.977*** (0.000)	0.934*** (0.000)	0.982*** (0.000)	0.920*** (0.000)
FD	0.119 (0.538)	0.183 (0.819)	-0.206 (0.512)	-0.006*** (0.007)	-0.867 (0.143)
FD ₋₁	-0.156 (0.269)	-0.239 (0.781)	0.621 (0.125)	0.004 (0.392)	0.732 (0.228)
POP	-0.023 (0.825)	-0.053 (0.270)	-0.177 (0.250)	0.183 (0.348)	0.019 (0.904)
POP ₋₁	-0.099 (0.519)	0.033 (0.372)	0.244 (0.144)	-0.301 (0.235)	-0.095 (0.342)
Open	0.001 (0.416)	0.001 (0.604)	-0.002 (0.400)	0.002 (0.466)	0.002 (0.532)
Open ₋₁	-0.003 (0.109)	-0.002* (0.069)	-0.000 (0.881)	-0.002 (0.197)	-0.005*** (0.006)
GFC	0.008** (0.015)	0.011 (0.124)	-0.005 (0.651)	0.013* (0.057)	0.009 (0.263)
GFC ₋₁	-0.005 (0.301)	-0.005 (0.108)	0.024* (0.098)	-0.018 (0.355)	-0.003 (0.717)
C	0.714 (0.492)	0.221 (0.272)	-0.081 (0.881)	0.592 (0.174)	0.966 (0.148)
Covid-19	-0.055* (0.010)	-0.065*** (0.000)	-0.089*** (0.004)	-0.057*** (0.004)	-0.063*** (0.001)
No of obs	119	119	119	119	119
Countries	17	17	17	17	17
Instruments	17	17	17	17	17
AR (2)	0.529	0.818	0.170	0.332	0.187
Sargan statistic	0.160	0.117	0.922	0.606	0.672
Hansen statistic	0.572	0.547	0.838	0.286	0.770

Notes: In parentheses are p-values which reflect the significance of each correlation value. ***p<0.01, ** p<0.05 and *P<0.10. MM denotes the overall mobile money financial inclusion index; FI denotes Financial Institutions index; FM denotes Financial Markets Index; PSC denotes Bank credit to the private sector; FD denotes the overall Financial Development index (excluding mobile money indicators); and FD_MM denotes the overall Financial Development Index including mobile money indicators.

The results from a formal growth model estimated using the Vector Error Correction Model (VECM) are presented in Tables 4.5.2.2(a and b) and 4.5.2.3(a and b). These results reveal a cointegrating long-run relationship among the variables for both Kenya and Uganda, except for the mobile money index (MM) in the case of Kenya. The estimated coefficients for the error correction term (ECT) are negative and significant, indicating a stable long-run relationship, although the effect of the mobile money index on real GDP per capita in Kenya is not significant. In Uganda, however, the effect of the mobile money index on real GDP per capita is positive and significant (20.742, t-statistic 4.224), highlighting a robust long-run relationship. In contrast, the results for Kenya suggest the absence of a long-run relationship between mobile money and real GDP per capita (Table 4.5.2.2a). In the short run, the mobile money index was not significant for Kenya, while it had a negative and significant effect for Uganda. The short-run results for Kenya align with those for the SSA panel, which show that the mobile money index does not significantly affect real GDP per capita. These findings suggest that mobile money financial inclusion in Kenya, as well as in the wider SSA region, remains limited. This observation is consistent with Haini (2021), who argued that financial development may have a negative effect on economic growth at low levels of financial inclusion. Furthermore, the negative effects of mobile money, as highlighted by Bateman et al. (2019) in the context of M-Pesa in Kenya, may be reflected in the short-run dynamics for Kenya, underscoring potential risks such as over-indebtedness and financial exclusion.

However, for Kenya, the effect of the overall financial development index excluding mobile money (FD) and that including mobile money (FD_MM) on real GDP per capita was found to be positive and significant in the long run while in the case of Uganda, the effect was negative in the long run but positive in the short run. The short run findings for Kenya and Uganda contrast with the lack of significant results for the overall financial development index for SSA. However, the findings are consistent with Kenya's higher financial development relative to Uganda. In addition, the higher estimated coefficient for the financial development index including mobile money (FD_MM) compared to the financial development index excluding mobile money (FD) for both Kenya and Uganda points to a non-linear relationship between financial development and real

GDP per capita whereby the effect of financial development depends on the level of financial inclusion (Barajas et al., 2013; Ikhide, 2015; Haini, 2021).

Table 4.5.2.2a: Financial Development and Economic Growth in Kenya and Uganda – Long run results

Cointegrating Eq:	Kenya (1980-2022)				Uganda (1982-2022)			
	MM	PSC	FD	FD_MM	MM	PSC	FD	FD_MM
LRGDPPC	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
LGFC	-0.051*** [6.521]	-0.008* [1.475]	0.010* [1.669]	0.048*** [3.357]	0.859*** [6.352]	0.008 [1.161]	0.022** [2.532]	-0.002 [0.400]
ExtDebt	-0.004 [0.081]	-0.1786 [7.669]	-0.096*** [3.201]	-0.084 [0.979]	-6.158*** [5.453]	-0.082** [2.254]	-0.181*** [6.043]	-0.053* [1.661]
Open	0.005 [2.936]	0.004*** [3.325]	0.008*** [5.153]	0.018*** [5.097]	-0.293*** [4.503]	-0.030 [-7.542]	-0.022*** [5.903]	-0.017 [-5.854]
FinDevt	-0.245** [1.911]	0.009*** [3.783]	0.176 [4.128]	0.443*** [2.873]	20.742*** [4.224]	-0.025*** [-3.910]	-0.509*** [4.170]	-0.607*** [4.604]
C	-6.374	-3.355	-5.703	-7.296	119.156	-3.024	-1.751	-4.260
Multiple R-Squared	0.630	0.684	0.632	0.628	0.526	0.498	0.687	0.659
Adjusted R-squared:	0.507	0.564	0.510	0.503	0.316	0.266	0.543	0.502
Akaike AIC	-5.146	-5.255	-5.152	-5.140	-4.453	-4.352	-4.826	-4.741
Schwarz SC	-4.686	-4.753	-4.692	-4.680	-3.904	-3.798	-4.272	-4.186
Portmanteau Tests for Autocorrelations	0.9922	0.959	0.986	0.967	0.996	0.972	0.935	0.820
Heteroscedasticity	0.919	0.970	0.697	0.606	0.365	0.871	0.974	0.992

Notes: In parentheses are T-statistics which reflect the significance of each correlation value. ***T>2.576, ** T>1.96 and * T>1.282. FI denotes the financial institutions index; FM denotes the financial markets index; PSC denotes bank credit to the private sector; FD denotes the overall financial development index (excluding mobile money indicators); SV_FD denotes Svirydenka's (2016) Financial Development Index (FDI) and FD_MM denotes the overall financial development index (including mobile money indicators).

Table 4.5.2.2.b: Kenya and Uganda Financial Development and Economic Growth – Short run dynamics

Error Correction:	Kenya (1980-2022)				Uganda (1980-2022)			
	MM	PSC	FD	FD_MM	MM	PSC	FD	FD_MM
Ect	0.086 [1.657]	-0.152** [2.278]	-0.088* [1.849]	-0.035* [1.726]	-0.005** [2.133]	-0.074* [1.615]	-0.177*** [4.194]	-0.218*** [3.763]
Δ RGDPPC ₋₁	0.220* [1.554]	0.165 [1.235]	0.227* [1.607]	0.224* [1.580]	0.334* [1.961]	0.444*** [2.691]	0.427*** [3.316]	0.489*** [3.640]
Δ GFC ₋₁	0.005** [2.368]	0.004** [2.304]	0.004** [2.023]	0.004** [2.045]	0.003* [1.311]	0.002 [0.958]	0.000 [0.246]	-0.001 [0.451]
Δ ExtDebt ₋₁	0.104** [2.532]	0.056* [1.580]	0.058* [1.560]	0.070* [1.891]	-0.018 [0.966]	-0.010 [0.531]	0.025* [1.487]	0.0211 [1.220]
Δ Open ₋₁	-0.000 [0.492]	-0.000 [0.155]	-0.000 [0.096]	-0.000 [0.037]	-0.001 [1.230]	-0.002 [1.252]	-0.003 [2.854]	-0.003*** [2.669]
Δ FinDevt ₋₁	0.171 [1.167]	-0.001 [0.878]	0.052 [1.121]	0.079 [1.063]	0.210* [1.333]	0.000 [0.087]	0.152*** [2.685]	0.155** [1.981]
C	-0.006 [1.240]	0.002 [0.457]	-0.004 [1.030]	-0.005 [1.059]	-0.003 [0.266]	0.008 [1.002]	-0.007 [1.016]	0.004 [0.580]
Mobile money	0.013 [1.054]	0.016** [2.393]	0.024*** [2.884]	0.021** [2.539]	0.034* [1.651]	0.013 [1.057]	0.043*** [3.443]	0.012* [1.379]

Notes: In parentheses are T-statistics which reflect the significance of each correlation value. ***T>2.576, **T>1.96 and * T>1.282.

All financial dimensions, access, depth, and efficiency. were found to have a long-run cointegrating relationship with real GDP per capita, gross fixed capital formation, external debt, and openness in the case of Kenya. Conversely, in Uganda, only the financial access and efficiency dimensions were found to have a long-run cointegrating relationship with real GDP per capita and the other variables in the model. The results based on the access and depth sub-indices for Kenya revealed a positive and significant effect of both the depth (Depth) and efficiency (Efficiency) sub-indices on real GDP per capita in the long run, with coefficients of 0.108 (t-statistic = 2.111) and 0.023 (t-statistic = 3.315), respectively (Table 4.5.2.3a). Notably, the estimated coefficient for the depth sub-index (0.108) was higher than that for the efficiency sub-index (0.023), suggesting that the depth of financial development has a more substantial long-run impact on real GDP per capita compared to efficiency. In the short run, only the financial access dimension was found to have a significant effect on real GDP per capita, with an estimated coefficient of 0.032 (t-statistic = 1.369). These results underscore the differing dynamics between the short-run and long-run effects of financial development dimensions on economic growth in both countries.

In contrast, the results for Uganda revealed that the financial access sub-index had a positive and significant long-run effect on real GDP per capita, with an estimated coefficient of 19.699 (t-statistic = 5.769), while the efficiency index had a negative and significant effect, with a coefficient of -0.320 (t-statistic = 4.420). These findings suggest that, of the three financial development dimensions, financial access contributed more significantly to economic growth in Uganda, whereas financial depth had a greater contribution in the case of Kenya. The estimated long-run coefficients for financial depth and efficiency were higher for Kenya than for Uganda, which aligns with the higher level of financial development in Kenya relative to Uganda. Notably, while the estimated coefficient for the financial access dimension is positive and significant for Uganda, it was not significant for Kenya. This result is consistent with the Principal Component Analysis, which indicated that Uganda had a higher level of access to financial institutions and mobile money compared to Kenya, further supporting the notion that financial access plays a more prominent role in Uganda's economic growth.

Table 4.5.2.3a: Kenya and Uganda Financial Development (Dimensions) and Economic Growth – Long run results

Cointegrating Eq:	Kenya (1980-2022)			Uganda (1982-2022)		
	Access	Depth	Efficiency	Access	Depth	Efficiency
RGDPPC	1.000	1.000	1.000	1.000	1.000	1.000
GFC	0.005	0.042***	-0.007*	0.210**	0.035	0.011*
	[0.219]	[2.766]	[1.528]	[2.264]	[0.840]	[1.562]
ExtDebt	-0.013	-0.173	-0.117***	-4.730***	2.204***	-0.209***
	[0.077]	[1.277]	[6.624]	[5.918]	[6.531]	[8.282]
Open	0.039***	0.012***	0.004***	-0.218***	-0.029	-0.018***
	[7.105]	[2.955]	[3.974]	[3.804]	[1.128]	[6.038]
FinDevt	0.052	0.108**	0.023***	19.699***	-9.082***	-0.320***
	[0.547]	[2.111]	[3.315]	[5.769]	[7.357]	[4.420]
C	-8.996	-4.622	-4.564	94.114	-50.544	-1.222
R-squared	0.621	0.636	0.629	0.585	0.428	0.691
Adj. R-squared	0.494	0.515	0.506	0.393	0.163	0.548
Akaike AIC	-5.122	-5.164	-5.144	-4.542	5.836	-4.837
Schwarz SC	-4.662	-4.704	-4.684	-3.988	6.391	-4.283
Portmanteau Test	0.942	0.942	0.998	0.952	0.980	0.808
Heteroscedasticity	0.922	0.692	0.928	0.860	0.833	0.968

Notes: In parentheses are T-statistics which reflect the significance of each correlation value. ***T>2.576, **T>1.96 and * T>1.282.

