

**DETERMINANTS OF MOBILE
MONEY SUBSCRIPTIONS INDUCED
BY CONVENTIONAL BANKS IN SUB
SAHARAN AFRICA**

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Abstract

Mobile Money is labelled essential for financial inclusion and financial access in countries subject to low bank penetration and dispersion. Mobile Money has proven to reach utmost rural areas in Africa, by providing financial access which several commercial banks have struggled to achieve since inception. The cost of Mobile Money penetration in comparison to incumbent banking penetration are apart by massive margins, mainly based on tedious registration requirements and high infrastructure costs faced by commercial banks. The empirical research report methodology issues such as endogeneity bias, heteroscedasticity, serial correlation, significant coefficient selection and valid instrument selection measured in the short and long run. Mobile money is termed disruptive when undertaken by mobile network operators that eventually become quasi- or virtual banks, and exceedingly profitable when undertaken by commercial banks. What is unclear is how long these disruptions last before conventional banks latch on and hence the questions being put forward.

This paper examines the level of disruption fintech vices such as mobile money, remain influenced by reduced traditional commercial bank operations. The study employs quantitative analysis on secondary panel pooled data over the period 2010-2019. It analysed the short-run and long run dynamics of interaction between several facets that constitute traditional bank operations and mobile money subscriptions. This study critically analyses four traditional bank related conduits namely, Automated Teller Machines (ATM) to commercial branch dilution, commercial bank transaction value and commercial bank transaction volume. While mobile money components such as active mobile money subscriptions and mobile money agents are examined, the empirical model was estimated using the two-stage least-squares and the two-step system generalised method of moments technique. Hence, the key question this study poses is how mobile money subscriptions have significantly been affected by traditional banking payment mechanisms, in the short and long run within SSA. The empirical findings exhibited a significant relationship with the interaction between mobile money on traditional banking conduits such as automated teller machines within SSA and REC ECOWAS. This interaction revealed the positive long run effect increased commercial bank has on mobile money subscriptions, insinuating industry convergence. However, this study could not establish whether strong regulated banking institutions implied contrary results in parts of SADC.

Keywords: Secondary panel pooled data; ATM to branch dilution; registered mobile money subscriptions; Two stage least-squares; Two step system generalised method of moments; SSA.

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List of Acronyms

MNO – Mobile Network Operator

GDP – Gross Domestic Product

MFS – Mobile Financial Services

FSP – Financial Service Provider

ATM – Automated Teller Machines

P2P – Peer to Peer

A2P – Application to Peer

W2B – Wallet to Bank

B2W – Bank to Wallet

W2W – Wallet to Wallet

B2B – Bank to Bank

USSD – Unstructured Supplementary Service Data

FinTech – Financial Technology

RegTech – Regulatory Technology

SSA – sub-Saharan Africa

EAC – East African Community

ECCAS - Economic Community of Central African States

ECOWAS – Economic Community of West African States

NA – North Africa

SADC – Southern African Development Community

REC – Regional Economic Community

2SLS – Two Stage Lease Squares

GMM – Generalised Method of Moments

4IR – Fourth Industrial Revolution

WBG – World Bank Group

IMF – International Monetary Fund

Chapter 1

Introduction¹

1.1 Background and Context of the Study

During the pre-Covid 19 era, many scholars focused on recovery from the 2008 Global Financial Crisis, by making smarter investment decisions in line with the Sustainable Development Goals (Geis & Chauvin, 2011; Anyanwu, 2011). The ideology to add technology to our daily finance routines through automation, for instance usage of seamless processes such as Quick Response (QR) Codes, Mobile Money (M-Money) based payments and Mobile Banking, have proven to be effective and efficient, by providing transparency and minimising financial risk (GSMA, 2021; Yakean, 2020; Alexander, Shi & Solomon, 2017). Several research studies have examined the crucial role technology plays in aiding cashless payments such as mobile money and mobile banking (Asongu & Nwachukwu, 2016; Dubey, Sonar, & Mohanty, 2020; Personal, Archive & Asongu, 2015). M-Money is defined as a digital Pay-As-You-Go (PAYG) medium of exchange and store of value typically offered by a Mobile Network Operator (MNO) or alternatively through a corporate entity² partnership with an MNO (Opiyo, 2019). Recently, during the Corona Virus Disease (COVID-19) global pandemic, it became evident that non-contact and cashless payments such as M-Money, would play a vital role in the continuity of financial transactions, through alternate payment methods for daily essentials such as food, utility bills, medication, transportation etc (GSMA, 2021; Dubey et al. 2020; Yakean, 2020).

The purpose of this study is to determine the extent to which 4th industrial revolution components of financial technology (fintech) such as M-Money, have affected and digitally been transformed by traditional banking institutions in Sub-Saharan Africa (SSA) pre and post COVID-19 (Asongu, 2013; Asongu, Nwachukwu, & Aziz, 2018; Ky, Rugemintwari & Sauviat, 2019; Schueffel, 2018; Wante & Ngaram, 2016; Lee, Gerencser, Kelly, Portman & Daley-Harris, 2009). Numerous research has shown interest in the relationship between Automated Teller Machine (ATM) and commercial bank branch concentration, with active M-Money subscriptions, agents and payments (Dunne & Kasekende, 2018; Esawe, 2022; Ky et

¹ The first three chapters draw extensively on student proposal and chapter drafts previously submitted as part of the UCT MCOM in Development Finance research process.

² Commercial Bank, Microfinance or Fintech

al. 2019; Lutfi, 2016; Mothobi & Grzybowski, 2017). Mobile phones are considered the major tool of trade that facilitate mobile money and mobile banking financial transactions, hence, making cell phone penetration a vital part of digital transformation (Ebaidalla, 2014; Mothobi & Grzybowski, 2017; Odhiambo, Nyasha, Zerihun & Tipoy, 2019). Likewise, M-Money is known to heavily be dominated by telecommunication companies, originally derived from a stream of Mobile Financial Services (MFSs) that were constrained to merely remitting money through a mobile phone. Presently, fintech departments from several Mobile Network Operators (MNOs) in Africa such as MTN, Airtel and Safaricom are exploring financial products such as micro cash, airtime and data credit, savings, loans, insurance, and remittance payments, which have since propelled the unbanked to access financial services and investment platforms at their fingertips (Harris, Goodman & Traynor, 2013; Asongu, 2013; Idriss, Ajiya, Gumpy, & Madu, N.D).

Additionally, across the rising continent, MNOs in comparison to traditional commercial banks, dominate mobile phone provisioning and access through the facilitation of mobile phone based financial services as issuers of the Subscriber Identity Module (SIM) card. Ordinarily, majority M-Money transactions are comprised from the informal sector, entailing individuals without access to a formal bank account. However, studies have shown an increase in M-Money usage in the corporate sector as well as through agency banking and standalone consumer wallets created with minimal KYC requirements (Dzombo, Kilika & Maingi, 2018; Fabiana Meijon Fadul, 2019; Idoko & Chukwu, 2022; Ndiema, 2010). Hence, aspects such as a central National Financial Switch, regulated by the central bank, has encouraged convergence within the financial services industry (Baur-yazbeck, Kilfoil & Botea, 2019; Report, 2017).

Conversely, the rapid adoption of M-Money in Africa has raised security concerns regarding data privacy, cybersecurity, money laundering and consumer protection (Harris, Goodman, & Traynor, 2012). The Financial Action Task Force (FATF) recommends financial institutions that offer M-Money to perform due diligence on Know-Your-Customer (KYC) aspects such as client identity and scrutinized transaction records made available for at least a period of five years (Bahia & Muthiora, 2019; Harris et al. 2013; Didenko, 2017; (PwC, 2019). However, weak adherence to stipulated rule of law and limited privacy protection in most African countries, pose a challenge for transparency and record keeping practices. Thus, a minor section of this research is aimed at investigating the extent to which regulatory forces affect

mobile money operations (Choi & Ham, 2015; Fitri, 2016; Philippon & Carney, 2017; Vasilijeva & Lukanova, 2016; Wulan, 2017).

Traditional banks on the other hand consider these requirements as rational, prudent and non-contentious routine deliverables (Harris et al. 2013). Hence, insufficient privacy protection laws often lead to infringement by government and data miners, leaving consumer information subject to theft, leakage, and reputational damage by the Financial Service Provider (FSP). Similarly, Computer Emergency Response Teams (CERTs) known as valuable assets in detecting and monitoring fraudulent activity, are unfortunately in infancy in most parts of Africa. Therefore, awareness and sensitisation campaigns on cyber-crime, malicious activities and password confidentiality are essential in preventing M-Money fraud attacks in countries known to have numerous users with inadequate digital literacy (Harris et al. 2013; De Koker, 2013; Yakean, 2020).

In Africa, mobile calling rates remain relatively high by world standards, while mobile phone penetration leads across the globe. Additionally, digital payments are reported to have increased massively due to the 2019 global health pandemic. Similarly, according to GSMA (2021), the number of registered mobile money accounts across Africa grew to 562 million accounts at 12 percent, composed of 161 million active accounts recording 18 percent annual growth, leaving 401 million accounts in dormant state in 2020. While transaction volume and value denoted in United States Dollar (US\$) increased annually by 15 percent to 27.5 billion and 23 percent to \$495 billion, respectively (GSMA, 2021). It is forecasted that by 2025, 475 million Africans will have mobile internet use of which 27 percent and 3 percent are expected to account for 3G and 2G network respectively (GSMA, 2021). Hence, by 2024 the mobile industry is expected to contribute \$184 billion to overall sub-Saharan African Gross Domestic Product (GDP) (GSMA, 2021).

Post covid 19, financial inclusion and literacy increased across several regions in Africa mainly due to mobile money adoption. Countries in the SADC region such as Zambia with a total adult population of 9.5 million, report financial inclusion increased by 10.1 percentage points to 69.4% in 2020 from 59.3% in 2015 (Finscope, 2020). Furthermore, 71.2% of males are financially included compared to 67.9% of females, indicative of a slight prevalent gender gap (Finscope, 2020). Concurrently, urban areas accounted for 83.8% of adults, while rural areas reported approximately 56.9% financial inclusivity (Finscope, 2020). Moreover, formal financial inclusion increased to 61.3% in 2020 from 38.2% in 2015, representing a 62%

increment over half a decade, despite economic challenges such as currency depreciation (Finscope, 2020). Additionally, the usage of formalised mobile money increased to 58.5% in 2020 from 14% in 2015, indicating an approximate 24% adoption increase (Finscope, 2020).

At a micro level, cashless payments have proven desirable due to low financial transaction costs, increased sales from convenience and business expansion through online customer outreach on discounts, coupons, and promotional campaigns (Yakean, 2020). In contrary, large businesses that stance at a macro level, benefit from available big data to perform customer analytics and loyalty programs based on purchase preferences and buying patterns (Yakean, 2020). Hence, it is imperative to analyse the depth of convergence between mobile money payments and commercial bank payments within the financial service industry in SSA. For instance, founded in 2007 by Safaricom, M-Pesa allows subscribed users to perform traditional banking services using their mobile phones (Alexander et al. 2017).

Several cases of technology diffusion are observed among traditional financial service providers, such as, establishing a large Information and Communication Technology (ICT) department to oversee application and operating systems within the organisation. This dissemination is proposed to have enabled customer centric interfaces such as Automatic Teller Machines (ATMs) and online banking (Alt, Beck & Smits, 2018). However, it is proposed that FinTech companies offering global financial solutions, such as big data will play a pivotal role in boosting the traditional banking sector (Alexander et al. 2017). Digital payment systems such as mobile money applications: online finance and investment platforms have since provoked traditional financial services due to efficiency, economies of scale³ and scope⁴, user-friendly seamless products and platforms.

Empirical evidence indicates a few interesting notions that highlight conventional banks responses to disruptive technologies. Firstly, the nexus that growth from new financial innovation such as mobile phone transactions, has led individuals to a shift from more liquid assets to less liquid resources, that hence lower the demand for money from ATMs and bank branches (Dunne & Kasekende, 2018). In slight contrast, Nguena (2021) and Fanta (2016) examine financial innovations in fintech, lead to financially inclusion for the unbanked and bank disruption for the banked, as more individuals have convenient access to finance through M-Money. Similarly, Lutfi (2016) support the notion that aspects such as M-Money agents and

³ Cost advantages that enterprises obtain due to size, output, or scale of operation.

⁴ Cost advantages that result when firms provide a variety of products rather than specializing in the production or delivery of a single product or service

ATMs expand financial access and inclusion for both the unbanked and banked. While, the notion of Bank-MNO partnership adoption is an encouraged strategy for the financial services industry, by bridging convergence between two financial service provider spectrums (Ky et al. 2019; Ntwiga, 2020). A slightly divergent opinion by Karakara & Phil (2018) indicate ownership of a mobile phone and bank account, has resulted in gender inclusion, as more women access finance through M-Money. While mobile phones are deemed the optimal common tool that leverages financial access either through M-Money or conventional banking (Asongu & Nwachukwu, 2016; Chikaodi, 2018; Ebaidalla, 2014; Fanta, 2016; Mothobi & Grzybowski, 2017). Lastly, the launch of agency banking and consumer wallets by conventional banks, is considered the most competitive response to disruptive finance, as deployed bank agents accept deposits and cash outs initially dominated by M-Money Agents (Dzombo et al. 2018; Idoko & Chukwu, 2022; Ndiema, 2010).

1.2 Research Problem

Some researchers have suggested the rapid rate of mobile phone penetration in the last decade across Africa as the core reason for M-Money infiltration (Asongu, Nwachukwu, & Aziz, 2018; Aker & Mbiti, 2010; Aker, 2008; Asongu & Nwachukwu, 2016; Chikaodi, 2018; Ebaidalla, 2014; Fanta, 2016; Mothobi & Grzybowski, 2017). As a result, the financial services industry has experienced a shift towards digitisation and partnerships with fintech companies to provide relevant services to customers (Ky et al. 2019; Ntwiga, 2020). Nevertheless, some scholars have shown that convergence between upcoming FinTech's that offer mobile money and traditional banking institutions, produce the finest financial products and services as these are intergenerational (Vives, 2017; Didenko, 2017; Ky et al. 2019). Additionally, attributes of convergence within the financial services industry such as shared regulation and digitisation enables interaction between dominant and recessive parties within the financial sector (GSMA, 2021; Mbiti & Weil, 2016; Alexander et al. 2017). However, other researchers such as Amatus & Alireza (2015) suggest a negative relationship between financial inclusion and financial stability. Hence, following the 2008 credit crunch, banks prioritised controlling systematic risk on investments which have since shifted to adopting the agency banking model, as opposed to deployed ATMs and bank branches (Dzombo et al. 2018; Idoko & Chukwu, 2022; Ndiema, 2010). Thus, understanding the level of convenience that conventional banks provide services to the unbanked, is the most imperative attribute through the fourth industrial revolution drivers of digitisation.

1.3 Research Questions

This study aims to achieve the outlined set of objectives:

1. To understand the short-run dynamics of the interaction between Traditional Bank (TB) conduits and Mobile Phone Penetration (MPP) for M-Money Subscriptions (MMS) in SSA.
2. To understand the long-run dynamics of the interaction between Traditional Bank (TB) conduits and Mobile Phone Penetration (MPP) for M-Money Subscriptions (MMS) in SSA.

The primary question this study seeks to answer is, therefore, how mobile money subscriptions have significantly been affected by traditional banking payment mechanisms? This notion is further divided into the following key questions:

- (i) “Do Traditional Bank (TB) conduits have a significant effect on M-Money Subscriptions (MMS) for SSA and the selected REC in the short run?”
- (ii) “Do Traditional Bank (TB) conduits have a significant effect on M-Money Subscriptions (MMS) for SSA and the selected REC in the long run?”

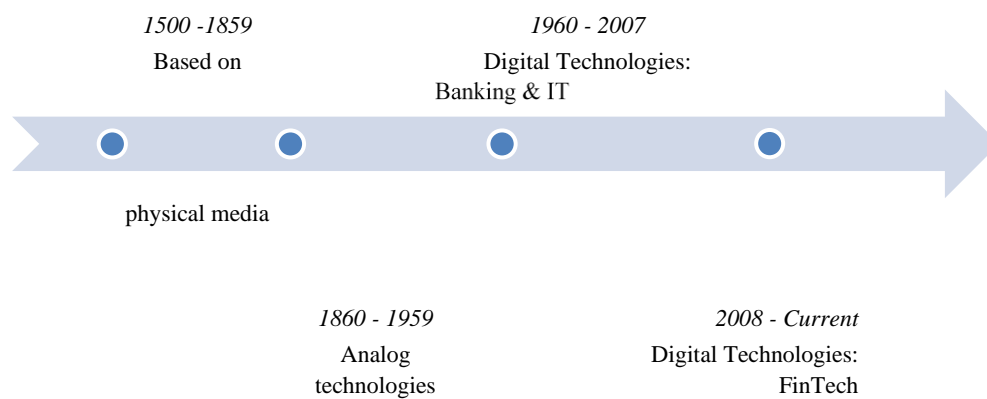
1.4 Research significance

Digitisation has resulted in ease and convenience for the unbanked to access finance as well as high risk of data protection in SSA (Arner, Barberis, Buckey, Arner & Buckley, 2017; Greenacre, n.d.; Maurer, 2012; Oney, 2018; Zetzsche, Buckley, Arner, & Barberis, 2018). Hence, while traditional banking institutions are premised on sterling regulation, mobile financial services are labelled questionable, in spite minimal efforts by central regulatory bodies (Dzombo et al. 2018; Idoko & Chukwu, 2022; Kiviatt Abstracr, 2015). Thus, with the accelerated convergence speed caused by the Covid-19 pandemic, it is vital to outline the severity of disruption and regulatory amendments within the financial services industry, to cater for modality measures in the short run and policy issuance in the long run.

This study will therefore contribute towards the budding research pool within the SSA region. Thus far, the relationship between M-Money and traditional banking conduits are empirically analysed from an SSA perspective (Dunne & Kasekende, 2018; Ebaidalla, 2014; Esawe, 2022; Ky et al. 2019; Lutfi, 2016; Mothobi & Grzybowski, 2017; Nguena, 2021; Odhiambo, 2020). Some empirical evidence has supported this as digital transformation, while other researchers have termed this as fintech disruption within the financial service industry (Alexander et al.

