# Digital Payment Technology and Financial Inclusion

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**A PROJECT WRITTEN AND SUBMITTED TO THE DEPARTMENT OF FINANCE, FACULTY OF MANAGEMENT SCIENCES IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE AWARD OF BACHELOR OF SCIENCE(B.SC) DEGREE IN FINANCE OF THE UNIVERSITY OF BENIN,BENIN CITY.**

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## DECLARATION

I, Chinedu Patrick Obiajuoyi, do hereby declare that this project is undertaken by me in the department of finance, Faculty of Management Sciences, University of Benin, Benin City, Edo State under the supervision of Dr. Abudu Kasimu. The work embodied in this project has not previously been submitted in candidature for any other degree and is not concurrently being submitted for any other degree. All references made to works of other persons have been duly acknowledged.

Any liability arising from this work is wholly my responsibility.

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**Chinedu Patrick Obiajuyi.** **Date**

## CERTIFICATION

This is to certify that this project work was carried out by Chinedu Patrick Obiajuoyi with Matriculation Number MGS2104758 in the Department of Finance, Faculty of Management Sciences, University of Benin, Benin city, Edo State, in partial fulfillment for the award of Bachelor of Science (B.Sc.) in Banking and Finance.

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## DEDICATION

This project is dedicated first to God Almighty being a Perfect Father to me! and to my caring, lovely and Great parents.

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## ABSTRACT

This study examines the impact of digital payment technologies on financial inclusion in Nigeria, focusing on Automated Teller Machine (ATM) transactions, Point-of-Sale (POS) transactions, Web Pay transactions, and mobile payments. Despite significant advancements in digital payment infrastructure, approximately 40% of adult Nigerians remain financially excluded, revealing persistent challenges in achieving universal access to financial services. The research addresses this gap by empirically investigating how different digital payment channels contribute to broadening financial participation in the formal economy. The study adopts an Ex-Post-Facto research design, utilizing quarterly time series data spanning from 2009Q1 to 2023Q4, yielding 60 observations. Secondary data were obtained from the Central Bank of Nigeria Statistical Bulletin and the Nigeria Inter-Bank Settlement System. Financial inclusion was operationalized as total savings as a ratio of GDP, while independent variables captured transaction volumes across the four digital payment channels. The analytical framework employed Augmented Dickey-Fuller unit root tests, Johansen cointegration analysis, and the Autoregressive Distributed Lag (ARDL) bounds testing approach to examine both short-run dynamics and long-run equilibrium relationships. Results indicate that only mobile payment transaction volume demonstrates a statistically significant positive effect on financial inclusion in Nigeria. ATM, POS, and Web Pay transaction volumes show no significant impact, attributed to infrastructure constraints, urban concentration of services, digital literacy gaps, and limited accessibility in rural areas. The superior performance of mobile payments stems from widespread mobile phone penetration, USSD technology compatibility with basic phones, minimal entry barriers, and distributed agent networks reaching underserved populations. The study concludes that mobile payments represent the most effective digital channel for advancing financial inclusion in Nigeria. Recommendations emphasize prioritizing mobile payment infrastructure development, addressing electricity and telecommunications constraints, enhancing financial and digital literacy programs, reforming regulatory frameworks, including tiered KYC requirements, expanding agent networks into rural areas, and leveraging mobile platforms for government-to-person payments. Policymakers should adopt comprehensive strategies integrating supportive ecosystems that enable access, build capability, and foster trust to maximize mobile payments' potential in achieving sustainable financial inclusion.


**Keywords:** Digital Payment Technologies, Financial Inclusion, Mobile Payments

# CHAPTER ONE

# INTRODUCTION

## 1.1 Background of the Study

In recent years, digital payment technologies have emerged as critical drivers of financial inclusion across the globe, particularly in developing economies. Financial inclusion, defined as the availability and accessibility of financial services to individuals and businesses, is widely recognized as a catalyst for poverty reduction, inclusive growth, and economic development (Ozili, 2018). In Nigeria, where large segments of the population remain unbanked or underbanked, the adoption of digital payment systems has become central to efforts aimed at bridging the financial access gap.