Table 4.5.2.3b: Kenya and Uganda Financial Development (Dimensions) and Economic Growth – Short run dynamics

Error Correction:	Kenya (1982-2022)			Uganda (1982-2022)		
	Access	Depth	Efficiency	Access	Depth	Efficiency
Ect	-0.015*	-0.047*	-0.156*	-0.007***	-0.146	-0.209***
	[1.289]	[1.917]	[1.811]	[2.749]	[0.119]	[4.421]
Δ RGDP _{PC,t-1}	0.208*	0.236*	0.234*	0.285*	19.936	0.399***
	[1.456]	[1.674]	[1.593]	[1.808]	[0.667]	[3.131]
Δ GFC _{t-1}	0.004*	0.004	0.003*	0.000	-0.520	0.000
	[1.917]	[2.135]	[1.764]	[0.173]	[1.279]	[0.256]
Δ ExtDebt _{t-1}	0.058*	0.060*	0.052*	-0.015	-1.762	0.007
	[1.530]	[1.657]	[1.291]	[0.858]	[0.422]	[0.445]
Δ Open _{t-1}	-0.000	0.000	0.000	-0.001*	-0.282*	-0.003***
	[0.280]	[0.088]	[0.249]	[1.410]	[1.564]	[2.904]
Δ FinDev _{t-1}	0.032*	0.011	0.001	0.277*	18.219*	0.0595*
	[1.36903]	[1.144]	[0.121]	[1.828]	[1.553]	[1.616]
C	-0.000	-0.004	-0.001	-0.007	1.162	-0.013*
	[0.00103]	[0.996]	[0.315]	[-0.692]	[0.882]	[-1.593]
D_mobile money	0.007337	0.023***	0.020***	0.044**	-3.715*	0.062***
	[0.83305]	[2.800]	[2.711]	[2.019]	[1.339]	[3.943]

Notes: In parentheses are T-statistics which reflect the significance of each correlation value. ***T>2.576, **T>1.96 and * T>1.282.

4.5.2.3 Discussion on Negative Findings

In this study, mobile money is integrated into the measurement of financial development to better capture its growing importance, particularly in developing economies such as Kenya and Uganda, where it has become a key driver of financial inclusion. One of the study's central findings is that mobile money exerts a negative effect on economic growth. When interpreted as a proxy for financial inclusion, this result suggests that despite widespread mobile money usage, meaningful financial inclusion remains limited. This implies that large segments of the population continue to be excluded from the broader financial system, thereby constraining the ability of finance to support sustained economic growth. This aligns with Haini (2021) who found that financial development had a negative effect on economic growth at low levels of financial inclusion.

The negative impact may also reflect deeper structural weaknesses that mirror the traditional causes of bank failures. These include inefficiencies in financial intermediation, inadequate risk

management, poor regulation, and limited capacity to perform the core functions of finance. If mobile money systems fail to adequately pool and channel resources toward productive investment, or if they undermine trust in the financial system due to systemic risks or fraud, then they may fail to fulfill their developmental role. Thus, insofar as mobile money contributes to financial intermediation and economic growth, the observed counterintuitive negative relationship may be attributed to potential causes such as regulatory inefficiencies, security concerns, limited financial literacy, and both potential and actual instances of fraud, all of which can result in resource misallocation.

Regulatory inefficiencies

The regulatory landscape for mobile money in Sub-Saharan Africa is still evolving and often characterized by institutional fragmentation and jurisdictional overlap. In many countries, mobile money services fall under the purview of both financial and telecommunications regulators, which can lead to inconsistent oversight and delayed policy coordination (Aron, 2018). Weak regulatory frameworks may also inhibit the development of interoperability standards, limit innovation, and increase the risk of systemic failures. When regulatory regimes fail to adequately supervise mobile money operators, particularly in rapidly growing markets such as Kenya and Uganda, trust in the digital financial ecosystem may erode, deterring investment and reducing usage beyond simple transfers.

Security concerns and fraud risks

Security vulnerabilities further constrain the growth enhancing potential of mobile money. Fraud, through phishing, SIM swap scams, identity theft, or unauthorized transactions, is a common and growing concern. Gilman and Joyce (2012) highlight how financial losses from fraud not only harm individuals but also diminish trust in mobile money platforms. When users perceive mobile money as insecure or unreliable, their engagement is likely to decline, limiting the breadth and depth of financial inclusion. Moreover, the absence of strong consumer protection mechanisms and limited capacity for recourse in the event of loss exacerbates the problem, particularly among marginalized or rural populations.

Financial literacy barriers

Mobile money systems have enabled millions to access basic financial services. However, low levels of financial and digital literacy remain a critical barrier to deeper engagement. Many users can send or receive money but are unaware of, or unable to use, more advanced services such as savings, microloans, or insurance. As a result, mobile money may facilitate transactions but fail to support capital formation, investment, or risk mitigation, which are essential to long-term economic growth (Demirgüç-Kunt et al., 2018). This phenomenon illustrates a form of shallow financial inclusion, wherein individuals have access to mobile money services but do not engage with them to their full potential (Kalba, 2016.).

The presence of these barriers suggests that mobile money's potential as a driver of growth hinges not merely on access, but also on depth, quality, and integration within the broader financial system. Addressing these constraints requires a multifaceted policy approach, which includes: strengthening regulatory coordination between central banks and telecommunications authorities to enhance consumer protection and market stability; investing in cybersecurity infrastructure and enforcing industry-wide standards for fraud prevention and redress; implementing national financial education strategies to improve digital literacy, with targeted programs for women, youth, and rural populations; promoting interoperability and linkages between mobile money platforms and traditional financial institutions to deepen the financial ecosystem. By addressing these challenges, Kenya and Uganda can further develop mobile money to support financial intermediation, risk-sharing, and capital allocation, functions essential for inclusive economic development.

4.5.3 Conclusion

The empirical evidence from the panel of 17 Sub-Saharan African (SSA) countries for the period 2015 to 2022 revealed that, based on the mobile money and overall financial development indices, financial development did not have a statistically significant effect on real GDP per capita across

the sample. However, the Granger causality analysis indicated heterogeneity within the sample. Specifically, the panel Granger causality results demonstrated that financial development Granger caused real GDP per capita in at least one of the countries. A similar outcome was observed for Uganda, while bi-directional causality was found for Kenya. These findings further support the existence of heterogeneity within the SSA sample, as indicated by the formal growth model results. While the system Generalized Method of Moments (GMM) estimator results for the panel analysis suggested that mobile money had no significant effect on real GDP per capita, the findings from country-specific case studies using the Vector Error Correction Model (VECM) indicated a significant relationship. In Uganda, the mobile money index exhibited a negative and statistically significant effect on real GDP per capita in the short run, while no significant effect was observed for Kenya. In the long run, however, while the effect of the mobile money index on real GDP per capita remained insignificant for Kenya, it was found to be positive and significant for Uganda.

The results also indicated that the estimated coefficient for the overall financial development index, which includes mobile money, was higher than that for the overall financial development index excluding mobile money. This finding aligns with the results derived from the panel of 17 Sub-Saharan African (SSA) countries and corroborates previous empirical evidence (Ugwuanyi et al., 2022), which suggested that the impact of financial institutions development on real GDP per capita exceeds that of mobile money financial innovation. Additionally, this result supports the notion of a non-linear relationship between financial development and real GDP per capita, with the effect varying depending on the level of financial access (Barajas et al., 2013; Ikhide, 2015; Haini, 2021).

Chapter 5

Summary and Conclusion

Following the 2008/2009 global financial crisis, empirical evidence on the finance-growth nexus has suggested that the relationship between financial development and economic growth may be non-linear. This observation has helped to explain the mixed outcomes, both positive and negative, that have characterized studies on this topic. One of the key factors contributing to this non-linearity is the level of financial inclusion, with the impact of financial development on economic growth being more pronounced at higher levels of inclusion. In Sub-Saharan Africa (SSA), the most significant financial development over the past two decades has been the substantial improvement in financial inclusion, with the mobile money innovation serving as a principal driver of this progress, especially since its successful adoption in Kenya in 2007. Previously excluded individuals have been integrated into the financial system, enabling them to both contribute and benefit from the pooling, mobilization, and allocation of financial resources.

Recent empirical research on the finance-growth nexus in SSA has concentrated on the role of mobile money, but has often focused predominantly on financial institutions, neglecting the financial market segment. This limited scope overlooks the complementary nature of these two segments within the financial sector, as articulated in finance-growth theory. Given the critical importance of financial development and economic growth in SSA, a region with a high concentration of low-income countries, this study aimed to fill this gap in the literature by considering a broader coverage of financial development. Specifically, the study constructed a comprehensive measure of financial development, incorporating mobile money indicators, financial institutions, and financial markets, to better capture the full scope of financial development and examine its relationship with economic growth in SSA. Furthermore, acknowledging that cross-country analyses often obscure significant country-specific factors, this study not only conducts a cross-country analysis but also incorporates two case studies, Kenya and Uganda, both of which are leading adopters of mobile money in SSA.

The study examined the role of financial inclusion, as proxied by mobile money, in the finance-growth nexus, utilizing a sample of 17 Sub-Saharan African (SSA) countries over the period from 2015 to 2022, in addition to country-specific case studies of Kenya (1980 to 2022) and Uganda (1982 to 2022). The empirical analysis employed Granger causality tests and a formal endogenous growth model. The findings suggest a nuanced, heterogeneous relationship between financial development and economic growth, shaped by the unique context of each country. For the SSA region, mobile money's impact on real GDP per capita was found to be negligible, highlighting the importance of traditional financial institutions in driving economic growth. However, mobile money played a more significant role in Uganda, with positive effects on economic growth, suggesting that the extent of financial inclusion and the integration of mobile money into the financial system can vary across countries. The results from the panel Granger causality tests for SSA and Uganda provide support for Patrick's (1966) supply-leading hypothesis, which posits that economic growth results from the intentional development of financial services. This finding suggests that policymakers in Uganda should prioritize the advancement of the financial sector, particularly across the dimensions of access, depth, and efficiency, as well as within both financial institutions and financial markets, to foster economic growth. Conversely, the results for Kenya lend support to Patrick's (1966) demand-following hypothesis, which asserts that financial development is driven by economic growth. Consequently, policymakers in Kenya should concentrate on strategies that promote economic growth, which, in turn, is likely to generate increased demand for financial services, thus driving further financial development.

For the empirical analysis of Sub-Saharan Africa (SSA), the System Generalized Method of Moments (GMM) estimator was employed, while the Johansen (1988) and Johansen and Juselius (1990) approach to cointegration, along with the estimation of the Vector Error Correction Model (VECM), were utilized for the case studies of Kenya and Uganda. These methodologies address the potential endogeneity in the finance-growth relationship, enabling a more accurate analysis of both the short-run and long-run dynamics between financial development and economic growth. Seven distinct measures of financial development were employed in the study: (i) mobile money financial inclusion indicators and an index representing these mobile money inclusion indicators;

(ii) bank credit to the private sector (PSC); (iii) an overall index encompassing financial institution indicators; (iv) an overall index representing stock market indicators; (v) an overall index combining both financial institutions and stock market indicators; (vi) an overall index integrating bank, market, and mobile money indicators; and (vii) Svirydzenka's (2016) financial development index. The overall financial development indices reflect the dimensions of access, depth, and efficiency across the financial institutions, financial markets, and mobile money sectors. To further investigate the role of financial inclusion (proxied by mobile money), the financial development index and PSC were interacted with the mobile money index. This approach allows for a more nuanced examination of how mobile money influences the broader finance-growth nexus, thereby enhancing the understanding of the relationship between financial development and economic growth in the context of SSA, Kenya, and Uganda.