2017; Didenko, 2017; Maurer, 2012; Must & Ludewig, 2010; Idriss, N.D). Hence, this study will focus on four TB conduits at SSA and REC level categorised by (Dunne & Kasekende, 2018; Ebaidalla, 2014; Esawe, 2022; Ky et al. 2019; Lutfi, 2016; Mothobi & Grzybowski, 2017; Nguena, 2021; Ntwiga, 2020; Odhiambo, 2020). Hence, TB conduits classified as bank access, bank decentralisation, transaction volume and transaction value are examined (Dunne & Kasekende, 2018; Ebaidalla, 2014; Esawe, 2022; Ky et al. 2019; Lutfi, 2016; Mothobi & Grzybowski, 2017; Nguena, 2021; Ntwiga, 2020; Odhiambo, 2020). Thus, the extent of additional components such as mobile phone penetration (MPP), point of sale terminals (POS), retail cashless transactions (RCT), credit from a financial institution or credit card (BFC) and outstanding loans (OLO), are analysed within SSA. Furthermore, these variables are derived from Commercial Banks, FinTech’s and Micro Finance Institutions (MFIs) within SSA.

Figure 1. FinTech Evolution - Version 1



Adapted Source – Alt, Beck, & Smits (2018), Adapted Source – Arner et al (2017)

Table 1. FinTech Evolution (Version 2)

Date	1866-1967	1967-2008	2008-Current	
Era	FinTech 1.0	FinTech 2.0	FinTech 3.0	FinTech 3.5
Geography	Global	Developed	Developed	Emerging
Key Elements	Infrastructure	Internet	Start-ups	
Shift Origin	Linkages	Digitisation	Credit crunch	Last mover advantage
Events	Deployment of first transatlantic cable	ATMs SWIFT Calculator BACS CHIPS Mobile phone Financial Crisis	Smartphone iPhone	Bitcoin

Adapted Source – Alt, Beck, & Smits (2018), Adapted Source - Arner et al (2017)

Figure 1 illustrates the transition and development of fintech from inception to date. Arner (2017) discusses the term FinTech to originally be traced from a Citigroup mission in the early

1990s called “Financial Services Technology Consortium,” established to facilitate technological cooperation across borders. Table 1 exemplifies the evolution of FinTech and delivers the notable events that occurred during each era.

Citi Group (2016) investigate FinTech investments to have risen exponentially from \$1.8 billion in 2010 to \$19 billion in 2015. The following trends support FinTech as an alternative source of finance, of which Kenya and South Africa are the market leaders in SSA, noted to raise USD 16.7 million and USD 15 million respectively from online channels in 2015. Firstly, the 2008 Credit Crunch and rising high profile financial outrages such as the Lehman Brothers and Bernie Madoff scandal, derailed the trust and confidentially promised by traditional banking institutions. Secondly, transaction costs are minimised significantly through innovation and product optimisation, leading to services such as a digital mobile wallet that offer better convenience, efficiency, and financial inclusion. Vives (2017) correspondingly suggest FinTech as new digital technologies that automate an extensive array of financial activities in a more cost-effective manner. Lastly, the merging of forward-thinking technology, readily available and affordable infrastructure such as Wireless Network, mobile technology, technology maturity platforms that facilitate big data and interaction of buyers and sellers in the global economy market, have all attributed to the progression of FinTech (Leong et al, 2017).

Furthermore, Leong et al (2017) highlight lending as the major financial service affected by FinTech’s, alongside payments, transactions, wealth, and insurance. These transactions are historically considered the main deterrent for microloans. However, with smarter technologies, firms can provide micro loans via a mobile phone. For instance, since inception of Just Mobile (JUMO) in 2015, this MFS FinTech serves a customer base of over 15 million users across Africa and Asia, with over USD1 billion disbursed in loans and USD103 million raised funding. Active markets such as Ghana, Kenya, Pakistan, Tanzania, Uganda, and Zambia have access to micro loans offered with suitable interest rates and payback terms (Tanzar, 2022). Hence, mobile phones are seen to significantly provides cost savings of reduced transaction costs for non-collateral based micro loans.

While regional Mobile Network Operators (MNO) such as MTN and Airtel have an established and growing mobile money consumer base, Kenya’s Safaricom produced a FinTech, and financially inclusive mobile payment platform called M-Pesa. This success story, has been a leading example of reduced transaction costs through technology in East Africa, noting that

close to 60% of the adult population in Kenya has a mobile money account, while over 70% have an incumbent bank account (Didenko, 2017). However, Kim, Shin & Lee (2009) mention that technology adoption moves with trusting a reliable mobile banking system. M-Pesa holds a customer base of over 22.6 million out of 28 million subscriptions, representing approximately 81% active subscriptions. While 380 million out of 480 million transactions have been recorded. The volumes of transactions on the platform contributes to over 40% of Kenya's Gross Domestic Product at 0.33 (Didenko, 2017).

Currently, the 2019 Corona Virus Pandemic (COVID-19) has resulted in remote and freelance school and working structures as ideal to prevent the spread of the virus. However, in rural Africa, many students and employees still have inadequate technological resources to perform day to day activities. This challenge further highlights the call for the needs assessment criteria by governments to evolve towards dispensing required tools to affected parties. Tech savvy agents may provide a range of customer journeys from simplistic, moderate to highly advanced, allowing a wide variety of consumers to access the product. Additionally, like any market, competition from opponents either builds into product development and success or product loss and upheaval. In this case, FinTech's biggest competitor are bank incumbents that are transforming their products and services with online banking, cell phone banking and 24-hour toll free customer service. Vives (2017) opposes that the impact of fintech to bank incumbents can be felt in capital markets. However, due to the FinTech sector being smaller than the traditional banking sector, bank incumbents have a lower shadow cost of funding and that provide higher quality products than FinTech's.

For FinTech's to survive, risk and threat management are key to safeguard long term sustenance. FinTech insourcing online platforms in comparison to incumbents outsourcing the equivalent, enable FinTech's to access to raw data that can be used to analyse consumer patterns for product betterment, in comparison to mere financial data accessible by an incumbent loan provider. For example, 007fenqi in China understands its customer base better through their purchasing history on its e-commerce site (Leong et al, 2017). The firm can identify customer needs and spending trends but can also generate data to assess customer quality and eligibility, depending on indicators such as purchasing behaviour and payment history (Leong et al, 2017).

Additionally, partnering with Multinational Organisations (MNOs) to leverage on access to a stable customer base has worked out for JUMO Fintech, by associating with several

telecommunication and taxi giants such as MTN, Airtel and Uber in Zambia, Tanzania, and South Africa, respectively (Tanzar, 2022). Similarly, 007fenqi heightened its merchandise array and customer experience, by partnering with Wal-Mart to allow Students to purchase over 1000 items directly from Wal-Mart on 007fenqi's e-commerce site (Leong et al, 2017). Additionally, an e-commerce FinTech provider 007fenqi diversified its product range by offering loan facilities as well as fashion accessories, outdoor gear, face care products and apparel to compete with loan offers by incumbent players (Leong et al, 2017). Furthermore, FinTech's may use e-commerce as an offered service to incumbent players to draw additional financial muscle. A FinTech comprised of both e-commerce and loan disbursements, can cushion the risk of operating in an unregulated environment (Leong et al, 2017).

Also, limited access to credit facilities due to unavailable financial data is another chief contest for FinTech's to measure credit risk. Leong et al (2017) mention employment to prevent loan default with no collateral. However, the literature suggests that formal employment does not demonstrate the ability to repay a loan as a basic requirement by majority incumbent banks. Micro money lender such as JUMO, may use utilities, bill payment and airtime advance payment histories as proxies for financial data during their credit scoring process to determine customer eligibility. Conversely, traditional banks are trying to narrow their technological gap between them and fintech start-ups, by transforming paperwork processes to electronic paperless processes through technology (Didenko, 2017). However, stringent business models and routine-based processes are weighing technological advancement of incumbent banks. Hence, Didenko (2017) confirm that FinTech's are rapidly reshaping the Financial Services Industry through Big Data, Robo-advisors ⁵ and Internet of Things (IoT), by providing new technological solutions such as virtual currencies e.g., bitcoin, online lending platforms and robo-advisory services. While blockchain technology has guaranteed trust among contracting parties through smart contracts. Blockchain technology, however, is in its early phases and authors argue that Africans are still trying to understand the credibility that guaranteed trust among contracting parties through smart contracts, is susceptible to be realised. Central Banks have deemed grey areas present in this fintech module, making it risky for use and causing controversy among blockchain circles. Additionally, digitisation and artificial intelligence have so far provided securitization and curtailed identity theft through biometric platforms.

⁵ computer programs that generate investment advice according to information they have about customers, and using machine learning tools, are a cheap alternative to human wealth advisors.

The South African Reserve Bank has expressed a cautious attitude towards virtual currencies such as Bitcoin explicitly, to hold no responsibility to oversee, supervise or regulate the landscape, systems or intermediaries for effectiveness, soundness, integrity, or robustness. Hence, any risks related to the virtual currency trading are barred by the end-user as independent risk (Didenko, 2017). An important challenge underlying virtual currencies concern Anti-Money Laundering and Countering the Financing of Terrorism (AML/CFT) restrictions. Inadequate Know-Your-Customer (KYC) checks connected to modern cryptocurrencies such as Bitcoin, have been termed to transact substantial volumes of value, with no trace to identify the actual transacting parties ideally regarded anonymous. The Financial Intelligence Centre Act (FICA) stipulates relevant client identification rules containing a closed list of entities subject to the AML/CFT duties. Hence, cautions must be taken to ensure that all trades associated with virtual currencies are covered by FICA (Didenko, 2017). Tools such as biometric, artificial intelligence and big data are known to reduce KYC and ALM regulatory issues.

Similarly, in 2015 the Central Bank of Kenya (CBK) issued two distinct clarifications regarding the legitimate position of virtual currencies, such as Bitcoin. The first was addressed to the public that settled to cease transacting in Bitcoin and similar cryptocurrency products. Secondly, the central bank cautioned all financial institutions against transacting in virtual currencies at a risk of appropriate corrective action by the regulator. Nevertheless, developments such state-issued virtual currencies, may revise existing regulation (Didenko, 2017). Instead of formulating a single set of regulatory priorities in relation to FinTech, regulators generally respond to the more pressing issues independently, when the need arises. This can be illustrated by the response of regulators SARB and CBK on the risks associated with virtual currencies.

Furthermore, big data companies such as Oracle, Amazon and Cloudera provide services such Google facial recognition to authenticate identity (Navaretti, Calzolari, Mansilla-Fernández & Pozzolo, 2018). Nevertheless, Navaretti et al (2018) plunge deeper and conclude that FinTech and Incumbent banks will coexist for a while, making the future of the Financial Industry a convergence of the two opposing sectors of finance. In Addition, Vives (2017) underline regulatory arbitrage as the major rationale for incumbents and FinTech's to partner, provided less stringent regulation is administered to new entrants. However, bank incumbents are known to lose market share because of amplified regulatory burden (Vives, 2017). The overall positive outlook of FinTech in Africa by the public and incumbent banks, lies in the distinct role this

sector plays in creating financial inclusion. Hence, convergence of the two opposing sectors may cover a larger portion of the market, with simultaneous analysis of both financial data and big data as well as regulatory arbitrage (Didenko, 2017).

Table 2. Convergence between conventional and fintech banks

Fintech Disrupter	Traditional Bank Response
<ul style="list-style-type: none"> • Virtual Wallets e.g., High mobile wallet adoption rate in Africa – 183 million people • Data Driven/ Internet – Lending, Savings e.g., Peer to Peer (P2P) lending, Application to Peer (A2P) lending, Virtual group saving • Financial eCommerce e.g., User portals to track personal finance and wealth management • Infrastructure e.g., Point of Sale devices, Payment gateways and applications, White label ATMs. 	<ul style="list-style-type: none"> • Agency banking, Aware & Active e.g., Creation of innovation tech labs and hubs • Launch products e.g., Mobile wallets, Prepaid instruments, Online lending • Invest / Acquire / Partner e.g., Acquire FinTech start-ups • Infrastructure e.g., ATM e-wallet cash outs processed on mobile phones

Adapted Source (Alexander et al. 2017).

The regulator pertains a trade-off between competition and financial stability to respectively foster a lighter regulatory approach for FinTech’s than traditional financial services and provide a major concern caused by the expansion of FinTech. Bofondi & Gobbi (2017) confront this concession by referring to the evolution of the regulatory structure in the 1980s, when IT and innovation such as money market funds challenged traditional banking. This led to steady deregulation aimed at stimulating competition and efficiency, however, perils such as shadow banking, the undertaking of risky off-balance sheet activities by banks and the 2008 credit crunch resulted. Hence, a similar pattern is expected to be observed should lighter regulation on FinTech’s be observed. Navaretti et al (2018) further expand light regulation as Sandbox regimes to be considered as temporary explorative tools that understand the implications of new products and services in the financial services industry. Didenko (2017) provides a study of firms selected for a sandbox trail exposed to various benefits, such as bespoke authorisation processes, no enforcement action letters or waivers of certain regulatory requirements.

Didenko (2017) argued the main contest to the regulatory sandbox design as unclear regulation towards the selection criteria to determine business eligibility. Making the preferences obtained by the select few as an unfair advantage. To resolve this, the Kenyan Capital Markets Authority in June 2017 launched communal consultation campaign for proposals on the regulatory

framework applicable to sandboxes in Kenya, while South Africa, has evidence of ongoing discussions towards this cause (Didenko, 2017). In theory, sand box regimes remain uncertain for the future, however designs offer customised support to technology trendsetters on a case-by-case basis may provide a better understanding of these new technologies by regulators. In addition, Didenko (2017) further claim that FinTech solutions often do not fit into prevailing regulatory frameworks and can decentralise, disintermediate, and anonymise financial service delivery, making it a challenge to apply domestic regulation to the new technologies. Hence, sand boxing establishes a win-win collaboration between the regulators and the regulated because authorities attain a deeper understanding of new technologies, creating a suitable, conducive, and controlled legal environment for businesses operate freely, administered by a clearer law binding framework (Didenko, 2017).

Additionally, due to competitive pressure from FinTech's, incumbent banks might manipulate opportunities of regulatory arbitrage and increase the riskiness of their activities. In Navaretti et al (2018), assessing and revising active regulatory theories to adapt to FinTech innovations have become a key component to ensure China's efforts towards building a modern framework for financial regulation. Hence, due to the proposed convergence between FinTech's and incumbent banks, the revised regulatory framework should allude to services rendered rather than the source of the service, creating a proportional competing arena. Navaretti et al (2018) propose a case-by-case regulatory approach, entailing each FinTech product having a unique set of regulations assigned to it. For instance, innovative payments are considered new and unknown with unclear regulations, while P2P lending typically requires full transparency to users. Guido Ferrarini states that imposing bank regulation to FinTech's could be irrelevant, considering the opaque bank platforms proposed to transform risks and maturities. Additionally, Navaretti et al (2018) suggest that if the lending party decides potential borrowers, regulation under portfolio managers takes effect.

Similarly, payment service regulation should be adhered when a platform collects money without consultation of third-party payment service provider. Lastly, the security regulation is employed when the platform develops secondary markets for their products and the issuance of tradable and non-tradable securities. FinTech is seen as a vital healthy evolution of financial markets of which disruption can be avoided. Likewise, Vives (2017) spot fintech as a welfare-enhancing disruptive capability that needs regulation to adapt digital technology towards ensuring financial stability. In accordance to Vives (2017) ultimate disruption to the financial service industry may arise from complete entrance of top digital internet companies such as

Amazon, Apple, Facebook, Twitter or Google, who are already active in fintech. These companies hold high potential resulting from large pools of customer data captured from their various platforms.

Yet again, scepticism on data privacy and consumer protection are major regulatory concerns from regulators to these high-end digital companies. Hence controls and securitization are proposed to be heavily embedded on these interfaces. Specifically, social media platforms such as Twitter, We-Chat, WhatsApp, Facebook and Instagram may follow suit Amazon's steadily growing lending platform with close to 150 million users by leveraging of readily available big data on user patterns. This extends the disruptive capacity and potential fintech has on bank incumbents with little or no access to such data. Services such as Apple Pay, WhatsApp Pay, Google Pay, We-Chat Pay, Facebook Pay and PayPal are making headway for users to make secure online payments. Leong et al, (2017) mention Chinese commercial colossuses, Alipay and WeChat host an 800 million customer base that dominates China's mobile payment emporium.

Didenko (2017) outlines a report specifying the key regulatory challenges affecting the African regional FinTech leaders Kenya and South Africa by performing desk-based research, legal expert consultations and roundtable discussions with various stakeholders in both countries. It was discovered that principal issues currently faced by the regulators are not technology related. Labelling the most acute challenges surrounding unequal treatment among parties, uncertainty and unclarity of existing rules applicable rules to FinTech firms. Interestingly, Kenya and South Africa provide statistics that over 70% of the adult population has access to a bank account. Hence, discovering whether an overlap exists between owning an incumbent based bank account and a FinTech based financial account provide an interesting outlook of the two sectors (Didenko, 2017).

Moreover, technology is considered to bring escalations in fraud, as processes are more exposed and interlinked to multiple operators. Examples include identity theft and money laundering. Hence, digitisation and artificial intelligence have so far provided securitization to curtail cyber-crimes, through biometric and certified secure site platforms. Unfortunately, as technology advances, cyber hackers advance, and regular routine system checks for anomalies by internal system owners and independent audit teams, aid reduces crimes but are not permanently sufficient. Regulating concerns in Fintech mainly relate to technology ills such as cybercrime, data privacy, and transparency and insider trading. Cybercrime prevention is one

of the key FinTech challenges in both Kenya and South Africa, with Symantec carrying out a cybercrime and cybersecurity study in 2016 that ranked the SSA countries 1st and 2nd respectively, as having experienced recurrent cyber-attacks, malware spells, spam scares and phishing hosts (Didenko, 2017). Worldwide, South Africa was listed as having the 3rd highest number of cybercrime victims, while research by Serianu shows that over 70% of people in Kenya are victims of cybercrime. Highlighting the weak cybercrime legal framework provided in these jurisdictions.

To curtail this, in June 2017 Kenya established the Computer and Cybercrimes Bill published in the Kenya Gazette, while South Africa took a similar course in July 2017 by creating the Cybercrimes and Cybersecurity Bill which was open for public consultation (Didenko, 2017). In addition, the Socio-Economic Impact Assessment System (SEIAS) was established and labelled to be particularly useful in shaping the future FinTech regulation through social and economic impact assessment driven by new technologies. Furthermore, online crowdfunding podiums finance projects that ordinary banking channels were not capable of undertaking. South Africa lacks a bespoke crowdfunding regulation resulting in the following array of rules as applicable. These include the Banks Act, relating to earlier mentioned deposit making activities; the Companies Act, applicable to company disclosure requirements and fiduciary responsibility; the Collective Investment Schemes Act, focused on investments pooled to channel into securities; The Financial Advisory and Intermediary Services Act, fixate intermediary services or advice; the Financial Markets Act observe online platforms matching investors with issuers and additionally, oversee securities traded on an over-the-counter basis; Lastly, the National Credit Regulation Act, closely monitor the platform that matches lenders with borrowers to provide unsecured loans (Didenko, 2017).