The introduction and expansion of Automated Teller Machines (ATMs), Point-of-Sales (POS) terminals, Web Pay platforms, and mobile payment services have significantly transformed the financial landscape in Nigeria. ATMs, which were introduced in the late 1980s, provided the first wave of self-service banking and laid the foundation for digital financial transactions (Oluwafemi & Adeoye, 2017). Over the years, the proliferation of ATMs has been linked to improvements in financial accessibility and convenience, although their impact has been constrained in rural areas due to infrastructure challenges.

Subsequently, POS terminals emerged as vital tools for merchant payments and retail transactions. Their growth in Nigeria has been remarkable, particularly since the Central Bank of Nigeria (CBN) launched the *cashless policy* in 2012 to encourage electronic payments and reduce reliance on cash. Studies have shown that POS adoption has expanded opportunities for small and medium-sized enterprises (SMEs) and improved financial participation among low-income populations (Adeniran, 2020).

The evolution of Web Pay and online transaction platforms has further expanded the reach of financial services by enabling e-commerce and digital service payments. Web-based payment systems have provided convenience for customers and increased revenue streams for businesses. However, their usage remains largely urban-centered due to internet penetration disparities, raising questions about their inclusivity in a country with stark digital divides (Ogunleye & Shittu, 2021).

Perhaps the most transformative has been the rapid rise of mobile payments. With the widespread penetration of mobile phones in Nigeria, mobile banking apps, USSD transactions, and mobile money platforms have become crucial in reaching previously excluded populations, particularly in rural areas. Research has highlighted the strong positive relationship between mobile payments and financial inclusion in sub-Saharan Africa, underscoring their potential to reduce poverty and foster inclusive growth (Jack & Suri, 2011; Ozili, 2018).

Despite these advances, challenges remain. Issues such as infrastructural deficits, digital illiteracy, cyber fraud, and regulatory hurdles continue to hinder the full potential of digital payment technologies in driving financial inclusion. Nonetheless, evidence from Nigeria suggests that increased transaction volumes across ATMs, POS, Web Pay, and mobile platforms correlate positively with greater financial participation (Adeniran, 2020; Ogunleye & Shittu, 2021). This makes it important to empirically examine the extent to which each of these digital payment channels contributes to financial inclusion in Nigeria.

This study, therefore, investigates the impact of digital payment technologies on financial inclusion in Nigeria, focusing specifically on the effects of ATM transactions, POS transactions, Web Pay transactions, and mobile payments. By doing so, it contributes to the understanding of how digital finance can be harnessed as a tool for inclusive economic development in Nigeria.

## 1.2 Statement of the Research Problem

Despite the introduction of innovative digital payment systems, approximately 40% of adult Nigerians remain financially excluded. The NFIS target for 2020 was not met, revealing persistent challenges in achieving universal access to financial services. Problems such as low trust in financial systems, cyber security concerns, poor infrastructure, and limited digital literacy hinder the adoption of digital payment technologies. Furthermore, empirical evidence on the direct impact of various digital

payment platforms on financial inclusion remains inconclusive, leaving a gap in both academic literature and practical policy frameworks.

### 1.3 Research Questions

This study seeks to address the following questions:

1. What are the effects of the volume of Automated Teller Machine (ATM) transactions on financial inclusion in Nigeria?
2. How does the volume of Point-of-Sales (POS) transactions affect financial inclusion in Nigeria?
3. In what ways does the volume of Web Pay transactions influence financial inclusion in Nigeria?
4. To what extent do mobile payment transactions contribute to financial inclusion in Nigeria?

### 1.4 Objectives of the Study

The main objective of this study is to examine the impact of digital payment technologies on financial inclusion in Nigeria. Specifically, the study aims at the following:

1. To determine the effects of the volume of Automated Teller Machine (ATM) transactions on financial inclusion in Nigeria.
2. To examine the effects of the volume of Point-Of-Sales (POS) transactions on financial inclusion in Nigeria.

3. To evaluate the effects of the volume of Web Pay transactions on financial inclusion in Nigeria.
4. To investigate the effects of the volume of Mobile payments on financial inclusion in Nigeria.