The impact of mobile money on real GDP per capita exhibited both positive and negative effects across the SSA panel, as well as in the cases of Kenya and Uganda. However, the findings suggest that mobile money has had a more pronounced positive and significant effect in Uganda compared to the broader SSA panel and Kenya. The results thus indicate that the impact of mobile money varies significantly across countries, highlighting the heterogeneity within the SSA sample regarding the role of financial inclusion (proxied by mobile money) in the finance-growth nexus. Despite this variation, there are commonalities in the findings for mobile money transactions and the number of mobile money agents, underscoring their importance as key channels of mobile money financial inclusion in SSA, as well as in Kenya and Uganda. The presence of negative estimated coefficients suggests that mobile money may also entail potential negative effects and risks. Some of these risks, as identified by Bateman et al. (2019) in the case of M-Pesa in Kenya, include the displacement of viable microfinance businesses and an increase in both formal and informal indebtedness. Additionally, empirical evidence indicates that the negative effects of financial development may sometimes reflect the entry of unsophisticated borrowers, as noted by Carre' and L'oeillet (2018). Given these findings, policymakers should consider the potential negative consequences and risks associated with mobile money when formulating financial inclusion strategies. Future research that delves deeper into the negative effects and risks linked to

mobile money could provide valuable insights for policymakers, helping to strike a balance between promoting financial inclusion and mitigating any adverse outcomes arising from mobile money-driven financial innovations.

In the study of broad measures of financial development, the SSA panel analysis did not reveal a significant effect from the financial institutions and financial market indices on real GDP per capita. However, certain indicators of financial institutions, specifically the number of ATMs per 1,000 km², the number of credit union and credit cooperative branches per 1,000 km², and the number of credit union and credit cooperative branches per 100,000 adults, were found to have positive and statistically significant effects. This suggests that ATMs and non-bank financial institutions, such as credit unions and credit cooperatives, play a critical role in enhancing financial inclusion and driving economic growth. Furthermore, the estimated coefficients for these financial institutions indicators were notably larger in magnitude when compared to the negligible coefficient associated with mobile money indicators. This aligns with the findings of Ugwuanyi et al. (2022), who concluded that traditional financial inclusion, represented by indicators such as bank branches and ATMs, has a more substantial positive impact on real GDP per capita than mobile money-based financial inclusion. The overall financial development index, which combined mobile money, financial institutions, and the financial market, was found to be statistically insignificant. This indicates that, for the SSA region, the effect of mobile money on the finance-growth nexus has been relatively negligible. Traditional financial institutions, therefore, remain a pivotal component of the financial sector in fostering economic growth.

The results from the country case studies revealed notable differences between Kenya and Uganda in terms of the financial development indices. In Kenya, only the financial market index was found to be significant in the short run, with a positive and significant effect on real GDP. In the long run, both bank credit to the private sector, the financial market, and the financial institutions indices were all positively and significantly associated with real GDP per capita. Conversely, in Uganda, both the financial market index and the overall financial development index had a positive and significant impact on real GDP per capita in the short run. However, in the long run, the estimated

coefficients for bank credit to the private sector, the financial market, and financial institutions indices were negative. These contrasting results for Kenya and Uganda, particularly concerning the financial institutions and financial markets indices, stand in stark contrast to the insignificant effects observed for the SSA panel. This further underscores the heterogeneity present within the SSA sample, highlighting the varying dynamics of financial development across countries in the region.

Regarding the financial dimensions, the results for Kenya indicated that, in the short run, only the financial access dimension had a significant effect on real GDP per capita. In contrast, in the long run, both the financial depth and financial efficiency dimensions had positive and significant coefficients, while the financial access dimension did not exhibit a significant relationship with real GDP per capita. For Uganda, the estimated coefficients for all financial dimensions were positive and significant in the short run. In the long run, however, the coefficient for financial access remained positive, while the coefficients for financial depth and financial efficiency were negative and significant. These results further suggest that, in the long run, financial institutions' depth and access to financial markets positively influence real GDP per capita in Kenya. In Uganda, financial institutions' depth positively influences real GDP per capita, but mobile money access has a negative influence on real GDP per capita. These findings underscore the importance of the traditional financial system, particularly financial institutions and financial markets, in both Kenya and Uganda. The results suggest that policies aimed at promoting economic growth in these countries should continue to prioritize the development of financial institutions and financial markets.

A key finding of this study is that, for both Kenya and Uganda, the estimated coefficient for the financial development index that includes mobile money is larger than that for the financial development index excluding mobile money. This result supports the hypothesis that financial inclusion, as proxied by mobile money, positively influences the finance-growth relationship, as proposed in finance-growth theory. The findings thus provide strong evidence in favour of policies aimed at leveraging mobile money to enhance financial inclusion in these countries. Furthermore,

the results concerning the financial dimensions suggest that, in both Kenya and Uganda, financial development policies should focus on improving all three key dimensions: access, depth, and efficiency, within the financial sector. The findings contribute to the understanding of the finance-growth nexus by highlighting the importance of a comprehensive approach to financial development, which includes both mobile money and traditional financial institutions. Policymakers in SSA should aim to foster a balanced financial system that integrates mobile money with traditional financial services. They should also address the potential risks associated with mobile money, such as over-indebtedness and the displacement of microfinance institutions, ensuring that financial inclusion efforts are sustainable and inclusive.

The findings from this study have several important policy implications, particularly for countries in Sub-Saharan Africa (SSA) that are seeking to foster economic growth through financial development and inclusion. The study underscores the importance of mobile money in enhancing financial inclusion. Given the positive role that mobile money has played, especially in Uganda, policymakers should continue to support policies that expand mobile money services, particularly in rural and underserved areas. However, as mobile money adoption is not universally effective, it is essential to consider country-specific factors when designing these policies. In some contexts, like Kenya, the focus might need to shift toward fostering demand-driven financial services, while in others, such as Uganda, supply-driven strategies may prove more effective.

While mobile money has had a significant impact on financial inclusion, traditional financial institutions like banks, credit unions, and cooperatives remain crucial drivers of economic growth, as observed from the findings of this study. Policymakers should, therefore, encourage the integration of mobile money systems with existing financial institutions. This can include facilitating collaboration between mobile money providers and traditional banks to improve the accessibility of savings and credit facilities for previously excluded populations. In the case of Kenya and Uganda, policies should aim to strengthen both the mobile money sector and traditional financial institutions, ensuring a more holistic approach to financial inclusion. Furthermore, the results suggest that financial inclusion (measured through both mobile money and traditional

financial channels) has a significant impact on economic growth, but the benefits are most pronounced when the financial system is deep, accessible, and efficient. Policymakers should therefore prioritize enhancing all three dimensions of financial development: improving access to financial services, increasing the depth of financial markets, and ensuring the efficiency of financial institutions. This could include creating an enabling regulatory environment that encourages the growth of mobile money platforms while enhancing the performance and competitiveness of banks and other financial institutions.

While mobile money has significantly contributed to financial inclusion, there are potential negative effects, such as the displacement of microfinance institutions and rising indebtedness. Policymakers must address these risks by implementing appropriate safeguards. These might include strengthening consumer protection laws, improving financial literacy programs, and regulating mobile money services to prevent over-indebtedness and ensure fair lending practices. Additionally, greater emphasis should be placed on monitoring the entry of unsophisticated borrowers, as highlighted in the literature, to prevent financial instability in mobile money services. Given the heterogeneity in the mobile money-finance-growth relationship across SSA countries, it is crucial that policies be tailored to the specific economic, social, and technological contexts of each country. While mobile money has been effective in Kenya and Uganda, other countries may face different barriers to adoption or may have more pressing needs in other areas of financial inclusion. Policymakers should thus invest in country-specific assessments to determine the most effective financial inclusion strategies based on local realities.

In the case of Uganda, the financial market dimension of financial development was found to significantly affect economic growth. Policymakers should therefore consider policies aimed at enhancing the stock market and other financial market infrastructures. This can involve improving regulations to support investment in financial markets, fostering the development of capital markets, and encouraging private sector participation in financial market activities. Given that the relationship between financial development and economic growth is complex and non-linear, continuous monitoring and evaluation of financial development policies are essential.

Policymakers should invest in data collection and analysis to better understand the dynamic relationship between mobile money, financial inclusion, and economic growth. This would enable them to adjust policies in response to evolving financial and economic conditions.

One limitation of this study is that its findings may not be broadly generalizable. As highlighted in the literature (Lashitew et al., 2019) and reflected in the contrasting results for the case studies of Kenya and Uganda, developing countries exhibit significant variations in their experiences with mobile money adoption. Differences in the factors facilitating or inhibiting the adoption of mobile money have led to divergent patterns of usage and its subsequent impact on financial inclusion across countries. Additionally, while this study acknowledges the potential risks and negative effects of mobile money, as noted in existing literature (Bateman et al., 2019; Asongu and Le Roux, 2024), it does not provide a detailed identification or quantification of these specific risks. Future research that investigates and quantifies the negative effects and risks associated with mobile money would offer valuable insights to guide policy makers in managing its adoption and mitigating its adverse impacts.

References

- Abdi, H. & Williams, L.J. 2010. Principal component analysis. *Wiley interdisciplinary reviews: computational statistics*, 2(4), pp.433-459.
- Abeka, M.J., Andoh, E., Gatsi, J.G. & Kawor, S. 2021. Financial development and economic growth nexus in SSA economies: The moderating role of telecommunication development. *Cogent Economics & Finance*, 9(1), p.1862395.
- Acaravci, S.K., Ozturk, I. & Acaravci, A. 2009. Financial development and economic growth: Literature survey and empirical evidence from Sub-Saharan African countries. *South African Journal of Economic and Management Sciences*, 12(1), pp.11-27.
- Adusei, M. 2013. Finance-growth nexus in Africa: a panel generalized method of moments (GMM) analysis. *Asian Economic and Financial Review*, 3(10), pp.1314-1324.
- Agbetsiafa, D. 2004. The finance growth nexus: evidence from Sub-Saharan Africa. *Savings and Development*, pp.271-288.
- Agbetsiafa, D. 2004. The finance growth nexus: evidence from Sub-Saharan Africa. *Savings and Development*, pp.271-288.
- Ahmad, A.H., Green, C. & Jiang, F. 2020. Mobile money, financial inclusion and development: A review with reference to African experience. *Journal of Economic Surveys*, 34(4), pp.753-792.
- Akileng, G., Lawino, G.M. & Nzibonera, E. 2018. Evaluation of determinants of financial inclusion in Uganda. *Journal of Applied Finance and Banking*, 8(4), pp.47-66.
- Alananga, S.S. & Mutasa, F. 2021. Finance-growth nexus in Eastern and Southern African countries: insights from a panel ARDL analysis. *The Pan-African Journal of Business Management*, 5(2), pp.31-61.
- Alfaro, L., Kalemli-Ozcan, S. & Volosovych, V. 2008. Why doesn't capital flow from rich to poor countries? An empirical investigation. *The review of economics and statistics*, 90(2), pp.347-368.
- Alper, E., Clements, B., Hobdari, N. & Moya Porcel, R. 2020. Do interest rate controls work? Evidence from Kenya. *Review of Development Economics*, 24(3), pp.910-926.
- Aluko, O.A. & Ibrahim, M. 2020. Institutions and the financial development–economic growth nexus in Sub-Saharan Africa. *Economic Notes*. 49(3):e12163.
- Aluko, O.A., Adeyeye, O.P. & Oladele, P.O. 2020. Finance–growth nexus in sub-Saharan Africa revisited: Evidence based on a new composite index. *Economic Change and Restructuring*, 53(2), pp.333-355.
- Anand, S. & Chhikara, K.S. 2013. A theoretical and quantitative analysis of financial inclusion and economic growth. *Management and Labour Studies*, 38(1-2), pp.103-133.
- Andrianaivo, M. & Kpodar, K. 2011. ICT, financial inclusion, and growth: Evidence from African countries.
- Arayssi, M. & Fakhri, A. 2017. The finance-growth nexus, again: New evidence from Kenya. *Economic Issues*, 22(2), pp.33-59.
- Arcand, J. L., Berkes, E. & Panizza, U. 2015. Too much finance? *Journal of economic growth*. 20(2):105-148