Additionally, legislation around FinTech is unclear and constantly growing, because a huge driver for FinTech, i.e., innovation, has no boundaries. According to Navaretti et al (2018) regulation has primary effects on the patterns of evolution of FinTech, possibly as essential as technological innovation. Citi Group (2016) suggest that an unregulated environment can provide opportunistic attributes for FinTech to thrive, based on unclear correction policies towards failure to comply. Vives (2017) provide evidence that Fintech outlets benefit from both explicit and implicit government guarantees, narrowing those successful operations depend on how much government regulation and guarantee are provided. On the other hand, little or no regulation in the FinTech market can result in uncertain goals by the firm, highlighting risk due to unrepresented policy constraints (Ventura et al. 2015). Likewise, Leong

et al (2017) mention 007fenqi to leverage on existing in an unregulated environment, by driving the IT team to adopt agile methodologies, to optimise the development cycle of their product. However, credit analysis comprised of credit scoring and risk assessment in the event of loan default are essential factors that determine loan eligibility and loan recovery (Leong et al. 2017).

With incredible opportunities for FinTech start-ups to disrupt the financial sector, formidable risk mitigation measures align to ensure their models do not violate financial rules and policies instituted before the Cyberspace age. Hence, regulatory uncertainty is a vital concern of FinTech's. These concerns are highlighted by Didenko (2017) as forming the foundation of a rule of law compliant legal regime, that govern the principle entailing all persons and authorities within the state, whether public or private should be bound to as beneficiaries. Furthermore, the number of successful FinTech businesses are relatively low, not limited to issues such as low technology adoption, but also jurisdiction confines on regulation. Didenko (2017) also mentions that despite the potential benefits of fintech, without clear regulation and enforcement, new technologies have been used by Ponzi firms in the past to deceive clients. For instance, Ezubao labelled once as one of the largest online lending platforms in China, collected over 9 billion US Dollars from over 900 000 investors fraudulently.

1.5 Organisation of research

Divided into five chapters, Chapter Two (Literature Review) provides an in-depth collection of previous theoretical and empirical themes examined by various researchers in the industry on M-Money and Traditional Financial Services. The selection of opposing views from various literature scholars are likely to suggest strong conclusions and recommendations. Chapter Three (Methodology) aims at the author's conduction of research through empirical analysis on panel data. Thus, hypothesis and scientific tests will be used to find answers to the research questions previously outlined. The Quantitative Methods research design approach is chosen and will be employed to panel data from FinTech and traditional financial sectors within SSA.

Chapter Four (Discussions and Findings) entails the analytical and theoretical results from the empirical analysis of secondary data sources. The accuracy of measurement and sampling techniques used in chapter three (methodology) will directly affect these discussions and results. Hence, it is important that elements of biasedness, endogeneity and heteroscedasticity are controlled. Chapter Five (Conclusion and Recommendations) summarises the research and

endorses theories based on the findings from chapter four and existing literature from chapter two and three. Hence, the authors perspective should clearly produce feasible proposals for FinTech's and the traditional financial service industry, in line with the research questions and objectives posed. Lastly, the author aims to state whether the research investigation has answered the research questions and problems, by proposing recommendations based on the theoretical and empirical analysis.

Chapter 2

Literature Review

2.1 Introduction

Firstly, this chapter identifies and defines key literature terms. Secondly, it offers stylised facts pertaining to mobile money subscriptions, commercial bank rudiments, mobile phone penetration and regulation. Thirdly, it stipulates theoretical frameworks on the relationship between mobile money subscriptions and commercial banks rudiments. Fourthly, it investigates existing empirical literature adopted by researchers on this relationship, across Sub-Saharan Africa (SSA). Lastly, this chapter settles by denoting a summary of key findings.

2.2 Definition of Key Terms

Mobile Money is defined as a digital Pay-As-You-Go (PAYG) medium of exchange and store of value typically offered by a Mobile Network Operator (MNO) or alternatively through a corporate entity partnership with an MNO (Opiyo. 2019). The ingenuity M-Money provides, cascades the unbanked and financially excluded to access financial services with a basic mobile phone as the only requirement (Asongu, 2013; Idriss et.al, N.D). The preliminary surge of M-Money was highly anonymous, as vast majority of users purchased and used unregistered pre-paid phones.

Presently, the procedure to acquire a mobile wallet entails Subscriber Identity Module (SIM) Card registration with a mobile phone, thereby obtaining a unique virtual account linked to the applicant's mobile phone number, reducing anonymity and private use (Harris et al. 2013). Traditional bank indicators are analysed such as bank service dispersion of ATMs and branches (Dunne & Kasekende, 2018; Esawe, 2022; Ky et al. 2019; Lutfi, 2016; Mothobi & Grzybowski, 2017), revenue attributes such as transaction value and volume (Odhiambo et al. 2019; Oyelami & Ogundipe, 2020) and mobile phone penetration (Ebaidalla, 2014; Maana, Mwita & Odhiambo, 2010; Mothobi & Grzybowski, 2017). Hence, supporting the concept that reduced usage of TB indicators should ideally increase M-Money subscriptions in areas that reflect large unbanked populations.

Acemoglu & Restrepo (2018) define FinTech as an ecosystem of: Digital and electronic currencies such as Bitcoin wallets in the West and M-Pesa⁶ in Kenya, that remarkably drives financial transactions accounting for at least 31 percent of this east African country's Gross Domestic Product (GDP); Digital payment systems such as mobile money applications; Online finance and investment platforms have since provoked traditional financial services due to efficiency, economies of scale⁷ and scope⁸; user-friendly seamless products and platforms. For instance, organisations have used artificial intelligence to create computerised financial advisory forums targeted at millennials to combat wealth management.

Additionally, Acemoglu & Restrepo (2018) propose crowdfunding and innovative investment⁹ such as Kickstarter and Indiegogo to have propelled lucrative capital raising on online platforms for entrepreneurs and start-ups. Lastly, big data analytics has muddled the need for small and medium sized entrepreneurs to spend large amounts of time to gain access to credit, due to development of efficient risk and business models. Hence, these technologies have enabled the unbanked to gain access to finance and credit, thus promoting financial inclusion and well-intentioned societal goals across micro-sectors of the economy. Regulating this sector requires financial education and literacy that will have an impact on the masses, by avoiding harmful technology ills such as cybercrime¹⁰, personal privacy, and concerns over transparency and insider trading.

2.3 Overview of Traditional Banks, Mobile Phone Penetration and Mobile Money

2.3.1 Traditional Bank conduits within SSA.

Despite several decades of commercial bank existence before and after liberation within sub-Saharan Africa, research shows huge differences in TB conduits across RECs (Calice, Chando & Sekioua, 2012; Elsherif, 2016; Idoko & Chukwu, 2022; Ntwiga, 2020). Financial institutions such as commercial banks within SSA are still considered highly laggard in terms of decentralised access to finance, according to world standards (Amatus & Alireza, n.d.; Dinçer & Hacıoglu, 2013; The World Bank Group (WBG) G20 Financial Inclusion Indicators database, 2019; WBG World Development Indicators database, 2019). Thereby, encouraging

⁶ Pesa means money in Swahili.

⁷ Cost advantages that enterprises obtain due to size, output, or scale of operation.

⁸ Cost advantages that result when firms provide a variety of products rather than specializing in the production or delivery of a single product or service.

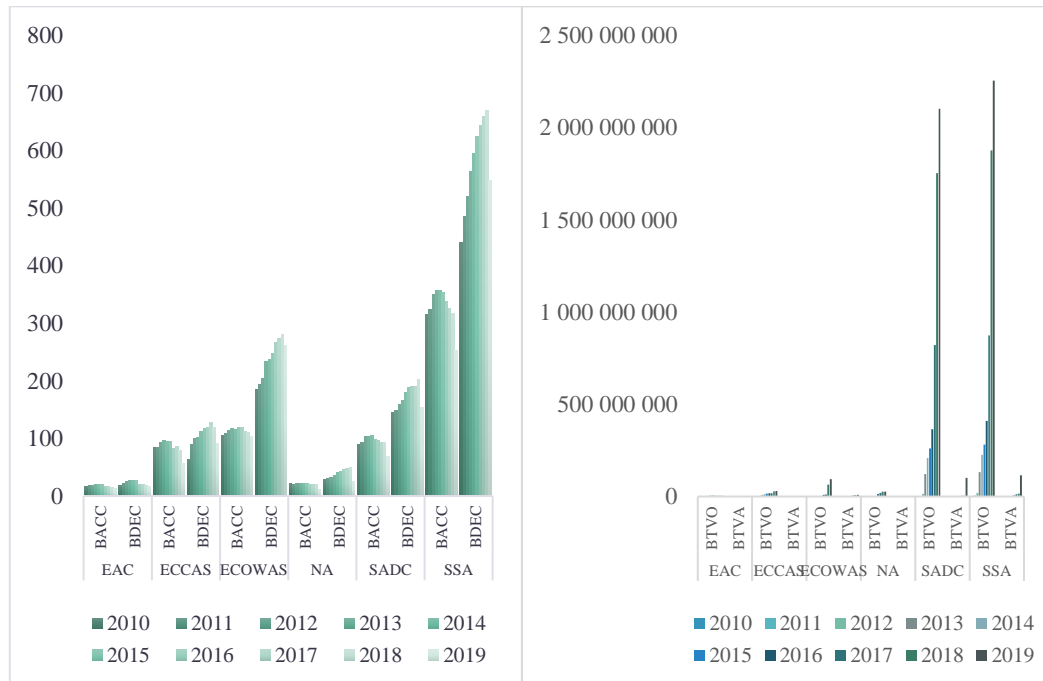
⁹ Investment in research and design and new technology (Michie & Sheehan, 2008).

¹⁰ Criminal activity that involves infringes data privacy through a computer or network.

the launch of inadequate financial products and services, due to infant scaled financial institutions, in comparison to global benchmarks (Paper, 2012)

Figure 2. Bank Branches & ATMs

Figure 3. Bank Transaction & Volume



Note: *EAC* represents the East African Community, *ECCAS* represents the Economic Community of Central African States, *ECOWAS* denotes the Economic Community of West African States, *NA* represents North Africa, *SADC* denotes the South African Development Community, and *SSA* represents overall sub-Saharan Africa. *BACC* denotes commercial bank access; *BDEC* denotes commercial bank decentralisation; *BTVO* measures annual commercial bank transaction volume; *BTVA* measures annual commercial bank transaction value. Results were based on the 45 selected countries in this study. Source: Author’s computations using The WBG (2019), G20 Financial Inclusion Indicators database and The International Monetary Fund (2019), Financial Access Survey database.

Figure 2 illustrate bank access and decentralisation highest in *ECOWAS*, followed by *SADC*, *ECCAS*, *NA* and lowest in *EAC*. Similarly, Figure 3 showcases bank transaction volume and value highest in *ECOWAS*, then *SADC*, *ECCAS*, *NA* and lowest in *EAC*.

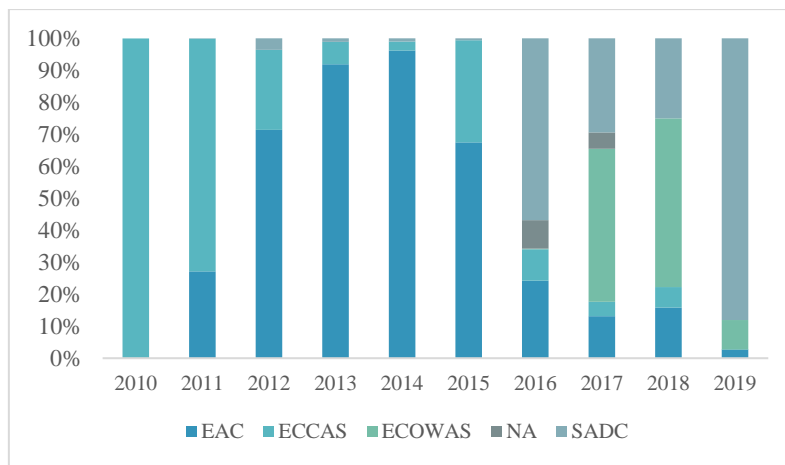
2.3.2 Mobile Phone Penetration within SSA

Mobile Phone Penetration has seen phenomenal growth across all regional economic groups within sub-Saharan Africa (The WBG G20 Financial Inclusion Indicators database, 2019). This is fundamentally owed to aspects such as increased mobility by individuals in rural areas to digitally access information from urban households and vice versa (Mothobi & Grzybowski, 2017; The WBG G20 Financial Inclusion Indicators database, 2019). Hence, resolving issues related to physical distance, considered highly relevant during the Covid 19 Pandemic. SADC,

ECOWAS and EAC report the highest penetration rates within SSA (The WBG G20 Financial Inclusion Indicators database, 2019).

Figure 4 reveal SADC as the highest significant increase from 3 million to 82 million in 2018 and 2019, respectively (The WBG G20 Financial Inclusion Indicators database, 2019). While MPP rates in ECOWAS and EAC moderately increased year on year (The WBG G20 Financial Inclusion Indicators database, 2019). ECCAS and NA expose reduced levels beyond 80 percent of the previous MPP value (The WBG G20 Financial Inclusion Indicators database, 2019).

Figure 4. Mobile Phone Penetration

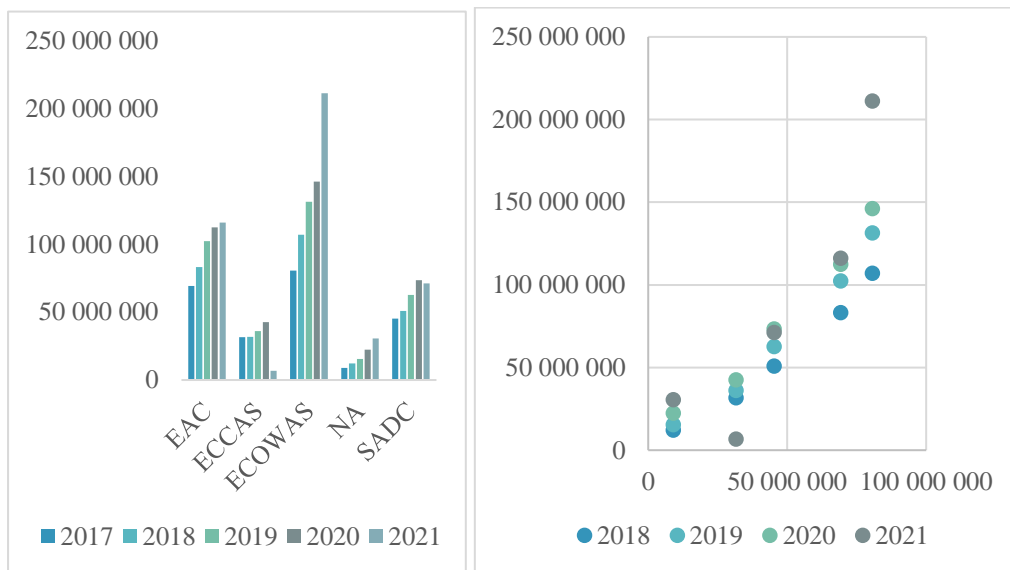


Note: *EAC* represents the East African Community, *ECCAS* represents the Economic Community of Central African States, *ECOWAS* denotes the Economic Community of West African States, *NA* represents North Africa, *SADC* denotes the South African Development Community. Results were based on the 45 selected countries in this study. Source: Author’s computations using the WBG (2019), G20 Financial Inclusion Indicators database and The IMF (2019), Financial Access Survey database.

2.3.3 Mobile Money Subscriptions within SSA

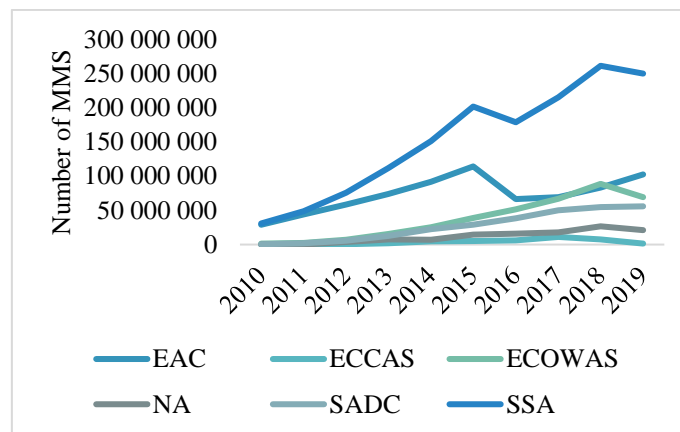
Post the Covid-19 pandemic figures 5 and 6 depict annual M-Money Subscriptions from 2019 to 2021 increased by 13%, 61%, 99% and 14% for *EAC*, *ECOWAS*, *NA*, *SADC*, respectively. While *ECCAS* declined by 81% from 2019 to 2021. Overall, SSA M-Money Subscriptions increased by 25% from 2019 to 2021 (The IMF, 2019). It is therefore imperative that SSA reveal keen interest in M-Money.

Figure 5. Mobile Money Subscriptions (Pre-Post Covid 19)



Note: *EAC* represents the East African Community, *ECCAS* represents the Economic Community of Central African States, *ECOWAS* denotes the Economic Community of West African States, *NA* represents North Africa, *SADC* denotes the South African Development Community. Results were based on the 45 selected countries in this study. Source: Author's computations using the IMF (2019), Financial Access Survey database.

Figure 6. Mobile Money Subscriptions



Note: *EAC* represents the East African Community, *ECCAS* represents the Economic Community of Central African States, *ECOWAS* denotes the Economic Community of West African States, *NA* represents North Africa, *SADC* denotes the South African Development Community. Results were based on the 45 selected countries in this study. Source: Author's computations using the IMF (2019), Financial Access Survey database.

2.4 Theoretical framework

Scholar theoretical frameworks presented in the following subsection to determine the TB-Mobile Phone Penetration state for regional economic communities within SSA. These are examined in three segments: TB and M-Money Subscriptions, Mobile Phone Penetration and M-Money Subscriptions, and thereafter, a full 360-degree relation is assessed.