- Arellano, M. & Bond, S. 1991. Some tests of specification for panel data: Monte Carlo evidence and an application to employment equations. *The review of economic studies*, 58(2), pp.277-297.
- Arellano, M. & Bover, O. 1995. Another look at the instrumental variable estimation of error-components models. *Journal of econometrics*, 68(1), pp.29-51.
- Aron, J. 2018. Mobile money and the economy: A review of the evidence. *The World Bank Research Observer*, 33(2), 135–188.
- Asongu, S.A. & Le Roux, S. 2024. The role of mobile money innovations in the effect of inequality on poverty and severity of poverty in Sub-Saharan Africa. *Information Systems Frontiers*, 26(4), pp.1565-1579.
- Barajas, M.A., Chami, M.R. & Yousefi, M.R. 2013. The finance and growth nexus re-examined: Do all countries benefit equally?. *International Monetary Fund*.
- Basu, M.A., Calamitsis, M.A.A. & Ghura, M.D. 2000. Promoting growth in sub-Saharan Africa: learning what works. *International Monetary Fund*.
- Bateman, M., Duvendack, M. & Loubere, N. 2019. Is fin-tech the new panacea for poverty alleviation and local development? Contesting Suri and Jack's M-Pesa findings published in *Science*. *Review of African Political Economy*, 46(161), pp.480-495.
- Beck, R., Georgiadis, G. & Straub, R. 2014. The finance and growth nexus revisited. *Economics Letters*, 124(3), pp.382-385. Take into account structural aspects and they find non-linear relationship using a panel of 152 countries.
- Beck, T. 2002. Financial development and international trade: Is there a link?. *Journal of international Economics*, 57(1), pp.107-131.
- Benczúr, P., Karagiannis, S. & Kvedaras, V. 2019. Finance and economic growth: Financing structure and non-linear impact. *Journal of Macroeconomics*, 62, p.103048.
- Bharadwaj, P. & Suri, T. 2020. Improving financial inclusion through digital savings and credit. In *AEA Papers and Proceedings* (Vol. 110, pp. 584-588). 2014 Broadway, Suite 305, Nashville, TN 37203: American Economic Association.
- Blundell, R., Bond, S. & Windmeijer, F. 2001. Estimation in dynamic panel data models: improving on the performance of the standard GMM estimator. *Nonstationary panels, panel cointegration, and dynamic panels*, pp.53-91.
- Bond, S.R., Hoeffler, A. & Temple, J.R. 2001. GMM estimation of empirical growth models. Available at SSRN 290522.
- Boukraine, W. 2020. The Finance-Growth Nexus In High And Middle Income Economies. *Journal of Smart Economic Growth*, 5(2), pp.45-58.
- Boyd, J.H., Levine, R. & Smith, B.D. 2001. The impact of inflation on financial sector performance. *Journal of monetary Economics*, 47(2), pp.221-248.
- Breitenlechner, M., Gächter, M. & Sindermann, F. 2015. The finance–growth nexus in crisis. *Economics Letters*, 132, pp.31-33.
- Burns, S. 2015. Mobile money and financial development: The case of M-PESA in Kenya. Available at SSRN 2688585.
- Bwire, T. & Musiime, A. 2015. Financial development-economic growth nexus: Empirical evidence from Uganda. *J Soc Sci*, 4(2), pp.1-18.

- Chen, H., Hongo, D.O., Ssali, M.W., Nyaranga, M.S. & Nderitu, C.W. 2020. The asymmetric influence of financial development on economic growth in Kenya: evidence from NARDL. *Sage Open*, 10(1), p.2158244019894071.
- Chhabra, E. & Das, B. 2019. *Mobile Money Note*. (Report). Washington, D.C: Financial Institutions Division, International Monetary Fund (IMF).
- Chinoda, T., Nyoni, J., Chufama, M., Jeremiah, A. and Dandira, M. 2021. The Nexus between Financial Innovation, Financial Inclusion, and Economic growth in Africa: A PMG Approach.
- Chudik, A. & Pesaran, M.H. 2013. Large panel data models with cross-sectional dependence: a survey. *CAFE Research Paper*, (13.15).
- Dacanay, J.C., Nito, B. & Buensuceso, P. 2011. Microfinance, financial inclusion and financial development: An empirical investigation with an international perspective. In *Proceedings of the International Conference on Managing Services in the Knowledge Economy*, Universidade Lusíada de Famalicão, Vila Nova de Famalicão, Portugal (pp. 153-173).
- De Long, J.B. & Summers, L.H. 1991. Equipment investment and economic growth. *The Quarterly Journal of Economics*, 106(2), pp.445-502.
- Demetriades, P.O. & Rewilak, J.M. 2020. Recovering the finance-growth nexus. *Economics Letters*.196:109563.
- Demetriades, P.O. & James, G.A. 2011. Finance and growth in Africa: The broken link. *Economics Letters*, 113(3), pp.263-265.
- Demetriades, P.O. & Rousseau, P.L. 2016. The changing face of financial development. *Economics Letters*, 141, pp.87-90.
- Demetriades, P. & Hook Law, S. 2006. Finance, institutions and economic development. *International journal of finance & economics*, 11(3), pp.245-260.
- Demirgüç-Kunt, A. & L. Klapper. 2012. Financial inclusion in Africa: An overview. *Policy Research Working Paper 6088*, World Bank: Washington, D.C. Available: <http://documents.worldbank.org/curated/en/534321468332946450/Financial-inclusion-in-Africa-an-overview> [2021, September 18]
- Dijkstra, A.G. & Van Donge, J.K. 2001. What Does the Show Case Show? Evidence of and Lessons from Adjustment in Uganda. *World development*, 29(5), pp.841-863.
- Driffill, J. 2003. Financial aspects of economic development. ISSN: 1463-6786 , 1467-9957; DOI: 10.1111/1467-9957.00351. *The Manchester school* , 2003, Vol.71(4), p.363-380
- Dumitrescu, E.I. & Hurlin, C. 2012. Testing for Granger non-causality in heterogeneous panels. *Economic modelling*, 29(4), pp.1450-1460.
- Ehigiamusoe, K.U. & Lean, H.H. 2018. Finance–growth nexus: New insights from the West African region. *Emerging Markets Finance and Trade*, 54(11), pp.2596-2613.
- Ehigiamusoe, K.U. & Samsurijan, M.S. 2021. What matters for finance-growth nexus? A critical survey of macroeconomic stability, institutions, financial and economic development. *International Journal of Finance & Economics*, 26(4), pp.5302-5320.
- Engle, R.F. & Granger, C.W. 1987. Co-integration and error correction: representation, estimation, and testing. *Econometrica: journal of the Econometric Society*, pp.251-276.

- European Union and Joint Research Centre (EU&JRC). 2008. Handbook on constructing composite indicators: methodology and user guide. OECD publishing.
- Eton, M., Gilbert, U., Fabian, M., Godfrey, B. & Benard, P.O. 2019. Financial Inclusion and Economic Growth in Uganda A case study of selected districts in Western Uganda.
- Fabregas, R. & Yokossi, T. 2022. Mobile money and economic activity: Evidence from Kenya. *The World Bank Economic Review*, 36(3), pp.734-756.
- Financial Sector Deepening [FSD]. 2023. Measuring Kenya's financial inclusion journey.
- Financial Sector Deepening Uganda [FSDU]. 2018. FinScope Survey Report.
- FSDU. 2013. FinScope Survey Report.
- Fowowe, B. 2011. The finance-growth nexus in Sub-Saharan Africa: Panel cointegration and causality tests. *Journal of International Development*, 23(2), pp.220-239.
- Gilman, L. & Joyce, M. 2012. Managing the risk of fraud in mobile money. GSMA: Mobile Money for Unbanked (MMU).
- Gaffeo, E. & Garalova, P. 2014. On the finance-growth nexus: additional evidence from Central and Eastern Europe countries. *Economic Change and Restructuring*, 47, pp.89-115.
- Goldsmith, R.W. 1975. The quantitative international comparison of financial structure and development. *The Journal of economic history*. 35(1):216-237.
- Granger, C.W., 1969. Investigating causal relations by econometric models and cross-spectral methods. *Econometrica: journal of the Econometric Society*, pp.424-438.
- Gurley, J.G. & Shaw, E.S. 1955. Financial aspects of economic development. *The American Economic Review*. 45(4):515-538.
- Hagan, E. & Amoah, A. 2019. Foreign direct investment and economic growth nexus in Africa: New evidence from the new financial fragility measure. *African Journal of Economic and Management Studies*.
- Haini, H. 2021. Financial access and the finance-growth nexus: evidence from developing economies. *International Journal of Social Economics*. 48(5).
- Hall, A., 2004. Generalized method of moments. Oxford.
- Hamilton, J.D. 1989. A new approach to the economic analysis of nonstationary time series and the business cycle. *Econometrica: Journal of the econometric society*, pp.357-384.
- Hatemi-J, A. & S. Hacker, R., 2009. Can LR Test Be Helpful in Choosing the Optimal Lag order in the VAR Model When Information Criteria Suggest Different Lag Orders?. *Applied Economics*. 41 (09), pp.1121-1125. [ff10.1080/00036840601019273](https://doi.org/10.1080/00036840601019273). [ffhal-00582108f](https://doi.org/10.1080/00036840601019273)
- Hauner, D. 2009. Public debt and financial development. *Journal of development economics*, 88(1), pp.171-183.
- Hayward, M.P.C., Iden, M.G., Lybek, M.T., Mehran, M.H., Swaray, M.S., Ugolini, M.P. & Briffaut, J.P. 1998. Financial sector development in sub-Saharan African countries. International Monetary Fund.
- Herwartz, H. & Walle, Y.M. 2014. Openness and the finance-growth nexus. *Journal of Banking & Finance*, 48, pp.235-247.
- Huang, A. 2023. Understanding Financial Inclusion: A Comparative Analysis of Financial Mechanisms in Uganda.

- Hughes, N. & Lonie, S. 2007. M-PESA: mobile money for the “unbanked” turning cellphones into 24-hour tellers in Kenya. *Innovations: technology, governance, globalization*, 2(1-2), pp.63-81.
- Ibrahim, M. & Alagidede, P. 2018. Effect of financial development on economic growth in sub-Saharan Africa. *Journal of Policy Modeling*, 40(6), pp.1104-1125.
- Idun, A.A.A. 2021. Does Finance Lead to Economic Growth Convergence in Africa?. *The Journal of Developing Areas*. 55(3):23-55.
- Ikhide, S. 2015. The finance and growth debate in Africa: What role for financial inclusion [Lecture]. University of Stellenbosch Business School. 15 November.
- International Monetary Fund [IMF]. 2019. Mobile Money Note.
- IMF. 2009. Uganda: Sixth Review Under the Policy Support Instrument and Request for an Extension of the Policy Support Instrument-Staff Report; Press Release on the Executive Board Discussion; and Statement by the Executive Director for Uganda.
- Islam, A., Muzi, S. & Rodriguez Meza, J.L. 2018. Does mobile money use increase firms’ investment? Evidence from Enterprise Surveys in Kenya, Uganda, and Tanzania. *Small Business Economics*, 51, pp.687-708.
- Jack, W., Ray, A. & Suri, T. 2013. Transaction networks: Evidence from mobile money in Kenya. *American Economic Review*, 103(3), pp.356-361.
- Jack, W. & Suri, T. 2014. Risk sharing and transactions costs: Evidence from Kenya's mobile money revolution. *American Economic Review*, 104(1), pp.183-223.
- Jalil, A., Feridun, M. & Ma, Y. 2010. Finance-growth nexus in China revisited: New evidence from principal components and ARDL bounds tests. *International Review of Economics & Finance*, 19(2), pp.189-195.
- Jemiluyi, O.O. & Jeke, L. 2023. How Catalytic Is Digital Technology in the Nexus between Migrants’ Remittance and Financial Development in Sub-Saharan African Countries?. *Economies*, 11(3), p.74.
- Jobarteh, M. & Kaya, H. 2019. Non-linear finance-growth nexus for African countries: A panel smooth transition regression approach. *Theoretical & Applied Economics*. 26(3).
- Johansen, S. 1988. Statistical analysis of cointegration vectors. *Journal of economic dynamics and control*, 12(2-3), pp.231-254.
- Johansen, S. & Juselius, K. 1990. Maximum likelihood estimation and inference on cointegration—with applications to the demand for money. *Oxford Bulletin of Economics and statistics*, 52(2), pp.169-210.
- Juodis, A., Karavias, Y. & Sarafidis, V. 2021. A homogeneous approach to testing for Granger non-causality in heterogeneous panels. *Empirical economics*, 60(1), pp.93-112.
- Kalba, K. 2016. Explaining the mobile money adoption-usage gap. *Communications & Strategies*, (103), p.113.
- Kasekende, L.A. 2001. Capital account liberalization: The Ugandan experience. *Development Policy Review*, 19(1), pp.101-120.
- Katusiime, L. 2021. Mobile money use: The impact of macroeconomic policy and regulation. *Economies*, 9(2), p.51.
- Khan, A. 2000. The finance and growth nexus. *Business review*, 2, pp.3-14.

- Kikulwe, E.M., Fischer, E. & Qaim, M. 2014. Mobile money, smallholder farmers, and household welfare in Kenya. *PloS one*, 9(10), p.e109804.
- Kim, D.W., Yu, J.S. & Hassan, M.K. 2018. Financial inclusion and economic growth in OIC countries. *Research in International Business and Finance*, 43, pp.1-14.
- King, R.G. & Levine, R. 1993. Finance and growth: Schumpeter might be right. *The quarterly journal of economics*, 108(3), pp.717-737.
- Kirchgässner, G., Wolters, J. & Hassler, U. 2012. *Introduction to modern time series analysis*. Springer Science & Business Media.
- Kirui, R.K. & Onyuma, S.O. 2015. Role of mobile money transactions on revenue of microbusiness in Kenya. *European Journal of Business and Management*, 7(36), pp.63-67.
- Koomson, I., Martey, E. & Etwire, P.M. 2023. Mobile money and entrepreneurship in East Africa: The mediating roles of digital savings and access to digital credit. *Information Technology & People*, 36(3), pp.996-1019.
- Kouladoun, J.C., Wirajing, M.A.K. & Nchofoung, T.N. 2022. Digital technologies and financial inclusion in Sub-Saharan Africa. *Telecommunications Policy*, 46(9), p.102387.
- Kusimba, S., Chaggar, H., Gross, E. & Kunyu, G. 2013. Social networks of mobile money in Kenya. Institute for money, technology & financial Inclusion (IMTFI), Working Paper, 1.
- Kuteesa, F.N. & Nabbumba, R. 2004. HIPC Debt Relief and Poverty Reduction Strategies: Uganda's Experience. HIPC Debt Relief Myths and Reality FONDAD.
- Lashitew, A.A., van Tulder, R. & Liasse, Y. 2019. Mobile phones for financial inclusion: What explains the diffusion of mobile money innovations?. *Research Policy*, 48(5), pp.1201-1215.
- Law, S. & Singh, N. 2014. Does too much finance harm economic growth? *Journal of Banking and Finance* 41, 36-44.
- Law, S.H., Azman-Saini, W.N.W. & Ibrahim, M.H. 2013. Institutional quality thresholds and the finance-growth nexus. *Journal of Banking & Finance*, 37(12), pp.5373-5381.
- Levine, R. & Zervos, S. 1998. Stock markets, banks, and economic growth. *American economic review*, pp.537-558.
- Levine, R. 2005. Finance and growth: theory and evidence. *Handbook of economic growth*. 1:865-934.
- Lucas Jr, R.E. 1988. On the mechanics of economic development. *Journal of monetary economics*, 22(1), pp.3-42.
- Mas, I. & Radcliffe, D. 2010. Mobile payments go viral: M-PESA in Kenya.
- Maturu, B.O. 2022. COVID-19 and the finance-economic growth nexus in Kenya (No. 60). KBA Centre for Research on Financial Markets and Policy Working Paper Series.
- Ministry of Finance, Planning and Economic Development and Bank of Uganda [MoFPED and BoU]. 2023. National Financial Inclusion Strategy 2023-2028.
- Misati, R.N. Kamau, A. & Nassir, H. 2019. Do migrant remittances matter for financial development in Kenya?. *Financial Innovation*, 5(1), pp.1-25
- Mishkin, F.S. 2009. Why We Shouldn't Turn Our Backs on Financial Globalization. *IMF Staff Papers*, 56(1), pp. 139-170.

- doi:10.1057/imfsp.2008.30.http://ezproxy.uct.ac.za/login?url=https://search.ebscohost.com/login.aspx?direct=true&db=aph&AN=37267783&site=ehost-live
- Mohamed, S. I. 2021. The Role of Institutional Quality in Finance-Growth Nexus: Evidence from North African Countries. *Journal of the Knowledge Economy*, pp.1-20.
- Musembi, G.R. & Chun, S. 2020. Long-run relationships among financial development, financial inclusion, and economic growth: empirical evidence from Kenya. *Global Business & Finance Review (GBFR)*, 25(4), pp.1-11.
- Muthiora, B. 2015. Enabling mobile money policies in Kenya: Fostering a digital financial revolution. *GSMA Mobile Money for the Unbanked*, pp.1-28.
- Muwanga, G. 2020. Financial Development–Economic Growth Nexus In The East African Community: Does Long-Run Cointegration With Structural Breaks Exist?. *Journal of Smart Economic Growth*, 5(2), pp.95-123.
- Muwanga-Zake, E.S.K. & Ndhaye, S. 2001. The HIPC Debt Relief Initiative: Uganda's Experience. Discussion Paper 2001/094. Helsinki: UNU-WIDER.
- Nakijoba, S. & Selotlegeng, L. 2019. Private Sector Credit-Economic Growth Nexus In Uganda (2000-2018): A Fully Modified OLS Analysis. *African Journal of Economics and Sustainable Development*, 2(1), pp.28-38.
- Nampewo, D., Tinyinondi, G.A., Kawooya, D.R. & Ssonko, G.W. 2016. Determinants of private sector credit in Uganda: the role of mobile money. *Financial innovation*, 2(1), pp.1-16.
- Nandi, B.K., Hasan, G.Q. & Kabir, M.H. 2022. A tale of the financial inclusion-growth nexus and the degree of financial inclusion: a dynamic panel approach on selected developing countries. *Journal of Financial Economic Policy*, 14(3), pp.381-402.
- Ngugi, B., Pelowski, M. & Ogembo, J.G. 2010. M-pesa: A case study of the critical early adopters' role in the rapid adoption of mobile money banking in Kenya. *The Electronic Journal of Information Systems in Developing Countries*, 43(1), pp.1-16.
- Nickell, S. 1981. Biases in dynamic models with fixed effects. *Econometrica: Journal of the econometric society*, pp.1417-1426.
- Nielsen, H.B. 2005. Generalized method of moments estimation. *Econometrics* 2.
- Nkoro, E. & Uko, A.K. 2016. Autoregressive Distributed Lag (ARDL) cointegration technique: application and interpretation. *Journal of Statistical and Econometric methods*, 5(4), pp.63-91.
- Nyasha, S. & Odhiambo, N.M. 2015. Do banks and stock markets spur economic growth? Kenya's experience. *International Journal of Sustainable Economy*, 7(1), pp.54-65.
- Nyasha, S. & Odhiambo, N.M. 2017. Banks, stock market development and economic growth in Kenya: An empirical investigation. *Journal of African Business*, 18(1), pp.1-23.
- Odhiambo, N.M. 2005. Financial liberalization and financial deepening: Evidence from three Sub-Saharan African (SSA) countries. *African review of money finance and banking*, pp.5-23.
- Odhiambo, N.M. 2008a. Financial depth, savings and economic growth in Kenya: A dynamic causal linkage. *Economic Modelling*, 25(4), pp.704-713.
- Odhiambo, N.M. 2008b. Financial Development in Kenya: a Dynamic Test of the Finance-led Growth Hypothesis. *Economic issues*, 13(2).

- Odhiambo, N.M. 2009. Interest rate reforms, financial deepening and economic growth in Kenya: an empirical investigation. *The Journal of Developing Areas*, pp.295-313.
- Odhiambo, N.M. & Nyasha, S. 2022. Financial development and economic growth in Uganda: A multivariate causal linkage. *Journal of African Business*, 23(2), pp.361-379.
- Okot, N. & Mbabazize, R. 2021. Financial Sector Development and Economic Growth: Evidence from Uganda. Bank of Uganda Working Paper.
- Olaniyi, C.O. & Oladeji, S.I. 2021. Moderating the effect of institutional quality on the finance–growth nexus: insights from West African countries. *Economic Change and Restructuring*, 54, pp.43-74.
- Onuonga, S.M. 2014. Financial development and economic growth in Kenya: An empirical analysis 1980–2011. *International Journal of Economics and Finance*, 6(7), pp.226-241.
- Pagano, M. 1993. Financial markets and growth: an overview. *European economic review*. 37(2-3):613-622.
- Pattillo, C. A., Gulde, A.M., Carey, K. J., Wagh, S. & Christensen, J. E. 2006. Financial Sector Reforms. In *Sub-Saharan Africa*. International Monetary Fund. DOI: <https://doi.org/10.5089/9781589065659.071>.
- Patrick, H.T. 1966. Financial development and economic growth in underdeveloped countries. *Economic development and Cultural change*, 14(2), pp.174-189.
- Pesaran, M. H., Shin, Y., & Smith, R. 2001. Bounds Testing Approaches to the Analysis of level relationships. *Journal of Applied Econometrics*. 16(3):289-326.
- Pesaran, M.H. 2007. A simple panel unit root test in the presence of cross-section dependence. *Journal of applied econometrics*. 22(2):265-312.
- Pesaran, M.H., Shin, Y. & Smith, R.P., 1999. Pooled mean group estimation of dynamic heterogeneous panels. *Journal of the American statistical Association*. 94(446):.621-634.
- Pesaran, M.H. & Shin, Y. 1995. An autoregressive distributed lag modelling approach to cointegration analysis (Vol. 9514). Cambridge, UK: Department of Applied Economics, University of Cambridge.
- Peterson, E.W.F., 2017. The role of population in economic growth. *Sage Open*, 7(4), p.2158244017736094.
- Purewal, K. & Haini, H. 2021. Re-examining the effect of financial markets and institutions on economic growth: evidence from the OECD countries. *Economic Change and Restructuring*, pp.1-23.
- Rafindadi, A.A. & Yusof, Z. 2013. A startling new empirical finding on the nexus between financial development and economic growth in Kenya. *World Applied Sciences Journal*, 28(9), pp.147-161.
- Ram, R. 1999. Financial development and economic growth: Additional evidence.
- Reinhart, C.M. & Rogoff, K.S. 2010. Growth in a Time of Debt. *American economic review*, 100(2), pp.573-578.
- Reinhart, C.M. & Tokatlidis, I. 2003. Financial liberalisation: the African experience. *Journal of African Economies*, 12(suppl_2), pp.ii53-ii88.
- Rioja, F. & Valev, N. 2004. Does one size fit all?: a reexamination of the finance and growth relationship. *Journal of Development economics*. 74(2):429-447.

- Romer, D., 2012. *Advanced Macroeconomics* 4th Ed. New York: McGraw Hill.
- Romero-Barrutieta, A.L., Bulir, A. & Rodríguez-Delgado, J.D. 2015. The dynamic implications of debt relief for low-income countries. *Review of Development Finance*, 5(1), pp.1-12.
- Roodman, D. 2009. How to do xtabond2: An introduction to difference and system GMM in Stata. *The stata journal*, 9(1), pp.86-136.
- Rousseau, P.L. & Wachtel, P. 2002. Inflation thresholds and the finance–growth nexus. *Journal of international money and finance*, 21(6), pp.777-793.
- Safavian, M. & Zia, B. 2018. The impact of interest rate caps on the financial sector: evidence from commercial banks in Kenya. *World Bank Policy Research Working Paper*, (8393).
- Sala-i-Martin, X., 1997. I just ran four million regressions.
- Samargandi, N., Fidrmuc, J. & Ghosh, S. 2015. Is the Relationship Between Financial Development and Economic Growth Monotonic? Evidence from a Sample of Middle-income Countries. *World Development* 68, 66-81.
- Sarma, M. 2008. Index of financial inclusion (No. 215). Working paper.
- Sarpong, B. & Nketiah-Amponsah, E. 2022. Financial inclusion and inclusive growth in sub-Saharan Africa. *Cogent Economics & Finance*, 10(1), p.2058734.
- Sethi, D. & Acharya, D. 2018. Financial inclusion and economic growth linkage: Some cross-country evidence. *Journal of Financial Economic Policy*, 10(3), pp.369-385.
- Ssonko, G.W. & Kawooya, D.R. 2020. Digital Financial Services, COVID-19, and Future Financial Services Landscape in Uganda. Bank of Uganda. WP No. 29/2020 .
- Stolbov, M. 2013. The Finance-Growth Nexus Revisited: From Origins to a Modern Theoretical Landscape. *Economics*.7(1).
- Suri, T., 2017. Mobile money. *Annual Review of Economics*, 9, pp.497-520.
- Suri, T., Jack, W. & Stoker, T.M. 2012. Documenting the birth of a financial economy. *Proceedings of the National Academy of Sciences*, 109(26), pp.10257-10262.
- Suri, T. & Jack, W. 2016. The long-run poverty and gender impacts of mobile money. *Science*, 354(6317), pp.1288-1292.
- Svirydzenka, K. 2016. Introducing a new broad-based index of financial development. Washington, D.C: International Monetary Fund.
- Swamy, V. & Dharani, M. 2020. The tipping point of financial development?—evidence from OECD countries. *International Economics and Economic Policy*, 17, pp.125-165.
- Trabelsi, M.. 2002. Finance and Growth: empirical evidence from developing countries, 1960-1990. *Cahier de recherche*, (2002-13).
- Twinamatsiko, D. 2022. A Stock market development and economic growth nexus in Uganda and Turkey, an ardl modelling approach (Doctoral dissertation, Makerere University).
- Uddin, G.S., Sjö, B. & Shahbaz, M. 2013. The causal nexus between financial development and economic growth in Kenya. *Economic Modelling*, 35, pp.701-707.
- Ugwuanyi, U., Ugwuoke, R., Onyeonu, E., Festus Eze, E., Isahaku Prince, A., Anago, J. & Ibe, G.I. 2022. Financial inclusion-economic growth nexus: traditional finance versus digital finance in Sub-Saharan Africa. *Cogent Economics & Finance*, 10(1), p.2133356.
- UN Capital Development Fund (UNCDF). 2021. The Impact of Mobile Money Taxation in Uganda. Report.