2.4.1 Traditional Bank Conduits and Mobile Money Subscriptions

2.4.1.1 Demand-Side

Digital transformation and the need to access proper finance, support increased M-Money Subscriptions as a direct effect from reduced usage of TB conduits (Alt et al. 2018; Kuada, 2019; Navaretti et al. 2018; Oney, 2018; Vasilijeva & Lukanova, 2016). Hence, TB convergence towards Fintech related methodologies is observed among traditional banks (Baur-yazbeck et al. 2019; Idoko & Chukwu, 2022; Report, 2017). Thereby, due to demand for financial inclusion, literacy, and access, fintech's driven by modern technologies are tactically positioned to rapidly roll out financial products and services that meet demands of the unbanked population.

Additionally, Bank-Fintech partnerships marginalise asymmetric information costs that would in turn be experienced as separate entities, thus increasing TB indicators, and inversely affecting the relationship to M-Money Subscriptions. However, this is not the case for SSA due to infant marked financial systems according to global benchmarks (Amatus & Alireza, n.d.; Dinçer & Hacıoglu, 2013; The WBG G20 Financial Inclusion Indicators database, 2019; WBG World Development Indicators database, 2019).

2.4.1.2 Supply-Side

The supply-side hypothesis suggest that reduced usage of TB conduits result in increased M-Money Subscriptions. Recently, commercial banks are focused on Agency banking rather than launching branches and ATMs (Dzombo et al. 2018; Idoko & Chukwu, 2022; Ndiema, 2010). Hence, Bank to Wallet (B2W) and Wallet to Bank (W2B) transfers require M-Money wallets to complete transactions (Choi & Ham, 2015; YAKEAN, 2020). Therefore, supply led M-Money subscriptions are essential for industry convergence among financial service providers. The speed of convergence in developing countries is more robust than advanced economies, due to high levels of the unbanked population (Puschmann, 2017; Navaretti et al. 2018). Furthermore, less stringent regulation towards commercial banks on Agency banking and wallet issuance are prone to increase M-Money Subscriptions. The selected four TB conduits will be analysed to determine the magnitude financial conduits accelerate the movement of Mobile Phone Penetration towards M-Money Subscriptions within sub-Saharan Africa.

2.4.2 Mobile Phone Penetration and Mobile Money Subscriptions

2.4.2.1 *Micro elements*

At household level, mobile phones are used to transfer necessary information on daily operations such as the physical status of each occupant. People mainly use mobile phones to make bill payments, remit and receive funds, send short messaging service (SMS), utilise wireless data, make voice calls and access smartphone applications such as social media (Betjeman, Soghoian & Foran, 2013). It is evident that during the Covid 19 pandemic, health related information spread at a faster rate through electronic means via social media platforms such as Facebook, Twitter and WhatsApp (Kabakama, Konje, Dinga, Kishamawe, Morhasonbello, Hayombe, Adeyemi, Chimuka & Lumu, 2022). Specifically, due to social distancing restrictions, many resorted to using online channels such as mobile banking and M-Money for payment, transfers and withdrawals (Esawe, 2022). Hence, M-Money products such as cashless loans, micro insurance, access to mobile data and airtime became more convenient than physically going to a store to purchase goods and services.

2.4.2.2 *Macro elements*

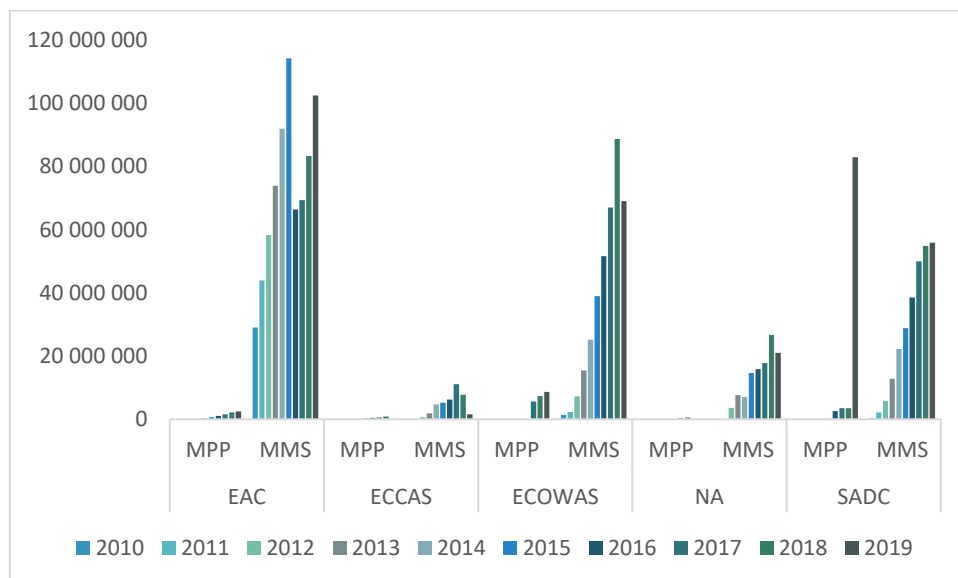
At a macro level, mobile phones are used to broadcast information and sensitisation on aspects such as rule of law by governing bodies. Many government institutions across sub-Saharan Africa and the rest of the world transitioned to channelling more critical public domain related information through digital means such as websites, social media platforms and mobile applications. For instance, remittances such as social cash transfers, grants, national health insurance payments, tax payments and pension contribution tracking have since been made available on zero rated websites, smartphone applications or USSD applications in parts of SSA (Lastunen, Rattenhuber, Adu-ababio, Gasior, Jara, Jouste, Nichelatti, Oliveira, Richiardi, & Wright, 2021; Lusaka, 2021; Mohammed, 2022). Thus, governments have partnered with MNOs to provide zeroised access to citizens at no data cost.

2.4.3 Traditional Bank Conduits, Mobile Phone Penetration and Mobile Money Subscriptions

Currently, no available theoretic works describe the Traditional Bank-Mobile Phone Penetration-Mobile Money Subscriptions relations. This nexus has been described differently partly in several studies. For instance, Dunne and Kasekende (2018); Lutfi (2016) examine the relationship between ATMs, bank concentration and M-Money agents. Ebaidalla (2014), Mothobi & Grzybowski (2017), Odhiambo (2020) mention relations between mobile phone

penetration and M-Money subscriptions. It is assumed that increased mobile phone penetration and reduced TB conduits make great complements to increase M-Money subscriptions. In contrary, it is assumed that reduced mobile phone penetration, increased TB conduits make great complements to reduce M-Money Subscriptions. Hence, resulting in a negative relationship between M-Money Subscriptions and the interaction between TB and mobile phone penetration. Therefore, the four TB conduits will test these hypotheses in the short and long run within SSA. Figure 7 provides a side-by-side outlay of Mobile Phone Penetration and M-Money Subscriptions. It can be observed that MPP in SADC significantly increased in 2019 and surpassed MMS in comparison to prior years.

Figure 7. Mobile Phone Penetration vs Mobile Money Subscriptions



Note: *EAC* represents the East African Community, *ECCAS* represents the Economic Community of Central African States, *ECOWAS* denotes the Economic Community of West African States, *NA* represents North Africa, *SADC* denotes the South African Development Community. Results were based on the 45 selected countries in this study. Source: Author's computations using the IMF (2019), Financial Access Survey database.

2.5 Empirical Literature

The following subsection examines the empirical literature on this three-dimensional TB-MPP-MMS nexus within SSA. The three divisions observed include: TB on M-Money Subscriptions, Mobile Phone Penetration on M-Money Subscriptions and TB interactions with Mobile Phone Penetration.

2.5.1 Traditional Bank Conduits and Mobile Money Subscriptions

Dunne and Kasekende (2018), Ky et al. (2019) and Lutfi (2016) empirically examined the TB-M-Money Subscriptions nexus within SSA. These scholars primarily focused on bank access,

bank decentralisation and M-Money Subscriptions (Dunne & Kasekende, 2018; Ky et al. 2019; Lutfi, 2016). Dunne & Kasekende (2018) examined 34 SSA countries from 1980 to 2013 and utilised ATM concentration, Bank concentration, and private sector credit growth as bank conduits. The study used the Dynamic General Methods of Moments (GMM) with fixed effects estimation, that significantly indicated financial innovation relating to reduced TB conduit usage, showed significantly positive long-run coefficients for money demand, where real money was used as the dependent variable (Dunne & Kasekende, 2018).

From a single country perspective, Ky et al. (2019) analysed 13 variables within Kenya from 2009 to 2015 and used bank performance as the dependent variable and M-Money adoption as a key independent variable. The study used Two Stage Least Squares (2SLS) with fixed effects and interaction variables and bank performance, Bank-MNO partnership to MMS as bank transaction value and volume indicators (Ky et al. 2019). Findings from the 2SLS estimation generally showed significant coefficients for transaction value and volume once proxied.

Similarly, Lutfi (2016) investigated 14 SSA countries, with key focus on access to finance as the dependent variable, while M-Money agents and ATM concentration were labelled explanatory variables. The study used the Two Stage Least Squares (2SLS) with fixed effects (Lutfi, 2016). Findings revealed a rise in the number of registered mobile money agents, increased financial access and inclusion in SSA (Lutfi, 2016).

2.5.2 Mobile Phone Penetration and Mobile Money Subscriptions

Fanta (2016), Karakara and Phil (2018), Mothobi and Grzybowski (2017) empirically examined the Mobile Phone Penetration-M-Money Subscriptions nexus within SSA. Mothobi and Grzybowski (2017) studied mobile phones show a significant effect to M-Money transactions. Their study analysed the Mobile Phone Penetration-M-Money Subscriptions nexus in 11 SSA countries in 2011 using the Logit regressions estimation technique.

In addition, Karakara and Phil (2018) show access to mobile phones significantly affected the ability to save through M-Money. This country specific study analysed Ghana in 2014 using the Logit regression estimation technique (Karakara & Phil, 2018). Similarly, Fanta (2016) examined several SSA countries using the Logit regression estimation technique. Hence, results show lower penetration of mobile phones reduced mobile money subscriptions (Fanta, 2016).

2.5.3 Traditional Bank Conduits and Mobile Phone Penetration

The TB-Mobile Phone Penetration link has been analysed in SSA, namely the effect of Mobile Phone Penetration on TB (Chikaodi, 2018; Countries, 2020; Tchouassi, 2012) . Tchouassi (2012) examined the effect of Mobile Phone Penetration on TB for 30 SSA countries from 2002 to 2009. Overall, the study showed that mobile phones had a significant positive effect on financial sector provisioning within the banking sector, leading to high bancarisation (*ceteris paribus*) (Tchouassi, 2012). The study selected the Generalized Least Squares (GLS) estimation, after the Ordinary Least Squares (OLS) estimation reported biased results. The study used mobile phones as an instrumental variable for the unbanked (Tchouassi, 2012).

Similarly, Countries, (2020) examined the significant effect of mobile phones on TB, in Nigeria countries from 2010 to 2018, using the qualitative meta-synthesis estimation. Overall, the ease of using a mobile device for personal banking significantly affected bank transactions and value (Countries, 2020). Chikaodi (2018) examined the effect of mobile phones on TB but for 93 developing countries in 2011 using the GMM estimation. Chikaodi (2018) discovered an increase in mobile phones significantly increased the capability to make bill payments through mobile banking, thus increasing bank transaction value and volume.

Table 3. Empirical Evidence

Source	Empirical Study	MMS & TB Related Variables Used	Summary of Findings
Asongu (2018)	Examined 25 variables for 49 SSA countries for the period 2000–2012	Bank density, Regulation Quality, Internet penetration	Supports the notion of positive correlation between mobile phone penetration and domestic savings, regulation, bill payments and remittances
Asongu et.al (2018)	Examined 25 variables for 49 SSA countries in 2011	Trade, Financial Depth, Inflation, Interest Margin, Loan Spread, Interest Spread, Bank Density, Bank Return on Equity and Return on Asset, Foreign Investment, Internet Penetration	Supports the notion that mobile phones improve the livelihood of individuals residing in remote areas through financial access
Mothobi et.al (2017)	Examined 11 SSA countries in 2017	Mobile Phone Subscriptions, Mobile, money, Mobile Transfers. Mobile Social and Internet activities	Supports the notion that mobile phones improve the livelihood of individuals residing in remote areas through financial access
(Dunne & Kasekende, 2018)	Examined 34 SSA countries for the period 1980–2013	ATM Concentration, Bank Concentration, Private Sector Credit Growth	Supports the expectation that growth in new financial innovation has led individuals to move away from more liquid assets to less liquid ones and that this lowers the demand for money
(Lutfi, 2016)	Examined 6 variables for 14 SSA countries for the period 2012–2018	Access to financial services per 100,000 adults, Mobile Money Agents per 100,000 adults, ATMs per 100,000 adults	Supports the evidence that increase in the number of registered mobile money agents led to increased access to financial services, thereby propelling financial inclusion through technology
(Esawe, 2022)	Examined 7 variables for 7 Middle East countries for the period January–December 2020	Registered and Active Mobile Money Accounts, Retail and Recreation, Grocery, and Pharmacy visits, Parks, Workplace Hours	Supports the notion that during the pandemic, the increased importance of MMS due to social distancing restrictions globally.
(Odhiambo, 2020)	Examined 39 SSA countries for the period 2004–2014	Financial Development, Mobile Phones, Regulation	Supports the implications that increased financial deepening through financial development could reduce carbon emissions footprint in SSA
(Ebaidalla, 2014)	Examined 9 variables for 30 SSA countries for the period 1995–2010	Trade Openness, Inflation, Mobile Subscriptions, Internet Users	Supports the potential of ICTs to improve the employability of young people in SSA

(Nguena, 2021)	Examined 11 variables for 34 SSA countries for the period 1999–2015	Fintech Innovation, Financial Openness, Commercial Openness	Supports the notion of fintech innovation increasing the fragility of the banking system in SSA
(Ntwiga, 2020)	Examined for Kenya for the period 2009–2018	Bank Credit Risk, Liquidity risk, Loan Intensity, Cost of Intermediation, Cost to Income, Return on Assets, Bank Size	Support the notion that fintech and banks collaborations had a positive influence on bank's technical efficiency for deposits versus loans and interest expenses versus deposits models.
(Ky et al. 2019)	Examines 13 variables in EAC for the period 2009 –2015	Bank-MNO Partnership, Mobile Money Payments, Mobile Money Transactions	Support the notion of mobile money adoption by banks through Bank-MNO partnerships
(Oyelami & Ogundipe, 2020)	Examined for 27 SSA countries	Remittances, Account Ownership and Income Per Capita	Support the notion that remittances have potential to explain changes in financial inclusion.
Fanta (2016)	Examine 10 variables for 11 SSA countries for the period 2014–2016	Mobile Phone Penetration, Mobile Money Account Ownership, Formal Inclusion, Informal Inclusion, Mobile Banking Usage, Internet Banking Usage, ATM Penetration, Remittances (inward and outward), and Remittances frequency.	Support the notion that mobile money is an affordable alternative to mobile banking
(Karakara and Phil, 2018)	Examine 6 variables for 11 SSA countries for the period 2014–2016	Own A Bank Account, Access to the Internet, Own a Mobile Phone, Access to Finance	Support the notion that more women would be financially included through mobile money
(Chikaodi, 2018)	Examine 8 variables for 93 developing countries for the year 2014	Mobile Pay, Credit, Remittances	Support the notion that financial literacy is essential to understand mobile phone transfers
(Countries, 2020)	Examine 8 variables for 27 SSA developing countries for the period 1990–2016	Remittances, Financial Inclusion	Support the notion that remittances have a significant effect on financial inclusion in the short and long run
(Tchouassi, 2012)	Examine 8 variables for 30 SSA countries for the period 2010–2018	Own A Bank Account, Income	Support the notion that ownership of a bank account is directly correlated to income earnings

2.6 Conclusion

The summary of sample studies in Table 3, indicate mixed support for demand side hypothesis, that supports increased M-Money result from reduced TB usage. While a few empirical studies have examined the interactive effect TB and Mobile Phone Penetration (MPP) on M-Money Subscriptions. Mainly due to MPP playing a critical role in M-Money and reduced usage of TB conduits withing sub-Saharan Africa. Empirical evidence such as the growth from new financial innovation such as mobile phone transactions has led individuals to a shift from more liquid assets to less liquid resources, that hence lower the demand for money from ATMs and bank branches (Dunne & Kasekende, 2018). In slight contrast, Nguena (2021) and Fanta (2016) examine financial innovations in fintech lead to financially inclusion for the unbanked and bank disruption for the banked as more individuals have convenient access to finance through M-Money.

Similarly, Lutfi (2016) support the notion that aspects such as M-Money agents and ATMs expand financial access and inclusion for both the unbanked and banked. While, the notion of Bank-MNO partnership adoption is an encouraged strategy for the financial services industry, by bridging convergence between two financial service provider spectrums (Ky et al. 2019; Ntwiga, 2020). A slightly divergent opinion by Karakara & Phil (2018) indicate ownership of a mobile phone and bank account has resulted in gender inclusion as more women access finance through M-Money. While mobile phone are deemed the optimal common tool leverages financial access either through M-Money or conventional banking (Asongu & Nwachukwu, 2016; Chikaodi, 2018; Ebaidalla, 2014; Fanta, 2016; Mothobi & Grzybowski, 2017). Lastly, the launch of agency banking by conventional banks is considered the most competitive response to disruptive finance, as deployed bank agents accept deposits and cash outs initially dominated by M-Money Agents (Dzombo et al. 2018; Idoko & Chukwu, 2022; Ndiema, 2010). Overall, mobile money accounts, bank density and mobile phone adoption were the most popular variables.

Therefore, literature gaps such as the level of convergence portrayed by the use mobile money related payments among traditional and upcoming financial institutions is highlighted by transactions such as instant Bank to Wallet and Wallet to Bank services. Furthermore, as convenience and accessibility are key for consumer choice presented with an array of financial products from both spectrums within the financial services industry, Fintech and conventional banking are swapping methodologies, unlearning inefficient operations such fixed branch

operations, and learning digitalised transactions. Additionally, based on the increase in mobile money and mobile banking transactions over the years, both unbanked and banked individuals have access to multiple wallet types further ascertaining separate financial options at consumer disposal. Thus, leading to probable aspects such as digitisation and convenience setting the two financial options streams apart, hence driving consumer choice.

Based on the literature review, the next chapter, Chapter 3, presents the study methodology, the empirical model and estimation techniques with reference to below hypothesis:

H0: Traditional banking conduits have no significant impact on increased mobile money subscriptions in sub-Saharan Africa (SSA) Regional Economic Communities (RECs).