- Valickova, P., Havranek, T. & Horvath, R. 2015. Financial development and economic growth: A meta-analysis. *Journal of Economic Surveys*, 29(3), pp.506-526.
- Van, L.T.H., Vo, A.T., Nguyen, N.T. & Vo, D.H. 2021. Financial inclusion and economic growth: An international evidence. *Emerging Markets Finance and Trade*, 57(1), pp.239-263.
- Walle, Y.M. 2014. Revisiting the finance–growth nexus in Sub-Saharan Africa: Results from error correction-based panel cointegration tests. *African development review*. 26(2):310-321.
- Wamuyu, P.K. 2014. The role of contextual factors in the uptake and continuance of mobile money usage in Kenya. *The Electronic Journal of Information Systems in Developing Countries*, 64(1), pp.1-19.
- Wolde-Rufael, Y. 2009. Re-examining the financial development and economic growth nexus in Kenya. *Economic Modelling*, 26(6), pp.1140-1146.
- Wooldridge, J.M. 2010. *Econometric analysis of cross section and panel data*. MIT press.
- World Bank. 2013. *Global financial development report 2014: Financial inclusion (Vol. 2)*. World Bank Publications.
- Wu, J., Hou, H. & Cheng, S. 2010. The dynamic impacts of financial institutions on economic growth: Evidence from the European Union. *Journal of Macroeconomics*. 32(3):879-891.

Appendix

Table A1: List of the Sub-Saharan African Countries in the Sample

<i>Low income</i>
Chad
Madagascar
Rwanda
Uganda
<i>Lower-middle income</i>
Angola
Botswana
Cameroon
Eswatini
Ghana
Kenya
Lesotho
Niger
Zimbabwe
<i>Upper-middle income</i>
Mauritius
Namibia
South Africa
<i>High income</i>
Seychelles
N=17

Source: World Bank country classification by Gross National Income per capita in 2022

Note: low <US\$1,135, lower-middle: US\$1,136 - US\$4,465, upper-middle: US\$4,466- US\$13,845, and high income: > US\$13,845.

Table A2: List of variables, notation and data sources

Variable	Notation	Data source
Real GDP per capita	RGDPpc	World Bank Development Indicators Database (WDI)
Svirydzhenka's (2016) Financial Development Index	FDI	IMF Financial Development database
<i>Financial Institutions Depth</i>	<i>FID</i>	
Private-sector credit to GDP		
Pension fund assets to GDP		
Mutual fund assets to GDP		
Insurance premiums		
life and non-life to GDP		
<i>Financial Institutions Access</i>		
number of ATMs per 1,000 adults		
number of commercial bank branches per 1,000 adults		
<i>Financial Institutions Efficiency</i>	<i>FIE</i>	
Net interest margin		
Lending-deposits spread		
Non-interest income to total income		
Overhead costs to total assets		
Return on assets		
Return on equity		
<i>Financial Markets Depth</i>	<i>FMD</i>	
Stock market capitalization to GDP		
Stocks traded to GDP		
International debt securities of government to GDP		
Total debt securities of financial corporations to GDP		
Total debt securities of nonfinancial corporations to GDP		
<i>Financial Markets Access</i>	<i>FMA</i>	
Percent of market capitalization outside of top 10 largest companies		
total number of issuers of debt		
<i>Financial Markets Efficiency</i>	<i>FME</i>	
Stock market turnover ratio		
<i>MMD (Mobile Money Depth)</i>		IMF Financial Access database (FAS)
Mobile money transactions per 1,000 adults		
Mobile money transactions(% of GDP)		
<i>MMA (Mobile Money Access)</i>		
Mobile money accounts per 100,000 adults		
Mobile money agents per 1,000 km ²		
Mobile cellular subscription per 100 adults		
Mobile money agents per 100,000 adults		
Bank credit/GDP	PSCgdp	WDI
Openness (exports+imports/GDP)	Open	WDI
Gross Fixed Capital Formation	GFC	WDI
Population growth	POP	WDI
External debt	Debt	WDI

Note: IMF and World Bank databases for the year 2023

Table A3a: Financial Inclusion (Financial Institutions) and Economic Growth

Dependent variable: Real GDP per capita (RGDPpc)								
Variable	FI1	FI2	FI3	FI4	FI5	FI6	FI7	FI8
RGDPpc	0.987*** (0.000)	0.986*** (0.000)	0.975*** (0.000)	0.967*** (0.000)	0.984*** (0.000)	0.966*** (0.000)	0.956*** (0.000)	0.945*** (0.000)
FD	-0.015 (0.727)	0.007 (0.354)	-0.022*** (0.000)	-0.000 (0.942)	0.000 (0.894)	0.013*** (0.000)	0.034*** (0.000)	0.000 (0.229)
FD ₋₁	0.013 (0.705)	-0.008 (0.353)	0.023*** (0.000)	0.000 (0.965)	-0.001 (0.682)	-0.010 (0.233)	-0.032*** (0.003)	-0.000 (0.221)
POP	-0.020 (0.847)	-0.013 (0.908)	0.094 (0.336)	0.003 (0.979)	-0.017 (0.629)	-0.092 (0.264)	-0.073** (0.024)	0.009 (0.849)
POP ₋₁	-0.001 (0.996)	-0.034 (0.764)	-0.124 (0.120)	0.043 (0.707)	0.013 (0.683)	-0.010 (0.881)	-0.029 (0.322)	-0.031 (0.694)
Open	0.001 (0.458)	-0.000 (0.843)	0.003*** (0.000)	0.002 (0.720)	0.001 (0.226)	-0.001 (0.678)	0.000 (0.920)	0.001 (0.265)
Open ₋₁	-0.002 (0.279)	-0.001 (0.635)	-0.003*** (0.006)	-0.003 (0.508)	-0.002* (0.072)	-0.000 (0.938)	-0.001 (0.529)	-0.003** (0.005)
GFC	0.006 (0.684)	0.007 (0.159)	0.009* (0.062)	0.001 (0.850)	0.009** (0.023)	0.003 (0.516)	0.005 (0.191)	0.005 (0.488)
GFC ₋₁	-0.000 (0.981)	-0.006 (0.142)	-0.014*** (0.010)	0.010 (0.265)	-0.003 (0.247)	-0.006* (0.062)	-0.004 (0.074)	0.002 (0.769)
C	0.122 (0.661)	0.269 (0.364)	0.370 (0.368)	-0.002 (0.997)	0.129 (0.638)	0.583* (0.050)	0.576 (0.001)	0.411 (0.364)
Covid-19	-0.071*** (0.003)	- 0.074*** (0.000)	-0.067*** (0.000)	-0.060** (0.043)	- 0.063*** (0.000)	-0.082*** (0.007)	-0.076*** (0.0000)	-0.063*** (0.001)
No of obs	119	119	119	119	119	119	119	119
Countries	17	17	17	17	17	17	17	17
Instruments	17	17	17	17	17	17	17	17
AR (2)	0.774	0.787	0.683	0.217	0.983	0.693	0.263	0.804
Sargan stat	0.329	0.701	0.993	0.779	0.117	0.992	0.993	0.615
Hansen stat	0.734	0.586	0.887	0.668	0.537	0.961	0.949	0.802

Notes: In parentheses are p-values which reflect the significance of each correlation value. ***p<0.01, ** p<0.05 and *P<0.10.

FI1 denotes Number of all microfinance institution branches per 1,000 km²; FI2 denotes Number of all microfinance institution branches per 100,000 adults; FI3 denotes Number of ATMs per 1,000 km²; FI4 Number of ATMs per 100,000 adults; FI5 denotes Number of commercial bank branches per 1,000 km²; FI6 denotes Number of credit union and credit cooperative branches per 1,000 km²; FI7 denotes Number of credit union and credit cooperative branches per 100,000 adults; FI8 denotes Number of deposit accounts with commercial banks per 1,000 adults.

Table A3b: Financial Inclusion (Financial Institutions) and Economic Growth

Dependent variable: Real GDP per capita (RGDPpc)								
Variable	FI9	FI10	FI11	FI2	FI3	FI4	FI5	FI6
RGDPpc	0.968*** (0.000)	0.947*** (0.000)	0.987*** (0.000)	0.985*** (0.000)	0.969*** (0.000)	0.960*** (0.000)	0.972*** (0.000)	0.973*** (0.000)
FD	0.003 (0.523)	0.016 (0.688)	-0.020 (0.855)	0.000 (0.854)	0.000 (0.860)	0.003 (0.180)	0.002 (0.635)	-0.002 (0.899)
FD ₋₁	-0.003 (0.536)	-0.033 (0.464)	-0.062 (0.717)	-0.003* (0.066)	-0.000 (0.760)	-0.003** (0.048)	-0.002 (0.571)	0.002 (0.924)
POP	0.004 (0.958)	-0.083 (0.247)	-0.104* (0.059)	-0.015 (0.824)	0.006 (0.953)	-0.002 (0.950)	-0.058 (0.564)	-0.025 (0.851)
POP ₋₁	-0.042 (0.738)	-0.020 (0.816)	0.066 (0.305)	-0.023 (0.741)	0.002 (0.985)	-0.052 (0.124)	0.022* (0.808)	-0.016 (0.844)
Open	0.001 (0.200)	-0.000 (0.904)	-0.001 (0.708)	0.001 (0.743)	0.002 (0.591)	0.001 (0.144)	0.002* (0.089)	0.002 (0.308)
Open ₋₁	-0.002*** (0.008)	-0.002 (0.210)	-0.002 (0.315)	-0.001 (0.412)	-0.004 (0.284)	-0.002*** (0.008)	-0.004*** (0.000)	-0.003*** (0.000)
GFC	0.004 (0.671)	0.009 (0.373)	0.012 (0.162)	0.004 (0.443)	0.004 (0.698)	0.001 (0.762)	0.010** (0.049)	0.010** (0.042)
GFC ₋₁	-0.006 (0.305)	-0.004 (0.375)	-0.003 (0.218)	-0.003 (0.409)	0.005 (0.739)	0.002 (0.492)	-0.004 (0.582)	-0.005 (0.598)
C	0.452 (0.385)	0.728 (0.379)	0.268 (0.397)	0.236 (0.290)	0.180 (0.804)	0.435*** (0.003)	0.315 (0.290)	0.336 (0.631)
Covid-19	-0.083*** (0.004)	-0.060*** (0.001)	-0.073** (0.000)	-0.065** (0.000)	-0.054** (0.047)	-0.075*** (0.000)	-0.072*** (0.000)	-0.074*** (0.000)
No of obs	119	119	119	119	119	119	119	119
Countries	17	17	17	17	17	17	17	17
Instruments	17	17	17	17	17	17	173	17
AR (2)	0.956	0.891	0.775	0.451	0.459	0.785	0.835	0.781
Sargan stat	0.300	0.602	0.583	0.279	0.548	0.991	0.356	0.269
Hansen stat	0.609	0.745	0.378	0.530	0.220	0.988	0.733	0.673

Notes: In parentheses are p-values which reflect the significance of each correlation value. ***p<0.01, ** p<0.05 and *P<0.10.