H1: Traditional banking conduits have significantly impacted at least one REC on increased mobile money subscriptions within SSA.

A 360-degree continental view of mobile money subscriptions with the selection of relevant variables such as mobile penetration, mobile money agents and commercial bank activity is obtained from REC marking regional representation. The hypothesis in the short run aims to highlight quick responses by conventional banks to upcoming Fintech's in a digital economy. As can be seen in the literature, Fintech 2.0 and Fintech 3.0 highlighted more than a 10-year period is required for long term responses such as refined financial products. Hence, testing the hypothesis in the long run is imperative.

Furthermore, based on literature, the null hypothesis determines the highly unlikely notion that reduced conventional banking fails to increase mobile money uptake. While the literature supports the alternative hypothesis denoting reduced conventional banking drives mobile money usage in Africa. Conclusively, the two opposing financial spectrums within the 4IR, are highly distinguished by digitisation, as this presently forms the foundation and relevance of FinTech's, and mobile banking wallets powered by smartphones.

Chapter 3

Methodology

3.1 Introduction

This chapter outlines the research approach and design to resolve research questions and hypothesis previously mentioned in Chapter 1. The chapter commences with a summary and identification of the nature and origination of selected sample data. Thereafter, it illustrates the linkage of examined literature in Chapter 2 to the selected empirical model and variables. Subsequently, the model estimation techniques are presented and thereafter a precise protocol is taken to ensure sound reliability and validity. Further, limitations are provided right before conclusions are drawn.

3.2 Research Approach and Design

The study employs quantitative analysis on publicly available secondary panel pooled data over the period 2010-2019, sourced from the WBG (2019) G20 Financial Inclusion Indicators database, WBG (2019) World Development Indicators database (2019), IMF (2019) Financial Access Survey database. This data includes early adoption of mobile money from focus countries year on year. This study adopts the cause-and-effect nexus between theories, and further assumes relationships are measurable and testable (Leavy, 2022; Thompson, 2012). The key variables of interest are quantifiable, namely, TB, Mobile Phone Penetration and M-Money Subscriptions. Hence, the selected quantitative research approach is deemed most appropriate to answer previously posed research questions and hypothesis. Initially, this study will run descriptive and inferential analysis on the panel and infer variable statistics and correlation relationships in logarithmic form.

3.2.1 Sample period and size

The sample period explored a ten-year period between 2010 – 2019, inclusive of earliest and latest year across all regional economic groups outlined below:

- (a) East Africa Community (*EAC*): Comprised of Burundi, Kenya, Rwanda, Tanzania, and Uganda.

- (b) Economic Community of West African States (*ECOWAS*): Comprised of Benin, Burkina Faso, Cabo Verde, Cote d'Ivoire, Gambia, Ghana, Guinea, Guinea – Bissau, Liberia, Mali, Nigeria, Senegal, Sierra Leone, and Togo.
- (c) North Africa (*NA*): Comprised of Algeria, Egypt, Libya, Morocco, and Tunisia.
- (d) Economic Community of Central African States (*ECCAS*): Comprised of Angola, Cameroon, Central African Republic, Chad, Congo Democratic Republic, Congo Republic, Equatorial Guinea, Gabon, and Sao Tome & Principe.
- (e) Southern African Development Community (*SADC*): Comprised of Botswana, Eswatini, Lesotho, Madagascar, Malawi, Mauritius, Mozambique, Namibia, Seychelles, South Africa, Zambia, and Zimbabwe.

This study utilised the clustered random sampling technique to sample the SSA population represented by each regional group totalling forty-five countries. Clustered random sampling ensures random allocation of countries within each REC (Thompson, 2012). Therefore, this method is most appropriate as the purpose is to study the most representative REC in the SSA country population. This study takes a quantitative research approach with post-positivistic assumption-based knowledge claims, which assume a strategy of inquiry that is experimental in design, leading to probable cause-and-effect relationships between independent and dependent variables (Leavy, 2022). The second assumption relates to the various 'certainties' of the relationship between concepts as measurable and testable, given existing theories (Thompson, 2012). Lastly, it assumes that a series of hypothesis testing can enhance prevailing theories (Patten & Newhart, 2017; Thompson, 2012; Sukamolson, 2007).

Given that, this study embraces a deep inferential research approach to test the causal relationship between mobile money subscriptions and traditional banking conduits, it is imperative to iterate that the deductive approach, concerns formulating sets of hypotheses to empirically test existing theories (Asongu, 2018; Asongu et.al., 2018; Mothobi et.al., 2017; Patten et.al., 2017; Thompson, 2012). The adoption of a quantitative research design as a strategy of inquiry is certainly appropriate, as key variables of interest such Mobile Money Subscriptions (MMS) and Traditional Banking (TB) conduits are quantifiable and, therefore, employed statistical analysis can settle probable relationships (Patten et.al., 2017). Hence, this research approach and design is most suitable to answer the research questions and hypothesis, among the various regional economic communities in sub-Saharan Africa.

3.2.2 Empirical Model

The dependent variable in this study is Mobile Money Subscriptions (*MMS*) and the independent variables are Commercial Bank Branches (*BACC*), Automated Teller Machines (*BDEC*), Commercial Bank Transaction Volume (*BTVO*), Commercial Bank Transaction Value (*BTVA*), Mobile Phone Penetration (*MPP*), Point of Sale Machines (*POS*), Retail Cashless Transactions (*RCT*), Borrowed from a financial institution or credit card (*BFC*) and Outstanding Loan (*OLO*).

$$MMS_{i,t} = \alpha_0 + \beta_1 MMS_{i,t-1} + \beta_2 \ln TB_{i,t} + \beta_3 \ln MPP_{i,t} + \beta_4 \ln (TB \times MPP)_{i,t} + \beta_z Z_{i,t} + \omega_i + \varepsilon_{i,t} \quad (1)$$

$MMS_{i,t}$ measures the Mobile Money Subscriptions (*MMS*), where i represents sub-Saharan Africa (*SSA*) or each Regional Economic Community (*REC*), and t represents the year. $MMS_{i,t-1}$ is the lagged *MMS*, where $t-1$ represents the previous year. β_i measures the independent variable coefficients. α_0 is the constant term. $TB_{i,t}$ measures the individual *TB* indicator. The indicators are abbreviated as *BACC* denoting commercial bank access, *BDEC* symbolising commercial bank decentralisation, *BTVO* indicating commercial bank transaction volume and *BTVA* representing commercial bank transaction value.

$MPP_{i,t}$ measures the mobile phone penetration, while $(TB \times MPP)_{i,t}$ measures the interactive effects of traditional bank conduits and mobile phone penetration. ω_i measures unobserved time invariant country specific effects. $Z_{i,t}$ is a matrix of control variables, with β_z that measures the coefficient of each control variable. These include point of sale terminals, retail cashless transactions, credit from a financial institution or credit card and outstanding loans denoted as *POS*, *RCT*, *BFC* and *OLO*. $\varepsilon_{i,t}$ represents the error term without ω_i .

A sensitivity check is employed by use of the Mobile Money Agents (*MMA*) as an alternative measure of the *MMS*. The empirical model adapted from (Dunne & Kasekende, 2018) is shown in Equation 2 below:

$$MMA_{i,t} = \alpha_0 + \beta_1 MMA_{i,t-1} + \beta_2 \ln TB_{i,t} + \beta_3 \ln MPP_{i,t} + \beta_4 \ln (TB \times MPP)_{i,t} + \beta_z Z_{i,t} + \omega_i + \varepsilon_{i,t} \quad (2)$$

$MMA_{i,t}$ measures the mobile money agents, where i represents either *SSA* or each *REC*, the country and t represents the previous year. $MMA_{i,t-1}$ denotes the lagged mobile money agent growth rate, where $t-1$ represents the previous year. The remaining variables have an

unchanged interpretation described in Equation 1. The author computed Equation 1 and Equation 2 empirical findings in Chapter 4 and Appendix B, respectively.

Furthermore, the post estimation ratio iterated in Equation 3 compute the long-run multiplier effects of each independent variable previously stated in Equations 1 and 2 (Paper, 2013; Publication, n.d.)

$$\gamma_i = \frac{\beta_i}{1-\beta_1} \quad (3)$$

where γ_i denotes the long-run multiplier coefficient for each explanatory variable. β_i represents the predicted coefficient for each independent variable and β_1 signifies the predicted coefficient for the lagged dependent variable. The delta method is used to generate the test statistics and probability (p) values using (Paper, 2013; Publication, n.d.).

3.2.3 Definition and Measurement of Variables

Mobile money subscriptions (MMS) and mobile money agents (MMA) are sourced from the IMF (2019), Financial Access Survey database and calculated in annual real value terms. The first duo of traditional bank conduits highlighted as Commercial Bank Branches (BACC) and Automated Teller Machines (BDEC) are sourced from the WBG (2019), G20 Financial Inclusion Indicators database. While the second pair of TB indicators namely, Commercial Bank Transaction Volume (BTVO) and Commercial Bank Transaction Value (BTVA) are sourced from the IMF (2019), Financial Access Survey database. Mobile Phone Penetration (MPP) was sourced from the WBG (2019), G20 Financial Inclusion Indicators database.

Similarly, the control variables namely, point of sale terminals (POS), retail cashless transactions (RCT), credit from a financial institution or credit card (BFC) and outstanding loans (OLO) were sourced from the WBG (2019), G20 Financial Inclusion Indicators database. POS control for automated teller machines, RCT controls for commercial bank branches, BFC controls for commercial bank transaction value and OLO controls for commercial bank transaction volume.

Table 4. Sampled Traditional Bank Indicators

Commercial Bank	BACC	BDEC	BTVO	BTVA
	Commercial bank branches per 100,000 adults	Commercial bank ATMs per 100,000 adults	Annual commercial bank transaction volume	Annual commercial bank transaction value

Source: The WBG (2019), G20 Financial Inclusion Indicators database; IMF (2019), Financial Access Survey database.

Tabulated traditional bank indicators in table 4 were sourced from the WBG (2019), G20 Financial Inclusion Indicators database; IMF (2019), Financial Access Survey database publicly available sources using sample cluster analysis and further grouped into financial access, decentralisation, transaction volume and value. Moreover, these conduits were categorised into groups that define digital transformation and market value dominance. This study principally examines SSA and selected REC financial institutions. Hence, these TB conduits are expected to provide the effect reduced usage of traditional bank variables on mobile money subscriptions. This study will use the natural log of dependent and independent variables data to reduce elements of skewness pertaining to non-normality, while the indicative variables are divided into ratios to reduce the presence of multicollinearity (Dunne & Kasekende, 2018; Ky et al. 2019; Mothobi & Grzybowski, 2017; Tchouassi, 2012). To reduce multicollinearity, the logarithmic interaction variable is normalised and then multiplied as comprehensively described in Appendix A

3.2.4 Estimation Techniques

The empirical estimations make use of the full sample and three sensitivity analyses in the short and long run. Firstly, the effect of traditional bank conduits and M-Money Subscriptions within SSA and ECOWAS. Secondly, the effect of mobile phone penetration on M-Money Subscriptions within SSA and ECOWAS. Thirdly, the interaction of mobile phone penetration with conventional banking conduits within SSA and ECOWAS. Based on empirical research, the study expects below hypothesis will result in Chapter 4:

H0: Traditional banking conduits have no significant impact on increased mobile money subscriptions in sub-Saharan Africa (SSA) Regional Economic Communities (RECs).

H1: Traditional banking conduits have significantly impacted at least one REC on increased mobile money subscriptions within SSA.

3.2.4.1 Endogeneity bias

It is particularly common for panel regression models to suffer endogeneity bias, defined as the correlation between explanatory or independent variables with the error term, that can lead to incorrect inferences deluding theoretical interpretations (Ullah, Akhtar & Zaefarian, 2018). Hence, this study aims at controlling endogeneity bias succumbed through simultaneity bias, omitted variable bias and measurement error bias (Wooldridge, 2002). The Durban-Watson test is utilised to estimated endogeneity across selected regional economic communities against sub-Saharan Africa. The Instrumental Variable (IV) technique is employed to control simultaneity bias and omitted variable bias (Papies, Ebbes, & Van Heerde, 2017; Frölich & Melly, 2013; Wooldridge, 2002). Furthermore, the inclusion of lagged variables minimises omitted variable bias.

3.2.4.2 Heteroskedasticity

The assumption of non-constant variance between the independent variable means and residual values entails model heteroskedasticity. Thus, two tests are performed to confirm the presence of non-constant variance, namely: F-Test and Wald F-Test. Significant values are reported at 99% level of significance, thus directing the rejection criteria for SSA and the selected REC. While the T-test merely compares the mean of two samples, selected from the set of variables.

Normally, the random effects model comprises addition of ω_i to the unobserved terms, hence formulating a new variable denoted in Equation 4:

$$\theta_{i,t} = \omega_i + \varepsilon_{i,t} \quad (4)$$

In contrast, the fixed effects model includes addition of ω_i to the constant term, hence expressing a new variable expressed by Equation 5:

$$\varphi = \omega_i + \alpha_0 \quad (5)$$

3.2.4.3 Two Stage Least Squares/Generalised Method of Moments

The sampled studies used various estimation techniques, with a majority that captured unobserved country- and/or time-specific effects to overcome endogeneity bias (Asongu, 2018; Ullah. Akhtar & Zaefarian, 2018; Papies et.al., 2017; Frölich et.al., 2013). The following

estimation techniques were used namely: Two-Stage least squares (2SLS) regression with fixed effects and Generalised Method of Moments (GMM). The Hausman test is used to determine whether fixed or random effects model estimation techniques should be utilised. These literature sources justify the selected estimation techniques for this study as reasonable rationale.

Two linear equations are derived from the two-step system GMM estimator, on the basis that error terms are serially uncorrelated, Instrumental Variables (IV) are exogenous or there are serially uncorrelated error terms, strictly exogenous IV of independent variables (Arellano & Bover, 1995; Blundell & Bond, 1998). The first equation in level terms coincides with Equation 1 but includes endogenous lagged variables (Arellano & Bover, 1995; Blundell & Bond, 1998).

$$a) E [MMSi, t - s (\Delta \varepsilon_i, t)] = 0 \text{ for } t \geq 3 \text{ and } s \geq 2 \quad (6)$$

$$b) E [TBi, t - s (\Delta \varepsilon_i, t)] = 0 \text{ for } t \geq 3 \text{ and } s \geq 2 \quad (7)$$

$$c) E [MPPi, t - s (\Delta \varepsilon_i, t)] = 0 \text{ for } t \geq 3 \text{ and } s \geq 2 \quad (8)$$

$$d) E [(TB \times MPP) i, t - s (\Delta \varepsilon_i, t)] = 0 \text{ for } t \geq 3 \text{ and } s \geq 2 \quad (9)$$

$$e) E [Zi, t - s (\Delta \varepsilon_i, t)] = 0 \text{ for } t \geq 3 \text{ and } s \geq 2 \quad (10)$$

Fixed effects are eliminated by differencing; (Arellano & Bover, 1995; Blundell & Bond, 1998):

$$\begin{aligned} MMSi, t - MMSi, t - 1 \\ = \beta_1 MMSi, t - 1 + \beta_2 TBi, t + \beta_3 MPPi, t + \beta_4 (TB \times MPP) i, t \\ + \beta_5 Zi, t + (\varepsilon_i, t - \varepsilon_i, t - 1) \end{aligned} \quad (11)$$

Equation 11 supports preceding moment conditions (Arellano & Bover, 1995; Blundell & Bond, 1998; Bun & Sarafidis, 2013):

The system GMM estimation technique incorporated external instruments that are strongly correlated with TB and MPP, indirectly correlated with $MMSi, t$ and uncorrelated with ε_i, t (Roodman, 2009; Arellano & Bover, 1995; Blundell & Bond, 1998; Wooldridge, 2002; Bun & Sarafidis, 2013; Wooldridge, 2002). Hence, following the empirical literature in Chapter 2, confident conclusions that endogeneity exists within interaction terms seem fitting (Chowdhury, 2016; Giuliano & Ruiz-Arranz, 2009). In addition, the lagged dependent variable $MMSi, t-1$ is considered endogenous (Bun & Sarafidis, 2013). Further, the Hansen J test and Arellano Bond test were used to check instrument validity and no second order serial correlation (Roodman, 2009; Arellano & Bover, 1995; Blundell & Bond, 1998).

3.2.4.4 Reliability and Validity

This study employs secondary country cross sectional panel data from reputable sources where an extensive set of TB variables are used to determine the effect of Mobile Money on Incumbent Banks (The IMF, 2019; The WBG, 2019). To ensure reliability of findings, the exclusion of sub-Saharan African countries with insufficient data were omitted from the study. As alluded earlier, sequential validity tests are performed throughout the study, ensuring model and instrument validity. The study period marked as a decade offers valid and reliable results provided available estimations can account for short run and long run analysis, while reducing endogeneity bias (Bun & Sarafidis, 2013).

3.3 Limitations

Based on the research available, two limitations to this study exist. First, there is insufficient data for SSA countries that led to shortening of the study period, as Mobile Money came into prominence existence in the mid-2010s. Secondly, it was difficult to quantify the amount of sufficient regulation required for mobile money banks, as most research provided qualitative information. Taking all this into account, answers to the research questions and hypothesis are provided in Chapter 4 and 5.

3.4 Conclusion

This chapter has provided adequate justification and validation for the selected research approach and design. Correspondingly, it has ensured reliability and validity of empirical finding through delivering an empirical model and a detailed description of estimation techniques. Conclusively, the study limitations impeding this research are outlined and proposed for future research. Chapter 4 presents a detailed discussion of findings through analysis.

Chapter 4

Discussion Of Findings

4.1 Introduction

This chapter showcases the empirical findings through a series of tests and analysis. Firstly, the pre-analysis diagnostic checks, denoted as descriptive and inferential statistics for each dependent and independent variable are outlined. Secondly, this chapter presents fundamental regression effects for short and long-run relationships across previously stated variables specified in Chapter 3. Subsequently, conclusions and recommendations are charted.

4.2 Descriptive Statistics

Table 5 and 6 summarise the descriptive statistics within SSA from original and transformed data, respectively. The transformed data corrects skewness caused by a large variance between the mean and median values. In table 5, Mobile Money Subscriptions was considerable volatile given the standard deviation value of 7 633 307. While annual bank transaction volume (BTVO) appears more volatile at standard deviation values of 128 000 000. In contrary, annual bank transaction value (BTVA) and mobile phone penetration (MPP) display less volatile figures at 4 571 048 and 3 952 584, respectively. It can be observed that BTVO, BTVA and MPP mean values were comparatively higher than other variables shown in the nonlogarithmic output. Bank access (BACC) retains more stable values than bank decentralisation (BDEC) in both original data and the transformed model. Furthermore, the transformed data results insinuate mobile phone penetration (MPP) was less volatile than all traditional bank indicators: BACC BDEC, BTVO and BTVA reported at a standard deviation of 3.488.

The statistics show that mobile phone penetration in SSA signified an average of 15.09% to mobile money subscriptions, holding lower and upper limits of 0.00% and 18.967%, respectively. The presence of positive skewness can be observed for MPP and TB conduits as the mean values were suggestively larger than the median values, while control variables were generally less skewed (Keller, 2014). Outstanding loans (OLO) and Point of Sale machines (POS) recorded the most volatile control variable standard deviations at 1 966.987 and 147.429, respectively. Less volatile control variables such as Retail Cashless Transactions (RCT) and BFC represent SSA at an average of 3.02% and 1.15%, respectively to MMS over the panel.

Regarding physical transaction tools of trade, POS machines (30.91%) comprise a higher segment of MMS than mobile phones (15.09%).

Table 5. SSA Summary – Original Variables

Variables	Observations	Minimum	Maximum	Mean	Median	Standard. Dev.
MSS	450	0.000	59 400 000.000	3 387 604.000	22 957.500	7 633 307.000
BACC	450	-0.000	4.009	7.318	0.456	9.671
BDEC	450	-0.000	89.993	12.782	5.355	17.741
BTVO	450	0.000	1 950 000 000.000	13 500 000.000	0.000	128 000 000.000
BTVA	450	0.000	95 900 000.000	329 618.000	0.000	4 571 048.000
MPP	450	0.000	82 700 000.000	279 841.500	0.000	3 952 584.000
POS	450	0.000	1 408.585	30.913	0.000	147.429
RCT	450	0.000	109.708	3.024	0.000	11.935
BFC	450	0.000	25.151	1.149	0.000	3.366
OLO	450	0.000	21 346.170	336.208	7.572	1966.987

Note: Original Data. MMS denotes mobile money subscriptions; BACC denotes commercial bank access; BDEC denotes commercial bank decentralisation; BTVO measures annual commercial bank transaction volume; BTVA measures annual commercial bank transaction value; MPP denote mobile phone penetration; POS denote point of sale terminals; RCT denote retail cashless transactions; BFC denote credit from a financial institution or credit card; OLO denote outstanding loans. Source: Author's Computations.

Table 6. SSA Summary - Logarithmic Values

Variables	Observations	Minimum	Maximum	Mean	Median	Standard. Dev.
MSS	450	0.000	59 400 000.000	3 387 604.000	22 957.500	7 633 307.000
lnBACC	450	-0.591	4.009	1.474	1.505	1.001
lnBDEC	450	-1.010	4.430	1.776	1.708	1.297
lnBTVO	450	0.000	18.379	1.826	0.000	4.149
lnBTVA	450	0.000	21.391	2.779	0.000	6.076
lnMPP	450	0.000	18.967	15.092	0.000	3.448
POS	450	0.000	1 408.585	30.913	0.000	147.429
RCT	450	0.000	109.708	3.024	0.000	11.935
BFC	450	0.000	25.151	1.149	0.000	3.366
OLO	450	0.000	21 346.170	336.208	7.572	1 966.987

Note: Includes logarithmic data (ln); MMS denotes mobile money subscriptions; BACC denotes commercial bank access; BDEC denotes commercial bank decentralisation; BTVO measures annual commercial bank transaction volume; BTVA measures annual commercial bank transaction value; MPP denote mobile phone penetration; POS denote point of sale terminals; RCT denote retail cashless transactions; BFC denote credit from a financial institution or credit card; OLO denote outstanding loans. Source: Author's Computations.

4.3 Inferential Statistics

Table 7 displays the correlation matrix on selected variables within SSA. The results show significant correlation among traditional banking conduit variables. It can be observed that all TB variables resulted in positive correlation albeit significant or insignificant. The strongest correlation was observed between BTVO and BTVA at a coefficient value of 0.9518. Hence, model disparities to minimise multicollinearity was employed in Model 2,4,6,8, while Model 1,3,5,7 omitted the interaction variable Mobile Phone Penetration (MPP). Furthermore, TB indicators BTVO and BTVA had significant positive correlation to mobile money subscriptions (MMS) displayed by coefficients 0.1551 and 0.1876, respectively. In contrary TB indicators BACC and BDEC had insignificant coefficients to MMS at -0.0213 and 0.0676, respectively.

Additionally, the interaction variable MPP displayed significance with MMS, BTVO, BFC and OLO at coefficient values of 0.1430, -0.0926, 0.1162 and -0.1020, respectively. Remarkably, for the selected control variables, RCT is the only variable significantly correlated with other control variables. Hence, coefficients 0.4035 and 0.1573 represent RCT significant correlation to POS and BFC, respectively. Moreover, the statistics show that RCT and BFC as the only control variables significantly correlated to MMS at -0.0964 and 0.1128, respectively. Overall, the control variables were reasonably correlated with the vital variables that allude TB indicators and the interaction variable. Nevertheless, the strength and validity of the control variables as selected instruments will thoroughly be tested in each model.

Table 7. Correlation Matrix - SSA

	MMS	lnBACC	lnBDEC	lnBTVO	lnBTVA	lnMPP	POS	RCT	BFC	OLO
MMS	1.0000									
lnBACC	-0.0213	1.0000								
P-Value	0.6520									
lnBDEC	0.0676	0.2614**	1.0000							
P-Value	0.1524	0.0000								
lnBTVO	0.1551**	0.2072	0.0506	1.0000						
P-Value	0.0010	0.0000	0.2841							
lnBTVA	0.1876**	0.2375**	0.0672	0.9518**	1.0000					
P-Value	0.0001	0.0000	0.1547	0.0000						
lnMPP	0.1430**	0.0572	0.0637	-0.0926**	-0.0654	1.0000				
P-Value	0.0024	0.2256	0.1770	0.0497	0.1664					
POS	-0.0805	-0.0770	0.2867**	-0.0836	-0.0845	0.0463	1.0000			
P-Value	0.0882	0.1030	0.0000	0.0766	0.0732	0.3275				
RCT	-0.0964**	0.0756	0.3714**	-0.1034**	-0.0993**	-0.0111	0.4025**	1.0000		
P-Value	0.0410	0.1093	0.0000	0.0284	0.0352	0.8144	0.0000			
BFC	0.1128**	0.0634	0.1326**	0.0996**	0.1013**	0.1162**	0.0347	0.1573**	1.0000	
P-Value	0.0166	0.1795	0.0049	0.0347	0.0317	0.0137	0.4627	0.0008		
OLO	-0.0519	0.2275**	0.1178	-0.0660	-0.0699	-0.1020**	-0.0195	-0.0260	-0.0369	1.0000
P-Value	0.2722	0.0000	0.0124	0.1621	0.1385	0.0305	0.6794	0.5828	0.4349	

Note: MMS denotes mobile money subscriptions; BACC denotes commercial bank access; BDEC denotes commercial bank decentralisation; BTVO measures annual commercial bank transaction volume; BTVA measures annual commercial bank transaction value; MPP denote mobile phone penetration; POS denote point of sale terminals; RCT denote retail cashless transactions; BFC denote credit from a financial institution or credit card; OLO denote outstanding loans. Source: Author's Computations.

4.4 Regression results

4.4.1 Two Stage Least Squares (2SLS) IV (Instrumental Variable) regression - Fixed effect

The Hausman test was employed on longitudinal panel data to determine whether the random effects or fixed effects model should be utilised for further analysis. Below null and alternative hypothesis define the decision criteria:

$$H_0: \text{Random effects model is appropriate}$$

$$H_1: \text{Fixed effects model is appropriate.}$$

Table 8. Hausman Test – MMS as dependent variable

Variable	Model	Chi2 Statistic	Chi2 P-value	Preferred Estimation
BACC	Model 1	136.35	0.000	Fixed Effects
	Model 2*	14.19	0.028	Fixed Effects
BDEC	Model 3	83.63	0.000	Fixed Effects
	Model 4*	133.57	0.000	Fixed Effects
BTVO	Model 5	70.93	0.000	Fixed Effects
	Model 6*	0.21	0.998	Random Effects
BTVA	Model 7	71.00	0.000	Fixed Effects
	Model 8*	0.02	1.000	Random Effects

Note: * represent models with interaction. Reject the null hypothesis where p-values < 0.05% and utilise the fixed effects estimation method, otherwise utilise the random effects estimator.

Source: Author's computations.

The results tabulated in table 8 indicate six models, namely: Model 1-5;7 preferred the fixed effects estimator, while two models, namely: Model 6;8 deemed the random effects estimator as idealistic. Hence, p-values less than 5% resulted in rejection of the null hypothesis, in preference of the fixed effects estimator (Bai, 2009; Effect et al. 2019). Due to dominance, the fixed effects estimation method is adopted across all models irrespective of statistical insignificance. Thus, the selected estimation method implies that unobserved country-specific effects are fixed and comprised in the constant term (Refer to Equation 5 in Chapter 3)

Table 9 suggests that approximately between 100% and 6% of the variation in the mobile money subscription growth rate was explained by external factors beyond the selected models, suggesting a joint explanatory variation between R-squared between 0% and 94%. Hence, Lutfi (2016) and Nguena (2021) reported R-squared figures of 0% - 89% and 0% - 52%, respectively for their 2SLS fixed effects models. However, their studies had sample sizes of about 86 and 2780, respectively (Lutfi, 2016; Nguena, 2021). Further, it can be observed that 50% of the models in Table 9, namely, Model 1; 3; 5-6 were statistically significant through measures by the F-test.

Decision criteria:

$H_0: p\text{-values} > 0.05$ - Model Invalid

$H_1: p\text{-values} < 0.05$ - Model Valid

Table 9. 2SLS fixed effects estimation SSA – Dependent Variable: MMS

Variables	MODEL 1	MODEL 2	MODEL 3	MODEL 4	MODEL 5	MODEL 6	MODEL 7	MODEL 8
MMS _{t-1}	0.546*** [13.69]	1.219 [0.49]	0.536*** [12.71]	0.504*** [5.71]	0.534*** [11.97]	0.541 [2.63]	0.534 [11.96]	0.426 [42.23]
lnBACC	4.022*** [7.73]	-12.084 [-0.15]						
lnBDEC			1.717*** [5.07]	1.469*** [2.14]				
lnBTVO					0.214*** [2.89]	0.169 [0.46]		
lnBTVA							0.164 [2.91]	0.717 [0.00]
lnMPP	-0.085 [-1.383]	-0.482 [-0.14]	-0.059 [-0.91]	-0.199 [-0.91]	0.063 [0.97]	0.012 [0.04]	0.064 [0.99]	0.790 [0.00]
BACC*lnMPP		0.103 [0.16]						
BDEC*lnMPP				0.009 [0.41]				
BTVO*lnMPP						0.000 [0.33]		
BTVA*lnMPP								0.000 [-0.00]
POS	-0.001 [-0.49]	0.002 [0.10]	0.001 [0.00]	0.001 [0.63]	0.001 [0.32]	0.004 [0.30]	0.001 [0.38]	-0.049 [-0.00]
RCT	-0.055 [-2.66]	0.031 [0.10]	-0.048 [0.02]	-0.055 [-1.97]	-0.027 [-1.18]	0.050 [0.20]	-0.030 [-1.32]	-1.118 [-0.00]
BFC	0.043 [0.80]	-0.012 [-0.05]	0.029 [0.06]	0.023 [0.40]	0.031 [0.54]	0.045 [0.17]	0.028 [0.48]	-0.179 [-0.00]
OLO	0.000 [-0.36]	0.000 [-0.11]	0.000 [0.00]	0.000 [0.67]	0.000 [0.14]	0.000 [0.03]	0.000 [0.17]	0.000 [0.00]
Constant	-0.39 [-0.36]	12.292 [0.16]	1.984 [1.86]	2.941 [1.16]	2.746 [2.55]	0.960 [0.13]	2.671 [2.47]	27.167 [0.00]
F-test Statistic	3.25***	0.000	2.23***	2.22***	1.98***	0.09	1.98	0.00
R-squared	0.46	0.15	0.77	0.46	0.94	0.00	0.93	0.05
Wald F Statistic	2447.10***	132.87***	2216.28***	2231.28***	2098.49***	99.48***	2099.26***	0.53
Corr (u _i , xb)	-0.19	0.00	0.34	-0.04	0.66	-0.57	0.63	-6.40
Hansen J Pvalue	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00
Sigma	4.49	0.00	3.09	4.25	2.68	14.11	2.67	185.21
Sigma e	4.49	0.00	3.09	4.25	2.68	14.11	2.67	185.21
rho	0.62	0.00	0.41	0.57	0.33	0.40	0.33	0.38
Countries	45	45	45	45	45	45	45	45
Observations	405	405	405	405	405	405	405	405

Note: Significance levels: *** 1%. Z-statistics denoted in brackets. a. The Kleibergen-Paaprk Wald F-test is a weak identification test, where a value less than 10 indicates weak instruments (Baum et al. 2007). b The Hansen J test checks for instrument validity, where p-values greater than 5% indicate that instruments are not correlated with ε_i , t (Wooldridge, 2013). MMS denotes mobile money subscriptions; BACC denotes commercial bank access; BDEC denotes commercial bank decentralisation; BTVO measures annual commercial bank transaction volume; BTVA measures annual commercial bank transaction value; MPP denote mobile phone penetration; POS denote point of sale terminals; RCT denote retail cashless transactions; BFC denote credit for a financial institution or credit card; OLO denote outstanding loans.

Source: Author's Computations.

The joint null hypothesis of the F-test is that the model is invalid, while the alternative hypothesis is that the model is valid (Keller, 2014). The joint null hypothesis was rejected at the 1% significance level for Model 2;4;7;8 for p-values <0.05. Subsequently, Kleibergen-Paap rk Wald F test values reported values above 10 in all models, except Model 8 deem it reasonable to accept that selected instruments were certainly correlated with the endogenous variables (Baum et al. 2007).

Decision criteria:

H₀: Wald F test < 10 – Invalid Instruments

H₁: Wald F test > 10 – Valid Instruments

Appendix B tabulates the selected four instruments. The Hansen J statistic, in Table 9, showed that all the chosen instruments were jointly invalid since the p-values were all greater than 5% in all the models (Roodman, 2009). Table 9 provide interactions between mobile phone penetration (MPP) and traditional bank (TB) indicators led to zero significant results. Therefore, suggesting MPP tagged with any TB: BACC; BDEC; BTVO; BTVA indicator results invalid substitutes for mobile money subscription. It can further be observed that commercial bank access (BACC) had a significant positive and negative effect on mobile money subscriptions (*ceteris paribus*) in Model 1 and 2 respectively. This is indicative of the interaction between BACC and MPP, resulting in the expected negative effect a percentage change in commercial bank access decreases mobile money subscriptions by 12.08 points *ceteris paribus* (Chikaodi, 2018; Tchouassi, 2012).

Models 3 and 5 showed that traditional bank conduits BDEC, BTVO and BTVA had significantly positive coefficients, suggesting these elements increased mobile money subscriptions without any interaction to mobile phone penetration. Similarly, Model 4 provided that BDEC interaction with MPP displayed significant positive relationship with mobile money subscriptions. However, Model 6 and 8 without MPP interaction posed insignificant positive effects to mobile money subscriptions. Lastly, Model 7 indicated an insignificant negative impact on mobile money subscriptions. The results suggest that 50% of the selected models had sturdy influence on MMS for sub-Saharan Africa. Nevertheless, mobile phone penetration (MPP) reported insignificant coefficients in all the models, suggesting a weak effect on MPP. Due to significant positive coefficients of the first lagged mobile money subscriptions denoted by MMS_{t-1} , it can be concluded the previous year had a persistent positive effect on current values in Model 1, 3-5. While aspects such as Point of Sale (POS) machines, Retail Cashless

Transactions (RCT), BFC and Outstanding Loans, portrayed highly insignificant positive or negative coefficients within SSA.

Table 10. 2SLS fixed effects estimation ECOWAS Dependent Variable: MMS

Variables	MODEL 1	MODEL 2	MODEL 3	MODEL 4	MODEL 5	MODEL 6	MODEL 7	MODEL 8
MMS _{t-1}	0.553*** [4.73]	0.558*** [4.15]	0.512*** [4.59]	0.497*** [4.31]	0.605*** [4.36]	1.151 [0.57]	0.527*** [4.078]	0.008 [0.00]
lnBACC	2.600*** [4.62]	3.130 [0.50]						
lnBDEC			1.530*** [5.33]	0.000*** [0.00]				
lnBTVO					3.000*** [2.523]	-2.200 [-0.25]		
lnBTVA							2.903*** [3.83]	-4.540 [-0.10]
lnMPP	-5.810 [-1.22]	-1.360 [-0.03]	-2.010 [-0.045]	-0.340 [-2.71]	6978.170 [0.01]	-3.140 [-0.28]	-4.570 [5.06]	-2.120 [-0.15]
BACC*lnMPP		-1.230 [-0.08]						
BDEC*lnMPP				2.919*** [5.22]				
BTVO*lnMPP						3.404 [0.28]		
BTVA*lnMPP								6.791 [0.16]
POS	-1.510 [-0.54]	-1.400 [-0.44]	-1.600 [-0.60]	-1.740 [-0.64]	2.540 [-0.64]	-4.910 [-0.28]	-2.490 [-0.82]	-7.970 [-0.17]
RCT	0.000 [0.00]	0.000 [0.00]	0.000 [0.00]	0.000 [0.00]	0.000 [0.00]	0.000 [0.00]	0.000 -	0.000 [0.00]
BFC	-1.800 [-0.40]	-9.020 [-0.25]	-1.050 [-0.41]	-1.800 [-0.68]	-7.440 [-0.23]	-6.810 [-0.056]	1.070 [-0.37]	-1.360 [-0.16]
OLO	-1.150 [-0.26]	-859.326 [-0.15]	-3.080 [-0.721]	-4.220 [-0.950]	2.020 [2.75]	-1.020 [-0.23]	3.880 [4.05]	-5.500 [-0.09]
F-test Statistic	5.01	4.68	2.63	2.45	3.19	0.21	5.55	0.05
R-squared	0.67	0.65	0.85	0.83	0.54	0.12	0.62	0.15
Wald F Statistic	11.32	9.09	13.49	12.95	6.73	0.42	9.28	0.07
Corr (u _i , xb)	-0.79	-0.80	-0.57	-0.73	-0.66	-0.92	-0.80	-0.83
Hansen J Pvalue	0.00	0.00	0.05	0.07	0.03	0.93	0.00	0.99
Sigma	1.81	1.78	6.79	9.11	1.95	7.23	2.56	1.25
Sigma e	1.81	1.78	6.79	9.11	1.95	7.23	2.56	1.25
rho	0.86	0.85	2.63	0.63	0.84	0.83	0.92	0.69
Countries	14	14	14	14	14	14	14	14
Observations	140	140	140	140	140	140	140	140

Note: Significance levels: *** 1%. Z-statistics denoted in brackets. a. The Kleibergen-Paaprk Wald F-test is a weak identification test, where a value less than 10 indicates weak instruments (Baum et al. 2007). b The Hansen J test checks for instrument validity, where p-values greater than 5% indicate that instruments are not correlated with ϵ_i , t (Wooldridge, 2013). MMS denotes mobile money subscriptions; BACC denotes commercial bank access; BDEC denotes commercial bank decentralisation; BTVO measures annual commercial bank transaction volume; BTVA measures annual commercial bank transaction value; MPP denote mobile phone penetration; POS denote point of sale terminals; RCT denote retail cashless transactions; BFC denote credit for a financial institution or credit card; OLO denote outstanding loans. Source: Author's Computations.