FI9 denotes Number of deposit accounts with credit unions and credit cooperatives per 1,000 adults; FI10 denotes Number of life insurance policies per 1,000 adults; FI11 denotes Number of non- life insurance policies per 1,000 adults; FI12 denotes Number of loan accounts with microfinance institutions per 1,000 adults; FI13 denotes Number of loan accounts with commercial banks per 1,000 adults; FI14 denotes Number of loan accounts with credit unions and credit cooperatives per 1,000 adults; FI15 denotes Mutual fund assets to GDP (%); FI16 denotes Pension fund assets to GDP (%).

Table A4: Unit root tests for Kenya data

Variables	ADF $H_0: \gamma=0$			Phillips–Perron test		
	Level	First difference	Order of integration	Level	First difference	Order of integration
Log real GDP per capita	-0.261 (-3.521)	-4.979 (-3.524)	I (1)	-0.207 (-3.521)	-5.000 (-3.524)	I (1)
Financial Development Index (FD_MM)	-3.247 (-3.524)	-4.692 (-3.524)	I (1)	-2.593 (-3.521)	-4.622 (-3.524)	I (1)
Financial Development Index (FD)	-2.194 (-3.524)	-4.601 (-3.524)	I (1)	-1.113 (-2.993)	-4.516 (-2.935)	I (1)
SK_FD	-1.650 (-2.933)	-6.177 (-2.935)	I (1)	-1.754 (-2.933)	-6.176 (-2.935)	I (1)
Bank credit/GDP	-3.205 (-3.521)	-7.167 (-3.524)	I (1)	-3.227 (-3.521)	-7.184 (-3.524)	I (1)
Openness (exports+imports/GDP)	-2.420 (-3.521)	-6.618 (-3.524)	I (1)	-2.476 (-3.521)	-6.808 (-3.524)	I (1)
Gross Fixed Capital/GDP	-2.877 (-2.933)	-6.063 (-2.937)	I (1)	-2.481 (-2.933)	-13.550 (-2.935)	I (1)
External debt	-3.553 (-3.537)		I (0)	2.992 (-1.949)	-3.347 (-1.949)	I (1)
MM	2.904 (-3.548)	-1.428 (-3.553)	I (2)	0.284 (-3.521)	-4.388 (-3.524)	I (1)
FI	-1.416 (-3.524)	-3.308 (-3.524)	I (2)	-0.753 (-3.521)	-3.370 (-3.524)	I (2)
FM	-0.307 (-3.553)	0.415 (-3.558)	I (2)	0.792 (-3.521)	-5.301 (-3.524)	I (1)

Notes: (.) presents the test statistic and the critical values (in parentheses); Schwarz Bayesian Criterion (SBC) lags were used. The ADF equation had a constant and trend when conducting unit root test of all the series in the levels. The critical values are at the 5 percent level of significance.

Table A5: Zivot-Andrews Unit Root Test for Kenya data

Variables	Level	First difference	Order of integration
Log real GDP per capita	-3.869 (-5.08)	-4.979 (-3.524)	I (1)
Log Financial Development Index (FD_MM)	-3.109 (-5.08)	-4.692 (-3.524)	I (1)
Financial Development Index (FD)	-4.251 (-5.08)	-4.601 (-3.524)	I (1)
SK_FD	-3.764 (-5.08)	-6.177 (-2.935)	I (1)
Bank credit/GDP	-5.145 (-5.08)	-	I (0)
	Potential break: 2013		
Openness (exports+imports/GDP)	-3.971 (-5.08)	-7.356 (-5.08)	I (1)
External debt	-2.564 (-5.08)	-5.990 (-5.08)	I (1)
Gross Fixed Capital	-4.046 (-5.08)	-6.932 (-5.08)	I (1)
MM	-5.334 (-5.08)	-	I (0)
Financial Institutions Index (FI)	-4.203 (-5.08)	-5.522 (-5.08)	I (1)
	Potential break: 2010		
Financial Market Index (FM)	-6.448 (-5.08)	-	I (0)
	Potential break: 1992		

Notes: .(.) presents the test statistic and the critical values (in parentheses). The critical values are at the 5 percent level of significance.

Table A6: VAR Lag Selection for Kenya data

Endogenous variables: LRGDPPC, LGFC,EXTDBT, OPEN MM

Lag	LogL	LR	FPE	AIC	SC	HQ
0	-276.5337	NA	3.600159	15.46327	16.52965	15.84588
1	85.92764	539.0451*	1.16e-07*	-1.842443	0.290328*	-1.077223*
2	105.9002	24.58165	1.74e-07	-1.584627	1.614530	-0.436797
3	134.0091	27.38817	2.06e-07	-1.744058	2.521485	-0.213618
4	168.4997	24.76243	2.43e-07	-2.230752*	3.101177	-0.317702

* indicates lag order selected by the criterion; LR: sequential modified LR test statistic (each test at 5% level); FPE: Final prediction error; AIC: Akaike information criterion; SC: Schwarz information criterion; HQ: Hannan-Quinn information criterion

Endogenous variables: LRGDPPC, LGFC,EXTDBT, OPEN **FD**

Lag	LogL	LR	FPE	AIC	SC	HQ
0	-302.9717	NA	13.96801	16.81906	17.88545	17.20167
1	44.58644	516.8813*	9.63e-07	0.277619	2.410390*	1.042839*
2	74.93895	37.35693	8.50e-07*	0.003131	3.202288	1.150961
3	92.89511	17.49575	1.70e-06	0.364353	4.629896	1.894793
4	134.1216	29.59854	1.42e-06	-0.467777*	4.864152	1.445273

* indicates lag order selected by the criterion; LR: sequential modified LR test statistic (each test at 5% level); FPE: Final prediction error; AIC: Akaike information criterion; SC: Schwarz information criterion; HQ: Hannan-Quinn information criterion

Endogenous variables: LRGDPPC, LGFC,EXTDBT, OPEN **FD_MM**

Lag	LogL	LR	FPE	AIC	SC	HQ
0	-285.1851	NA	5.610495	15.90693	16.97332	16.28954
1	59.47231	512.5675	4.49e-07	-0.485760	1.647012*	0.279460
2	93.38200	41.73500*	3.30e-07*	-0.942667	2.256490	0.205163*
3	112.2828	18.41619	6.27e-07	-0.629888	3.635654	0.900552
4	151.7669	28.34752	5.73e-07	-1.372660*	3.959269	0.540390

* indicates lag order selected by the criterion; LR: sequential modified LR test statistic (each test at 5% level); FPE: Final prediction error; AIC: Akaike information criterion; SC: Schwarz information criterion; HQ: Hannan-Quinn information criterion

Endogenous variables: LRGDPPC, LGFC,EXTDBT, OPEN **PSC**

Lag	LogL	LR	FPE	AIC	SC	HQ
0	-409.2608	NA	3253.530	22.26979	23.33617	22.65240
1	-92.45911	471.1410	0.001086	7.305595	9.438367*	8.070815
2	-72.53762	24.51875	0.001637	7.566032	10.76519	8.713862
3	-44.54585	27.27404	0.001951	7.412607	11.67815	8.943047
4	16.80706	44.04824*	0.000580*	5.548356*	10.88028	7.461406*

* indicates lag order selected by the criterion; LR: sequential modified LR test statistic (each test at 5% level); FPE: Final prediction error; AIC: Akaike information criterion; SC: Schwarz information criterion; HQ: Hannan-Quinn information criterion

Endogenous variables: LRGDPPC, LGFC,EXTDBT, OPEN **FI**

Lag	LogL	LR	FPE	AIC	SC	HQ
0	-292.2603	NA	8.064487	16.26976	17.33615	16.65237
1	51.68332	511.5060	6.69e-07	-0.086324	2.046447*	0.678896
2	73.62749	27.00821	9.09e-07	0.070385	3.269542	1.218215
3	96.81866	22.59652	1.39e-06	0.163146	4.428688	1.693586
4	150.8691	38.80543*	6.00e-07*	-1.326619*	4.005309	0.586431*

* indicates lag order selected by the criterion; LR: sequential modified LR test statistic (each test at 5% level); FPE: Final prediction error; AIC: Akaike information criterion; SC: Schwarz information criterion; HQ: Hannan-Quinn information criterion

Endogenous variables: LRGDPPC, LGFC,EXTDBT, OPEN **FM**

Lag	LogL	LR	FPE	AIC	SC	HQ
0	-308.4387	NA	18.48818	17.09942	18.16581	17.48203
1	28.58285	501.2116*	2.19e-06*	1.098315	3.231087*	1.863535*
2	50.50107	26.97627	2.98e-06	1.256355	4.455512	2.404185
3	72.36030	21.29873	4.86e-06	1.417420	5.682963	2.947860
4	112.6434	28.92118	4.26e-06	0.633673*	5.965602	2.546723

* indicates lag order selected by the criterion; LR: sequential modified LR test statistic (each test at 5% level); FPE: Final prediction error; AIC: Akaike information criterion; SC: Schwarz information criterion; HQ: Hannan-Quinn information criterion

Table A7: Cointegration test results for Kenya

FD_MM: Trace	Eigenvalue	Statistic	Critical Value	Prob.Critical Value
None *	0.687339	100.4597	69.81889	0.0000
At most 1 *	0.503650	53.95427	47.85613	0.0120
At most 2 *	0.415443	25.93530	29.79707	0.1306
At most 3 *	0.098427	4.459234	15.49471	0.8632
At most 4	0.007836	0.314662	3.841465	0.5748
Max-eigenvalue				
None *	0.687339	46.50544	33.87687	0.0010
At most 1 *	0.503650	28.01896	27.58434	0.0440
At most 2 *	0.415443	21.47607	21.13162	0.0447
At most 3 *	0.098427	4.144573	14.26460	0.8438
At most 4	0.007836	0.314662	3.841465	0.5748

Notes: * denotes rejection of the hypothesis of no cointegration at the 0.05 level

FD: Trace	Eigenvalue	Statistic	Critical Value	Prob.Critical Value
None *	0.727207	103.8087	69.81889	0.0000
At most 1 *	0.506193	50.54798	47.85613	0.0273
At most 2 *	0.372500	21.61793	29.79707	0.3202
At most 3	0.055716	2.511462	15.49471	0.9846
At most 4	0.003919	0.160987	3.841465	0.6882
Max-eigenvalue				
None *	0.727207	53.26074	33.87687	0.0001
At most 1 *	0.506193	28.93005	27.58434	0.0334
At most 2 *	0.372500	19.10647	21.13162	0.0938
At most 3	0.055716	2.350475	14.26460	0.9803
At most 4	0.003919	0.160987	3.841465	0.6882

Notes: * denotes rejection of the hypothesis of no cointegration at the 0.05 level

MM: Trace	Eigenvalue	Statistic	Critical Value	Prob.Critical Value
None *	0.530852	73.44455	69.81889	0.0249
At most 1 *	0.423969	42.41426	47.85613	0.1474
At most 2 *	0.241367	19.79889	29.79707	0.4366
At most 3 *	0.110861	8.473153	15.49471	0.4163
At most 4 *	0.085301	3.655566	3.841465	0.0559
Max-eigenvalue				
None *	0.530852	31.03029	33.87687	0.1054
At most 1 *	0.423969	22.61537	27.58434	0.1905
At most 2 *	0.241367	11.32574	21.13162	0.6148
At most 3 *	0.110861	4.817587	14.26460	0.7647
At most 4 *	0.085301	3.655566	3.841465	0.0559

Notes: * denotes rejection of the hypothesis of no cointegration at the 0.05 level

PSC: Trace	Eigenvalue	Statistic	Critical Value	Prob.Critical Value
None *	0.956336	224.8198	69.81889	0.0000
At most 1 *	0.765869	105.8331	47.85613	0.0000
At most 2 *	0.572798	50.66193	29.79707	0.0001
At most 3 *	0.381232	18.34301	15.49471	0.0181
At most 4 *	0.002682	0.102070	3.841465	0.7494
Max-eigenvalue				
None *	0.956336	118.9866	33.87687	0.0000
At most 1 *	0.765869	55.17118	27.58434	0.0000
At most 2 *	0.572798	32.31892	21.13162	0.0009
At most 3 *	0.381232	18.24094	14.26460	0.0112
At most 4	0.002682	0.102070	3.841465	0.7494