Table 10 suggests that approximately between 85% and 15% of the variation in the mobile money subscription growth rate was explained by external factors beyond the selected models,

suggesting a joint explanatory variation between R-squared between 15% and 85%. Furthermore, table 10 provide interactions between mobile phone penetration (MPP) and traditional bank (TB) indicators led to zero significant results. Therefore, suggesting MPP tagged with any TB: BACC; BTVO; BTVA indicator results invalid substitutes for mobile money subscription. In contrary, TB interaction with BDEC results in significant coefficients implying validity of substitutes in the short run. It can further be observed that logarithmic commercial bank access (lnBACC) and transaction value (lnBTVA) had a significant positive effect on mobile money subscriptions (*ceteris paribus*) in Model 1 (2.600) and Model 2 (2.930), respectively.

Nevertheless, mobile phone penetration (MPP) reported insignificant coefficients in all the models, suggesting a weak effect on MPP. Due to significant positive coefficients of the first lagged mobile money subscriptions denoted by MMS_{t-1} , it can be concluded the previous year had a persistent positive effect on current values in Model 1-5;7. While aspects such as Point of Sale (POS) machines, Retail Cashless Transactions (RCT), BFC and Outstanding Loans, portrayed highly insignificant positive or negative coefficients within SSA. Hence, the sensitivity analysis implying effect of traditional bank conduits and M-Money Subscriptions within SSA in the short run led to insignificant results in the short run. However, the sensitivity analysis implying effect of traditional bank conduits and M-Money Subscriptions within ECOWAS indicate the interaction variable $BDEC * \ln MPP$, revealed significant results in the short run.

Table 11 tabulated the post estimation method indicating the long run multiplier effects based on equation 11, in Chapter 3. The results indicate the long-run coefficients of a third of interactions, namely: $BDEC * MPP$; $BTVO * MPP$; $BTVA * MPP$ were statistically positively insignificant in the long run. On the other hand, $BACC * MPP$ display a negative insignificant relationship to logarithmic mobile money subscriptions in the long run. Similarly, it can be observed all four traditional bank conduits returned insignificant values after interaction with MPP, from Model 1;3;5;7 to Model 2;4;6;8 respectively. Hence, the sensitivity analysis implying effect of traditional bank conduits and M-Money Subscriptions within SSA indicate, revealed positive results in the long run.

Generally, the evidence supports that mobile phone penetration is independent to mobile money subscriptions across the panel. As alluded earlier, positive statistically significant values of the first lagged dependent variable indicate previous year persistence affecting current

findings. On the other hand, the long-run coefficient of point-of-sale machines and retail cashless transactions maintained significant negative effect to mobile money subscriptions in the long run, with Model 8 reporting the lowest values.

Table 11. 2SLS MMS as dependent - Long Run Multiplier Effects

Variables	MODEL 1	MODEL 2	MODEL 3	MODEL 4	MODEL 5	MODEL 6	MODEL 7	MODEL 8
MMSt-1	1.203*** [6.22]	1.211*** [3.42]	1.154*** [5.90]	1.015 [2.83]	1.147*** [5.58]	1.178 [1.21]	1.145*** [5.57]	0.741 [0.01]
lnBACC	8.859*** [6.69]	34.505 [0.42]						
lnBDEC			3.697*** [4.96]	2.960 [1.65]				
lnBTVO					0.460*** [3.04]	0.367 [0.48]		
lnBTVA							0.351*** [3.06]	1.248 [0.00]
lnMPP	-0.188 [-1.39]	2.664 [0.29]	-0.128 [-0.92]	-0.401 [-0.64]	0.135 [0.96]	0.027 [0.04]	0.138 [0.98]	1.375 [0.00]
BACC*lnMPP		0.498 [-0.31]						
BDEC*lnMPP				0.019 [0.44]				
BTVO*lnMPP						0.000 [0.33]		
BTVA*lnMPP								0.000 [-0.00]
POS	-0.002 [-0.49]	-0.009 [-0.37]	0.002 [0.56]	0.002 [0.64]	0.001 [0.32]	0.009 [0.30]	0.002 [0.37]	-0.085 [-0.00]
RCT	-0.122 [-2.70]	0.091 [0.13]	-0.103 [-2.23]	-0.111 [-2.38]	-0.059 [-1.18]	0.110 [0.19]	-0.065 [-1.33]	-1.947 [-0.00]
BFC	0.095 [0.81]	0.208 [0.49]	0.062 [0.51]	0.046 [0.40]	0.067 [0.54]	0.097 [0.17]	0.060 [0.49]	-0.312 [-0.00]
OLO	-0.001 [-1.83]	0.002 [0.24]	0.000 [-0.64]	0.000 [-0.68]	0.000 [0.14]	0.000 [0.03]	0.000 [0.17]	0.000 [0.00]
Constant	-0.397 [-0.36]	-12.400 [-0.321]	1.984 [1.86]	2.942 [-1.16]	2.746 [2.55]	0.960 [0.13]	2.671 [2.47]	27.167 [0.00]
F-test Statistic	3.25***	0.81	2.23***	2.22***	1.98***	0.09	1.98***	0.00
R-squared	0.46	0.15	0.77	0.46	0.94	0.00	0.93	0.05
Wald F Statistic	2447.10***	132.87***	2216.28***	2231.26***	2098.49***	99.48***	2099.26***	0.53
Corr (u _i , xb)	-0.19	-0.94	0.34	-0.04	0.66	-0.57	0.63	-6.40
Hansen J Pvalue	0.00	0.00	0.00	0.00	0.00	1.00	0.00	1.00
Sigma	4.49	22.45	3.09	4.25	2.68	14.11	2.67	185.21
Sigma e	4.49	22.45	3.09	4.25	2.68	14.11	2.67	185.21
rho	0.62	0.92	0.41	0.57	0.33	0.40	0.33	0.38
Countries	45	45	45	45	45	45	45	45
Observations	405	405	405	405	405	405	405	405

Note: Significance levels: *** 1%. Z-statistics denoted in brackets. a The Kleibergen-Paap rk Wald F-test is a weak identification test, where a value less than 10 indicates weak instruments (Baum et al. 2007). b The Hansen J test checks for instrument validity, where p-values greater than 5% indicate that instruments are not correlated with ε_i, t (Wooldridge, 2013). MMS denotes mobile money subscriptions; BACC denotes commercial bank access; BDEC denotes commercial bank decentralisation; BTVO measures annual commercial bank transaction volume; BTVA measures annual commercial bank transaction value; MPP denote mobile phone penetration; POS denote point of sale terminals; RCT denote retail cashless transactions; BFC denote credit for a financial institution or credit card; OLO denote outstanding loans. Source: Author's Computations

4.4.2 Two-step system GMM regression

Table 12. Two Step GMM estimation regression - MMS as dependent variable

Variables	MODEL 1	MODEL 2	MODEL 3	MODEL 4	MODEL 5	MODEL 6	MODEL 7	MODEL 8
MMS _{t-1}	0.722*** [6.03]	0.646*** [4.32]	0.782*** [8.62]	0.781*** [8.36]	0.786*** [11.66]	0.811*** [8.70]	0.739*** [8.64]	0.781*** [7.95]
lnBACC	3.101 [1.96]	5.666 [2.34]						
lnBDEC			1.103 [2.04]	1.175 [1.61]				
lnBTVO					0.136 [1.28]	0.145 [1.25]		
lnBTVA							0.173 [1.67]	0.173 [1.72]
lnMPP	-0.070 [-0.57]	0.022 [0.14]	-0.002 [-0.01]	-8.510 [-0.05]	0.053 [0.44]	0.065 [0.43]	-0.018 [-0.14]	0.028 [0.20]
BACC*lnMPP		-0.022 [-1.26]						
BDEC*lnMPP				-0.007 [-0.18]				
BTVO*lnMPP						0.000 [0.27]		
BTVA*lnMPP								0.000 [0.04]
POS	0.001 [0.13]	0.005 [0.56]	0.007 [0.69]	0.005 [0.32]	0.002 [0.15]	0.000 [-0.01]	-0.015 [-1.51]	-0.012 [-1.01]
RCT	-0.090 [-0.46]	-0.218 [-0.81]	-0.149 [-1.31]	-0.140 [-1.19]	-0.186 [-1.18]	-0.113 [-0.86]	-0.166 [-1.00]	-0.100 [-0.74]
BFC	0.052 [0.51]	0.045 [0.48]	0.036 [0.57]	0.040 [0.65]	0.052 [0.75]	0.045 [-0.65]	0.048 [0.62]	0.035 [0.49]
OLO	-0.002 [-1.48]	-0.001 [-0.49]	-0.001 [0.80]	-0.001 [-0.65]	-0.001 [-0.61]	-0.001 [-0.66]	0.000 [-2.48]	0.000 [-1.66]
Year*	-0.249 [-1.63]	-0.192 [1.47]	-0.186 [-1.51]	-0.189 [-1.53]	-0.328 [-1.46]	-0.382 [1.85]	-0.475 [-2.29]	-0.465 [-2.48]
Constant	503.157 [189.08]	-384.808 [1.46]	376.082 [1.51]	380.888 [1.53]	662.248 [1.46]	770.700 [1.84]	960.506 [2.29]	939.574 [2.48]
F-test Statistic	147.24***	102.26***	216.60***	231.23***	578.89***	321.23***	292.60***	197.16***
AR1 1 st differences	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
AR2 2 nd differences	0.15	0.12	0.17	0.17	0.18	0.20	0.18	0.21
Sargan Chi2 Pvalue	0.96	0.90	0.59	0.54	0.63	0.65	0.77	0.71
Hansen J Pvalue	0.88	0.63	0.86	0.84	0.95	0.94	0.82	0.92
Instruments	46	47	47	47	47	47	47	47
Countries	45	45	45	45	45	45	45	45
Observations	405	405	405	405	405	405	405	405

Note: Significance levels: *** 1%. T-statistics denoted in brackets. Arellano-Bond test for 1st order autoregressive model (AR1) in first differences. Arellano-Bond test for 2nd order autoregressive model (AR2) in first differences. Hansen J test for instrument validity. The collapse option is used to reduce the number of instruments. MMS denotes mobile money subscriptions; BACC denotes commercial bank access; BDEC denotes commercial bank decentralisation; BTVO measures annual commercial bank transaction volume; BTVA measures annual commercial bank transaction value; MPP denote mobile phone penetration; POS denote point of sale terminals; RCT denote retail cashless transactions; BFC denote credit for a financial institution or credit card; OLO denote outstanding loans.

Source: Author's Computations

Table 12 highlight the regression results from the dynamic panel two-step system GMM estimation on MMS as the dependent variable. The F-test is statistically significant for all

models, implying model validity (Keller, 2022). Additionally, instrumental variables uncorrelated to the error term are interpreted by p-values greater than 5% across all models. (Wooldridge, 2010). The null hypothesis of the Arellano Bond test could not be rejected as the p-value was greater than 5% in all AR2 models indicative of zero second order serial correlation (Version & Paper, 2013; Wooldridge, 2022). Table 12 denote traditional bank conduit interaction with mobile phone penetration led to insignificant coefficients. Thus, suggesting mobile phone penetration as an unjustified catalyst for mobile money subscription growth. Hence, the results propose very little evidence of the relation between bank access, decentralisation, transaction volume and value. Despite this insignificant relation after interaction, mobile phone penetration may act as a complement in a financial effective market, ceteris paribus. Instrument variables POS, RCT, BFC and OLO correct the endogeneity problem and support instrument validity, as the number of countries (n=45) is greater than the period (t=10).

Table 13. Two Step GMM Estimation - MMS as dependent variable (Coefficients)

Variables	MODEL 1	MODEL 2	MODEL 3	MODEL 4	MODEL 5	MODEL 6	MODEL 7	MODEL 8
lnMMSt-1	1.549*** [1.68]	1.828 [1.53]	3.589 [1.88]	3.559 [1.83]	3.677** [2.49]	4.299 [1.64]	2.836*** [2.25]	3.560*** [1.74]
lnBACC	11.153*** [1.96]	16.023 [2.72]						
lnBDEC			5.061 [2.30]	5.358 [1.74]				
lnBTVO					0.635 [1.50]	0.766 [1.70]		
lnBTVA							0.664 [2.09]	0.790 [2.29]
lnMPP	-0.252 [-0.62]	0.064 [0.14]	-0.008 [-0.01]	-0.031 [-0.05]	0.249 [0.41]	0.342 [0.41]	-0.069 [-0.14]	0.130 [0.20]
BACC*lnMPP		-0.061 [-1.26]						
BDEC*lnMPP				-0.003 [-0.18]				
BTVO*lnMPP						0.000 [0.27]		
BTVA*lnMPP								0.000 [0.04]
POS	0.003 [0.13]	0.014 [0.55]	0.030 [0.67]	0.021 [0.32]	0.010 [0.14]	-0.001 [-0.01]	-0.058 [-1.69]	-0.056 [-1.08]
RCT	-0.323 [-0.50]	-0.617 [-0.78]	-0.685 [-1.10]	-0.637 [-1.04]	-0.869 [-1.125]	-0.113 [-0.86]	-0.635 [-1.08]	-0.458 [-0.75]
BFC	0.187 [0.58]	0.128 [0.55]	0.166 [0.58]	0.182 [0.656]	0.24 [0.75]	-0.597 [-0.98]	0.183 [0.62]	0.158 [0.48]
OLO	-0.009 [-1.90]	-0.004 [-0.58]	-0.004 [-0.93]	-0.004 [-0.74]	-0.005 [-0.62]	-0.006 [-0.63]	-0.001 [-3.62]	-0.001 [-2.67]
F-test Statistic	147.24***	102.26***	216.60***	231.23***	573.89***	321.23***	292.60***	197.16***
AR1 1 st differences	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

AR2 2 nd differences	0.15	0.12	0.17	0.17	0.18	0.20	0.18	0.21
Sargan Chi2 Pvalue	0.96	0.90	0.59	0.54	0.63	0.65	0.77	0.71
Hansen J Pvalue	0.88	0.63	0.86	0.84	0.95	0.94	0.82	0.92
Instruments	46	47	47	47	47	47	47	47
Countries	45	45	45	45	45	45	45	45
Observations	405	405	405	405	405	405	405	405

Note: Significance levels: *** 1%. T-statistics denoted in brackets. Arellano-Bond test for 1st order autoregressive model (AR1) in first differences. Arellano-Bond test for 2nd order autoregressive model (AR2) in first differences. Hansen J test for instrument validity. The collapse option is used to reduce the number of instruments. MMS denotes mobile money subscriptions; BACC denotes commercial bank access; BDEC denotes commercial bank decentralisation; BTVO measures annual commercial bank transaction volume; BTVA measures annual commercial bank transaction value; MPP denote mobile phone penetration; POS denote point of sale terminals; RCT denote retail cashless transactions; BFC denote credit for a financial institution or credit card; OLO denote outstanding loans. Source: Author's Computations.

Similarly, table 13 displays insignificant long-run coefficient of catalyst interactions namely: BACC*MPP; BDEC*MPP; BTVO*MPP; BTVA*MPP. Thereby, proposing mobile phone penetration as a potential complement for MMS, rather than substitute in the long run. However, the lagged MMS coefficients in Model 1, 5 and 8 maintained positive significance in the long run. In contrary, lagged MMS coefficients in Model 2,3,4,6 and 7 retained positive values with dropped significance. Further, instrumental variables POS, RCT, BFC and OLO retained insignificant coefficients in the long run by correcting the endogeneity problem and support instrument validity, as the number of countries (n=45) is greater than the period (t=10).

4.5 Conclusion

The results conclude complete rejection of the null hypothesis (H₀) and acceptance of the alternative hypothesis (H₁).

H₀: Traditional banking conduits have no significant impact on increased mobile money subscriptions in sub-Saharan Africa (SSA) Regional Economic Communities (RECs).

H₁: Traditional banking conduits have significantly impacted at least one REC on increased mobile money subscriptions within SSA.

Hence, it can be observed increased mobile money activity in SSA has significantly been impacted by reduced usage of traditional banking conduits such a commercial bank branches, automated teller machines and commercial bank transaction volumes and value within EAC, ECCAS, ECOWAS and SADC. Specific RECs such as SADC, were expected to suggest contrary views, resulting from the presence of strong regulated banking institutions with specific reference to South Africa. Hence, South Africa within the SSA region known to have sturdy

financial institutions, may have an inaccurate representation diluted by other southern African countries. While *NA* represent insufficient data for complete analysis. The effect of traditional bank conduits and M-Money Subscriptions within SSA and ECOWAS correct the endogeneity problem and support instrument validity as the number of countries ($n=14$) is greater than the period ($t=10$). Secondly, the effect of mobile phone penetration on M-Money Subscriptions within SSA and ECOWAS. Thirdly, the interaction of mobile phone penetration with conventional banking conduits within SSA and ECOWAS.

Chapter 5

Conclusion And Recommendations

5.1 Introduction

The chapter summarises the conclusions based on results discussed in the previous chapter, with reference to the research objectives, questions and hypotheses highlighted in chapter 1, 2 and 3. In addition, policy recommendations are given on areas of research within the financial service industry. Lastly, this chapter presents avenues for future research around regulation of Mobile Money.