Notes: * denotes rejection of the hypothesis of no cointegration at the 0.05 level

FI:Trace	Eigenvalue	Statistic	Critical Value	Prob.Critical Value
None *	0.882397	211.5623	69.81889	0.0000
At most 1 *	0.792401	130.2256	47.85613	0.0000
At most 2 *	0.711206	70.48406	29.79707	0.0000
At most 3 *	0.446171	23.28653	15.49471	0.0027
At most 4 *	0.021665	0.832333	3.841465	0.3616
Max-eigenvalue				
None *	0.882397	81.33662	33.87687	0.0000
At most 1 *	0.792401	59.74159	27.58434	0.0000
At most 2 *	0.711206	47.19753	21.13162	0.0000
At most 3 *	0.446171	22.45420	14.26460	0.0021
At most 4	0.021665	0.832333	3.841465	0.3616

Notes: * denotes rejection of the hypothesis of no cointegration at the 0.05 level

FM:Trace	Eigenvalue	Statistic	Critical Value	Prob.Critical Value
None *	0.700002	98.77666	69.81889	0.0001
At most 1 *	0.423649	49.41352	47.85613	0.0354
At most 2 *	0.380718	26.82096	29.79707	0.1061
At most 3	0.144974	7.173987	15.49471	0.5575
At most 4	0.018185	0.752439	3.841465	0.3857
Max-eigenvalue				
None *	0.700002	49.36314	33.87687	0.0004
At most 1 *	0.423649	22.59256	27.58434	0.1915
At most 2 *	0.380718	19.64697	21.13162	0.0796
At most 3	0.144974	6.421548	14.26460	0.5597
At most 4	0.018185	0.752439	3.841465	0.3857

Notes: * denotes rejection of the hypothesis of no cointegration at the 0.05 level

Table A8: Unit root tests for Uganda data

Variables	ADF $H_0: \gamma=0$			Phillips–Perron test		
	Level	First difference	Order of integration	Level	First difference	Order of integration
Log real GDP per capita	-2.218 (-3.527)	-3.567 (-3.530)	I (1)	-2.421 (-3.527)	-3.568 (-3.530)	I (1)
Financial Development Index (FD_MM)	-4.597 (-3.533)		I (0)	-2.851 (-3.527)	-5.974 (-3.530)	I (1)
Financial Development Index (FD)	-1.057 (-3.527)	-5.191 (-3.530)	I (1)	-1.369 (-1.949)	-4.958 (-1.950)	I (1)
SK_FD	-2.196 (-3.527)	-6.178 (-3.530)	I (1)	-2.196 (-3.527)	-6.179 (-3.530)	I (0)
Bank credit/GDP	-4.616 (-3.527)		I (0)	-4.578 (-3.527)		I (0)
Openness (exports+imports/GDP)	-2.190 (-2.937)	-7.101 (-2.939)	I (1)	-2.061 (-2.937)	-8.844 (-2.939)	I (1)
Gross Fixed Capital/GDP	-1.370 (-2.937)	-6.270 (-2.941)	I (1)	-1.314 (-2.937)	-8.153 (-2.939)	I (1)
External debt	-1.312 (-2.937)	-6.273 (-2.939)	I (1)	-1.309 (-2.937)	-6.273 (-2.939)	I (1)
MM	-5.851 (-2.960)		I (0)	5.275 (-3.527)	-3.960 (-3.53)	I (1)
FI	-2.860 (-3.524)	-4.596 (-3.524)	I (1)	-2.305 (-3.521)	-4.510 (-3.524)	I (1)
FM	-1.928 (-2.935)	-4.682 (-2.935)	I (1)	-1.672 (-2.933)	-4.504 (-2.935)	I (1)

notes: .(.) presents the test statistic and the critical values (in parentheses); Schwarz Bayesian Criterion (SBC) lags were used. The ADF equation had a constant and trend when conducting unit root test of all the series in the levels. The critical values are at the 5 percent level of significance.

Table A9: Zivot-Andrews Unit Root Test for Uganda data

Variables	Level	First difference	Order of integration
Log real GDP per capita	-5.321 (-5.08) Potential break: 2005	-	I (0)
Financial Development Index (FD_MM)	-3.473 (-5.08)	-5.655 (-5.08)	I (1)
Financial Development Index (FDI)	-3.111 (-5.08)	-5.793 (-5.08)	I (1)
SK_FD	-6.455 (-5.08) Potential break: 1996	-	I (0)
Bank credit/GDP	-6.227 (-5.08) Potential break:2005	-	I (0)
Openness (exports+imports/GDP)	-3.971 (-5.08)	-7.356 (-5.08)	I (1)
External debt	-2.564 (-5.08)	-5.990 (-5.08)	I (1)
Gross Fixed Capital	-6.285 (-5.08) Potential break: 2014	-	I (0)
MM	-0.806 (-5.08)	-6.381 (-5.08)	I (1)
FI	-4.140 (-5.08)	-5.523 (-5.08)	I (1)
FM	-3.489 (-5.08)	-5.870 (-5.08)	I (1)

notes: (.) presents the test statistic and the critical values (in parentheses). The critical values are at the 5 percent level of significance.

Table A10: VAR Lag Selection for Uganda data

Endogenous variables: LRGDPPC, LGFC,EXTDBT, OPEN MM

Lag	LogL	LR	FPE	AIC	SC	HQ
0	-291.1968	NA	24.21676	17.36199	18.66814	17.82247
1	43.74847	470.7338	1.39e-06	0.608191	3.002799*	1.452402
2	63.85319	22.82158	2.23e-06	0.872801	4.355866	2.100744
3	119.5923	48.20677*	6.71e-07	-0.788771	3.782753	0.822905
4	165.2754	27.16297	5.59e-07*	-1.906781*	3.753201	0.088628*

* indicates lag order selected by the criterion; LR: sequential modified LR test statistic (each test at 5% level); FPE: Final prediction error; AIC: Akaike information criterion; SC: Schwarz information criterion; HQ: Hannan-Quinn information criterion

Endogenous variables: LRGDPPC, LGFC,EXTDBT, OPEN **FD**

Lag	LogL	LR	FPE	AIC	SC	HQ
0	-273.8340	NA	9.473677	16.42346	17.72961	16.88394
1	10.17017	399.1410	8.52e-06	2.423234	4.817842*	3.267446
2	30.72186	23.32895	1.34e-05	2.663683	6.146749	3.891627
3	77.74938	40.67245	6.44e-06	1.473007	6.044530	3.084683
4	141.4432	37.87198*	2.03e-06*	-0.618550*	5.041432	1.376859*

* indicates lag order selected by the criterion; LR: sequential modified LR test statistic (each test at 5% level); FPE: Final prediction error; AIC: Akaike information criterion; SC: Schwarz information criterion; HQ: Hannan-Quinn information criterion

Endogenous variables: LRGDPPC, LGFC,EXTDBT, OPEN **FD_MM**

Lag	LogL	LR	FPE	AIC	SC	HQ
0	-282.2134	NA	14.90148	16.87640	18.18255	17.33688
1	18.54265	422.6842	5.42e-06	1.970667	4.365275	2.814879
2	37.36483	21.36571	9.35e-06	2.304604	5.787670	3.532548
3	86.87312	42.81798	3.93e-06	0.979831	5.551355	2.591508
4	155.6278	40.88113*	9.42e-07*	-1.385284*	4.274698*	0.610125*

* indicates lag order selected by the criterion; LR: sequential modified LR test statistic (each test at 5% level); FPE: Final prediction error; AIC: Akaike information criterion; SC: Schwarz information criterion; HQ: Hannan-Quinn information criterion

Table A11: Cointegration test results for Uganda

FD_MM: Trace	Eigen value	Statistic	Critical value	Prob. Critical value
None *	0.851643	181.3102	69.81889	0.0000
At most 1 *	0.711974	110.7093	47.85613	0.0000
At most 2 *	0.613979	64.65531	29.79707	0.0000
At most 3 *	0.534655	29.43632	15.49471	0.0002
At most 4 *	0.030136	1.132194	3.841465	0.2873
Maximum eigen value				
None *	0.851643	70.60091	33.87687	0.0000
At most 1 *	0.711974	46.05403	27.58434	0.0001
At most 2 *	0.613979	35.21899	21.13162	0.0003
At most 3 *	0.534655	28.30412	14.26460	0.0002
At most 4 *	0.030136	1.132194	3.841465	0.2873

Notes: * denotes rejection of the hypothesis of no cointegration at the 0.05 level

FD: Trace	Eigen value	Statistic	Critical value	Prob. Critical value
None *	0.871531	177.8683	69.81889	0.0000
At most 1 *	0.760099	101.9419	47.85613	0.0000
At most 2 *	0.546079	49.12337	29.79707	0.0001
At most 3 *	0.373168	19.89960	15.49471	0.0101
At most 4 *	0.068306	2.617770	3.841465	0.1057
Maximum eigen value				
None *	0.871531	75.92638	33.87687	0.0000
At most 1 *	0.760099	52.81856	27.58434	0.0000
At most 2 *	0.546079	29.22378	21.13162	0.0029
At most 3 *	0.373168	17.28183	14.26460	0.0162
At most 4 *	0.068306	2.617770	3.841465	0.1057

Notes: * denotes rejection of the hypothesis of no cointegration at the 0.05 level

MM: Trace	Eigen value	Statistic	Critical value	Prob. Critical value
None *	0.914648	177.3157	69.81889	0.0000
At most 1 *	0.790986	86.25990	47.85613	0.0000
At most 2 *	0.424409	28.34177	29.79707	0.0729
At most 3 *	0.113641	7.904532	15.49471	0.4757
At most 4 *	0.088810	3.441122	3.841465	0.0636
Maximum eigen value				
None *	0.914648	91.05577	33.87687	0.0000
At most 1 *	0.790986	57.91813	27.58434	0.0000
At most 2 *	0.424409	20.43724	21.13162	0.0623
At most 3 *	0.113641	4.463410	14.26460	0.8075
At most 4 *	0.088810	3.441122	3.841465	0.0636

Notes: * denotes rejection of the hypothesis of no cointegration at the 0.05 level

PSC: Trace	Eigen value	Statistic	Critical value	Prob. Critical value
None *	0.872217	141.2351	69.81889	0.0000
At most 1 *	0.645854	65.11058	47.85613	0.0006
At most 2 *	0.351685	26.70291	29.79707	0.1091
At most 3 *	0.234367	10.66792	15.49471	0.2327
At most 4 *	0.021046	0.787008	3.841465	0.3750
Maximum eigen value				
None *	0.872217	76.12450	33.87687	0.0000
At most 1 *	0.645854	38.40767	27.58434	0.0014
At most 2 *	0.351685	16.03499	21.13162	0.2228
At most 3 *	0.234367	9.880915	14.26460	0.2199
At most 4	0.021046	0.787008	3.841465	0.3750

Notes: * denotes rejection of the hypothesis of no cointegration at the 0.05 level

FI: Trace	Eigen value	Statistic	Critical value	Prob. Critical value
None *	0.696222	92.26896	69.81889	0.0003
At most 1 *	0.578370	48.18496	47.85613	0.0465
At most 2	0.211025	16.23079	29.79707	0.6960
At most 3	0.171073	7.461045	15.49471	0.5247
At most 4	0.013929	0.519004	3.841465	0.4713
Maximum eigen value				
None *	0.696222	44.08400	33.87687	0.0022
At most 1 *	0.578370	31.95417	27.58434	0.0128
At most 2	0.211025	8.769745	21.13162	0.8506
At most 3	0.171073	6.942041	14.26460	0.4960
At most 4	0.013929	0.519004	3.841465	0.4713

Notes: * denotes rejection of the hypothesis of no cointegration at the 0.05 level

FM: Trace	Eigen value	Statistic	Critical value	Prob. Critical value
None *	0.868001	183.7446	69.81889	0.0000
At most 1 *	0.810884	108.8212	47.85613	0.0000
At most 2 *	0.616496	47.20169	29.79707	0.0002
At most 3	0.202227	11.74071	15.49471	0.1698
At most 4	0.087334	3.381239	3.841465	0.0659
Maximum eigen value				
None *	0.868001	74.92343	33.87687	0.0000
At most 1 *	0.810884	61.61952	27.58434	0.0000
At most 2 *	0.616496	35.46098	21.13162	0.0003
At most 3	0.202227	8.359470	14.26460	0.3433

Notes: * denotes rejection of the hypothesis of no cointegration at the 0.05 level