5.2 Discussion

The study objectives determine whether reduced traditional bank operations resulted in increased mobile money subscription in the short and long run, with supporting empirical evidence within sub-Saharan Africa. The interactive effect between mobile phone penetration and traditional bank conduits reveals the short and long run dynamics. Sub-Saharan Africa (SSA) was selected as the region for analysis, while ECOWAS REC was representative within the Africa. This study analysed 45 SSA countries over a decade, 2010 – 2019. This research examined four traditional banking conduits namely, bank access (BACC), bank decentralisation (BDEC), transaction volume (BTVO) and transaction value (BTVA). Hence, proxy variables outlined: Branches per 100,000 adults (BACC), ATMs per 100,000 adults (BDEC), Bank transaction volume (BTVO) and Bank transaction value (BTVA) captured from The WBG (2019), G20 Financial Inclusion Indicators database; IMF (2019), Financial Access Survey database.

The empirical results within SSA indicate insignificant relationships between the interaction variable mobile phone penetration (MPP) and TB conduits in 2SLS fixed effect estimation within the short and long run. However, contra wise to Dunne & Kasekende (2018), Fanta, (2016), Lutfi (2016) and Nguena (2021), bank access and mobile phone penetration (BACC*MPP) in SSA and ECOWAS suggests a negative relation to M-Money subscriptions (MMS) in the long run. Nevertheless, (BDEC*MPP) indicate a significant positive relationship to M-Money Subscriptions suggestive of the possibility of bank convergence as alluded in (Ky et al. 2019; Ntwiga, 2020).

Modern M-Money use cases allow agent withdrawals and deposits from M-Money wallets through agency banking. Hence, the launch of agency banking by conventional banks is considered the most competitive response to disruptive finance, as deployed bank agents accept deposits and cash outs initially dominated by M-Money Agents (Dzombo et al. 2018; Idoko & Chukwu, 2022; Ndiema, 2010). Negative coefficients were observed in the two-step system GMM estimation technique for interaction between bank access and mobile phone penetration (BACC*MPP) and bank decentralisation and mobile phone penetration (BDEC*MPP) in both the short and long run.

However, close to zero coefficients between bank transaction volume and mobile phone penetration (BTVO*MPP) and bank transaction value and mobile phone penetration (BTVA*MPP) indicate little association to M-Money Subscriptions. While mobile phones are deemed the optimal common tool leverages financial access either through M-Money or conventional banking (Asongu & Nwachukwu, 2016; Chikaodi, 2018; Ebaidalla, 2014; Fanta, 2016; Mothobi & Grzybowski, 2017). With reference to the null hypothesis outlined in Chapter 1, this study rejects the null hypothesis (H_0) indicative that none of the TB interaction with MPP resulted in significant effects in the short run in ECOWAS, in favour of the alternative hypothesis in the long run. Nevertheless, MPP coefficients were mostly insignificantly negative for BACC & BDEC related models in both 2SLS and GMM estimations run in the short and long run. Hence, implying MPP insignificantly effected MMS, in the presence of bank access and bank decentralisation. Similarly, the control variables namely, POS, RCT, BFC and OLO reported insignificant effects to MMS. Conclusively, the first lagged dependent variable, MMS_{t-1} primarily revealed significant positive coefficients in the short run and long run among both 2SLS with fixed effects and GMM estimation technique.

Furthermore, reduced bank density from fewer deployed *ATMs* and Commercial Branches triggered by severe technology adoption, that support mobile banking and mobile money remittances can be observed within the SSA. Hence, defending the concept of a positive association between mobile phone penetration, domestic savings, regulation, bill payments and remittances is in sync with Asongu (2018). While commercial banks save agency and infrastructure costs through mobile banking, mobile money operators through the deployment of inexpensive booths, that station operations to banking the underserved both in urban and rural. Thus, supporting Mothobi et.al (2017) notion that mobile phones improve the livelihood of individuals residing in remote areas through financial access. High densely populated areas such as markets, bus stations, bus stops, hospital entrances and shopping lobbies have

succumbed mushroomed mobile money agents causing the need to decongest distribution in Zambia for instance. Thus, this study reveals positive insignificant and significant effects of traditional bank conduits on M-Money Subscriptions within SSA and ECOWAS, respectively. Secondly, the effect of mobile phone penetration on M-Money Subscriptions within SSA and ECOWAS are mostly positive. Thirdly, the interaction of mobile phone penetration with conventional banking conduits within are significant among commercial bank branches in ECOWAS, while SSA reveals mostly positive results.

5.3 Policy recommendations

Firstly, the financial sector should encourage product convergence from traditional and incumbent players within the industry. Converged products such as Bank to Wallet (B2W), Wallet to Bank (W2B), Wallet to ATM (W2B), ATM to Wallet (B2W), Bank to Bank (B2B), micro non collateral based loans and microinsurance. As traditional banking practices require more policy than technical orientation, FinTech's are expected to merge this gap by infusing technology-oriented policies. Extension of a minimal KYC pre-requisite consumer wallets among conventional banks, should be encouraged to complement the agency banking model. Hence, resulting in a bi-directional information transfer between disruptive and undisrupted financial service providers. Similarly, the use of mobile phones for both mobile banking and mobile money transactions eliminates costs associated with ATM deployment, branch opening and customer queues for cash deposits and withdrawals housed by commercial banks.

Furthermore, the cell phone banking technology has allowed MNOs such as Airtel, MTN and Safaricom within SSA integrate e-money transactions with commercial banks such as ABSA, FNB, Standard Bank etc. Hence, with the use of mobile money, the unbanked can perform mobile money wallet to commercial bank transfers instantly, eradicating the need to consult a bank teller or ATM. Thus, banked individuals also hold the capacity to execute commercial bank to mobile money wallet transactions instantly. Thereby, bridging the gap between the underserved unbanked populace and the financial literate. Secondly, due to the financial support required to set up FinTech's access to credible financing is termed a major constraint to fund the start-up phase and the facts revealing FinTech's heavily stimulating the Micro Small Medium Enterprises (MSMEs), government and the private sector are encouraged to provide financial capability.

Moreover, SSA holding majority of the unbanked population and young populace across the globe alludes to the massive fintech capability for the continent. Likewise, governments may consider allocating financial aid towards the fintech sector outlined in the annual budget. Additionally, Africa is composed of youthful population, exposing a very high expectation that majority may easily acclimatise to grasping technology components once trained. Hence, it may be encouraged that leadership within this sector is comprised of a blend of early and mid-youth populace to sustain relevance.

Furthermore, traditional commercial banks should view FinTech's as potential pivotal partners rather than financial disrupters. Thereby, as the Fourth Industrial Revolution (4IR) sets the standard for future technologies, commercial banks should be encouraged to interpret this upheaval as an opportunity to build and refine technologies and policies suitable to meet demands of the millennial generation. Hence, regulatory policies surrounding FinTech's in SSA should be supported, as masses are affected by mobile money related transactions. Thus, formalisation such as official regulation and licencing from statutory bodies such as the Central Bank and the National transaction clearing house are imperative. Thus, the presence regulation will build confidence for commercial banks to form partnerships with FinTech's that avail payment and financial services in the micro sector space. Hence, the short run effects of fintech disruption such as account reallocation from commercial banks to mobile money operations are equalised by the 4IR in the long run. This is mainly due to convergence within the sector through technology adoption, policy transfer and regulation by comparable statutory bodies.

5.4 Research Avenues

It is recommended that future research conduct the extent of convergence between TB conduits and M-Money in low income, middle income, and high-income countries. Additionally, future research may analyse how various types of M-Money transactions affect TB conduits positively and negatively, from a regional perspective across Sub-Saharan Africa and the rest of the world. Conclusively, perspectives that focus on bridging the gender gap observed with financial literacy and inclusion are imperative to achieving a mix of the Sustainable Development Goals (SDG) 5 – Gender Equality through more woman accessing finance; SDG 8 – Decent Work and Economic Growth by recruitment of unemployed youth as M-Money agents that earn commission based salaries; SDG 9 – Industry, Innovation and Inclusivity through the adoption of fintech technologies encompassed by digital transformation; SDG 10 – Reduced Inequalities among countries as developing economies within SSA holding majority

unbanked strive for financial inclusion in line with advanced economies; SDG 17 – Partnerships for the Goals through institutional and remunerable support to SSA by global partners such as the World Bank Group and the International Monetary Fund. Conclusively, it is recommended that policy discussions that analyse increased convergence by micro sector FinTech's and macro commercial banks, will bridge asymmetry costs within the financial sector.

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Appendix A: Full variable description and sources

Indicator	Indicator Code	Source Description	Source
Number of registered mobile money accounts	FCMAR_NUM	“Use of Financial Services, Mobile Money, Number of registered mobile money accounts.”	The IMF (2019), Financial Access Survey database, December 2019
Branches per 100,000 adults	i_branches_A1_pop	“Denotes the number of branches of commercial banks for every 100,000 adults in the reporting country. Calculated as (number of institutions + number of branches) *100,000/adult population in the reporting country.”	The WBG (2019), G20 Financial Inclusion Indicators database, December 2019
ATMs per 100,000 adults	i_ATMs_pop	“Denotes the total number of ATMs for every 100,000 adults in the reporting country. Calculated as (number of ATMs) *100,000/adult population in the reporting country. Automated teller machines are computerized telecommunications devices that provide clients of a financial institution with access to financial transactions in a public place.”	The WBG (2019), G20 Financial Inclusion Indicators database, December 2019
Number of mobile and internet banking transactions (during the reference year) per 1,000 adults	FCMIBTA_NUM	“Key Indicators, Use of Financial Services, Number of mobile and internet banking transactions (during the reference year) per 1,000 adults.”	The IMF (2019), Financial Access Survey database, December 2019
Value of mobile and internet banking transactions (during the reference year) (% of GDP)	FCMIBTVG_GDP_PT	“Key Indicators, Use of Financial Services, Value of mobile and internet banking transactions (during the reference year) (% of GDP).”	The IMF (2019), Financial Access Survey database, December 2019
Number of active mobile money agent outlets per 100,000 adults	FCMOAA_NUM	“Number of active agent outlets per 100,000 adults”	The IMF (2019), Financial Access Survey database, December 2019
Number of non-branch retail agent outlets of commercial banks per 100,000 adults	FCROODCA_NUM	“Geographical Outreach: Key Indicators, Number of non-branch retail agent outlets of commercial banks per 100,000 adults”	The IMF (2019), Financial Access Survey database, December 2019
POS terminals per 100,000 adults	GPSS_4	“Denotes the number of point of sale (POS) terminals per 100,000 adults”	
Retail cashless transactions per 1,000 adults	GPSS_2	“Denotes the number of retail cashless transactions per 1,000 adults which includes the number of cheques, credit transfers, direct debits, payment card transactions (debit cards, credit cards), and payment by e-money instruments (card-based e-money instruments, mobile money products, and online money products).”	The WBG (2019), G20 Financial Inclusion Indicators database, December 2019

Access to a mobile phone (% age 15+)	gwp1_n	“Denotes the percentage of respondents, ages 15+, who report having access to a mobile phone”	The WBG (2019), G20 Financial Inclusion Indicators database, December 2019
Made payment using a mobile phone or the internet (% age 15+)	gf4_n	“Denotes the percentage of respondents, ages 15+, who report using a mobile phone or the internet to make or receive payments, to make a purchase, or to send or receive money through their financial institution account or through the use of a mobile money service in the past 12 months”	The WBG (2019), G20 Financial Inclusion Indicators database, December 2019
Used a mobile phone or the internet to check account balance in the past year (% age 15+)	fin6_a	“Denotes the percentage of respondents, ages 15+, who report using a mobile phone or the internet to check their balance for a financial institution account in the past 12 months.”	The WBG (2019), G20 Financial Inclusion Indicators database, December 2019
Financial knowledge score (0-3)	GPF11_TOTL	“Denotes the number of agents of payment service providers per 100,000 adults. Includes: agents of banks and other deposit taking institutions, as well as specialized entities such as money transfer operators and e-money issuers.”	The WBG (2019), G20 Financial Inclusion Indicators database, December 2019
Outstanding loans per 1,000 adults	s_loans_A1	“Denotes the number of point of sale (POS) terminals per 100,000 adults.”	The WBG (2019), G20 Financial Inclusion Indicators database, December 2019

Table 14. Hausman Test - MMA as dependent variable

Variable	Model	Hausman (Chi2 Statistic)	Chi2 P-value	Preferred Estimation
BACC	Model 1	133.89	0.000	Fixed Effects
	Model 2	0.01	1.000	Random Effects
BDEC	Model 3	80.44	0.000	Fixed Effects
	Model 4	30.42	0.000	Fixed Effects
BTVO	Model 5	74.99	0.000	Fixed Effects
	Model 6	0.12	1.000	Random Effects
BTVA	Model 7	75.23	0.000	Fixed Effects
	Model 8	0.02	1.000	Random Effects

Note: Reject the null hypothesis where p-values < 0.05% and utilise the fixed effects estimation method, otherwise utilise the random effects estimator.

Source: Author's computations

Appendix B: Empirical findings for MMA

Table 15. 2SLS Regression - MMA as dependent variable

Model	Regression
Model 1	1st lag of MMA, lnBACC, lnMPP, POS, RCT, BFC, OLO
Model 2	1st lag of MMA, lnBACC, lnMPP, BACC*lnMPP, POS, RCT, BFC, OLO
Model 3	1st lag of MMA, lnBDEC, lnMPP, POS, RCT, BFC, OLO
Model 4	1st lag of MMA, lnBDEC, lnMPP, BDEC*lnMPP, POS, RCT, BFC, OLO
Model 5	1st lag of MMA, lnBTVO, lnMPP, POS, RCT, BFC, OLO
Model 6	1st lag of MMA, lnBTVO, lnMPP, BTVO*lnMPP, POS, RCT, BFC, OLO
Model 7	1st lag of MMA, lnBTVA, lnMPP, POS, RCT, BFC, OLO
Model 8	1st lag of MMA, lnBTVA, lnMPP, BTVA*lnMPP, POS, RCT, BFC, OLO

MMA denotes mobile money agents; BACC denotes commercial bank access; BDEC denotes commercial bank decentralisation; BTVO measures annual commercial bank transaction volume; BTVA measures annual commercial bank transaction value; MPP denote mobile phone penetration; POS denote point of sale terminals; RCT denote retail cashless transactions; BFC denote credit for a financial institution or credit card; OLO denote outstanding loans.

Source: Author's Computations

Table 16. GMM Estimation - MMA as dependent variable

Model	GMM Estimation
Model 1	lnMMA, lnBACC, lnMPP, POS, RCT, BFC, OLO
Model 2	lnMMA, lnBACC, lnMPP, BACC*lnMPP, POS, RCT, BFC, OLO
Model 3	lnMMA, lnBDEC, lnMPP, POS, RCT, BFC, OLO
Model 4	lnMMA, lnBDEC, lnMPP, BDEC*lnMPP, POS, RCT, BFC, OLO
Model 5	lnMMA, lnBTVO, lnMPP, POS, RCT, BFC, OLO
Model 6	lnMMA, lnBTVO, lnMPP, BTVO*lnMPP, POS, RCT, BFC, OLO
Model 7	lnMMA, lnBTVA, lnMPP, POS, RCT, BFC, OLO
Model 8	lnMMA, lnBTVA, lnMPP, BTVA*lnMPP, POS, RCT, BFC, OLO

MMA denotes mobile money agents; BACC denotes commercial bank access; BDEC denotes commercial bank decentralisation; BTVO measures annual commercial bank transaction volume; BTVA measures annual commercial bank transaction value; MPP denote mobile phone penetration; POS denote point of sale terminals; RCT denote retail cashless transactions; BFC denote credit for a financial institution or credit card; OLO denote outstanding loans.

Source: Author's Computations

Appendix C: Empirical findings for MMS

Table 17. 2SLS Regression - MMS as dependent variable

Model	Regression
Model 1	1st lag of MMS, lnBACC, lnMPP, POS, RCT, BFC, OLO
Model 2	1st lag of MMS, lnBACC, lnMPP, BACC*lnMPP, POS, RCT, BFC, OLO
Model 3	1st lag of MMS, lnBDEC, lnMPP, POS, RCT, BFC, OLO
Model 4	1st lag of MMS, lnBDEC, lnMPP, BDEC*lnMPP, POS, RCT, BFC, OLO
Model 5	1st lag of MMS, lnBTVO, lnMPP, POS, RCT, BFC, OLO
Model 6	1st lag of MMS, lnBTVO, lnMPP, BTVO*lnMPP, POS, RCT, BFC, OLO
Model 7	1st lag of MMS, lnBTVA, lnMPP, POS, RCT, BFC, OLO
Model 8	1st lag of MMS, lnBTVA, lnMPP, BTVA*lnMPP, POS, RCT, BFC, OLO

MMS denotes mobile money subscriptions; BACC denotes commercial bank access; BDEC denotes commercial bank decentralisation; BTVO measures annual commercial bank transaction volume; BTVA measures annual commercial bank transaction value; MPP denote mobile phone penetration; POS denote point of sale terminals; RCT denote retail cashless transactions; BFC denote credit for a financial institution or credit card; OLO denote outstanding loans.

Source: Author's Computations

Table 18. GMM Estimation - MMS as dependent variable

Model	GMM Estimation
Model 1	lnMMS, lnBACC, lnMPP, POS, RCT, BFC, OLO
Model 2	lnMMS, lnBACC, lnMPP, BACC*lnMPP, POS, RCT, BFC, OLO
Model 3	lnMMS, lnBDEC, lnMPP, POS, RCT, BFC, OLO
Model 4	lnMMS, lnBDEC, lnMPP, BDEC*lnMPP, POS, RCT, BFC, OLO
Model 5	lnMMS, lnBTVO, lnMPP, POS, RCT, BFC, OLO
Model 6	lnMMS, lnBTVO, lnMPP, BTVO*lnMPP, POS, RCT, BFC, OLO
Model 7	lnMMS, lnBTVA, lnMPP, POS, RCT, BFC, OLO
Model 8	lnMMS, lnBTVA, lnMPP, BTVA*lnMPP, POS, RCT, BFC, OLO

MMS denotes mobile money subscriptions; BACC denotes commercial bank access; BDEC denotes commercial bank decentralisation; BTVO measures annual commercial bank transaction volume; BTVA measures annual commercial bank transaction value; MPP denote mobile phone penetration; POS denote point of sale terminals; RCT denote retail cashless transactions; BFC denote credit for a financial institution or credit card; OLO denote outstanding loans.

Source: Author's Computations