### 1.5 Research Hypothesis

The study will be guided by the following hypotheses:

1. The volume of ATM transactions does not have a significant effect on financial inclusion in Nigeria
2. The volume of POS transactions does not have a significant effect on financial inclusion in Nigeria
3. The volume of Web pay transactions does not have a significant effect on financial inclusion in Nigeria
4. The volume of Mobile payments does not have a significant effect on financial inclusion in Nigeria.

### 1.6 Scope of the Study

This study focuses on Nigeria's financial inclusion landscape, specifically examining the role of digital payment technologies in bridging the financial access gap. The research covers multiple payment platforms, including ATMs, POS terminals, mobile banking, USSD, digital wallets, and online banking. The study also considers the post-COVID-19 context, where digital adoption trends and economic recovery efforts have shaped the financial services sector.

## 1.7 Significance of the Study

### 1.7.1 To financial institutions

For **financial institutions**, the study provides useful insights into how different digital payment channels contribute to the broader goal of financial inclusion. By understanding the role of ATMs, POS terminals, Web Pay platforms, and mobile payments, banks and other financial institutions can make informed decisions on where to channel investments, expand infrastructure, and improve service delivery. The findings will also help them to identify gaps in customer usage patterns, which can inform the design of innovative financial products targeted at underserved populations.

### 1.7.2 To technology providers

For **technology providers**, such as fintech companies, payment gateway operators, and mobile network providers, the study offers evidence on the effectiveness of their innovations in driving financial inclusion. It highlights the areas where digital payment platforms are most impactful and where technological or infrastructural improvements are needed. With this knowledge, technology providers can refine their systems to ensure better user experience, security, and accessibility, thereby enhancing trust and adoption among Nigerians.

### 1.7.3 To citizens

For **citizens**, particularly those in rural and financially underserved communities, the study underscores how digital payment technologies can empower them to participate in the formal financial system. By revealing the relationship between transaction volumes and financial inclusion, the research demonstrates the potential benefits citizens can gain from adopting digital financial services, such as convenience, safety, and access to broader economic opportunities. Ultimately, it highlights how increased usage of digital payments can reduce financial exclusion, foster economic empowerment, and promote inclusive growth.

## 1.8 Limitations of study

### 1. Data Availability and Reliability

One of the major limitations of this study lies in the availability and reliability of data on digital payment technologies. While official data can be sourced from institutions such as the Central Bank of Nigeria (CBN) and the Nigeria Inter-Bank Settlement System (NIBSS), these figures may not always provide a complete picture. Many informal transactions remain undocumented, particularly in rural and semi-formal markets where cash continues to dominate. Furthermore, inconsistencies in the reporting of financial statistics, gaps in time-series records, or differences in data compilation methods may affect the reliability of the findings. This limitation means

that the actual impact of digital payment systems on financial inclusion may be under- or over-estimated depending on the scope and accuracy of available data.

**2. Measurement of Financial Inclusion**

Financial inclusion is a multi-dimensional concept that encompasses not just access to financial services, but also affordability, quality, regularity of use, and trust in financial institutions. However, the present study narrows its analysis to transaction volumes on platforms such as ATMs, POS, Web Pay, and mobile payments. This focus on usage metrics, while useful, does not capture the full complexity of financial inclusion. For example, having access to mobile payment services does not necessarily mean that users can afford transaction fees or that they trust the system enough to rely on it for regular financial needs. By concentrating mainly on volume, the study may overlook important qualitative dimensions of inclusion such as financial literacy, customer satisfaction, or service equity.

**3. Regional Disparities**

Another limitation of this study arises from regional differences in access to digital payment technologies. Nigeria is marked by significant urban–rural divides in terms of infrastructure, literacy, and economic activity. Urban centers such as Lagos and Abuja enjoy better network connectivity, higher levels of financial literacy, and more exposure to digital innovations, while rural areas often struggle with poor connectivity, electricity shortages, and limited access to financial agents.

Consequently, transaction volumes in rural regions may not accurately reflect the true level of exclusion experienced by their populations. This geographical imbalance could skew findings, making the impact of digital payment systems appear stronger at the national level than it truly is for marginalized communities.

**4. Technological and Infrastructure Constraints**

The effectiveness of digital payment technologies in promoting financial inclusion is heavily dependent on the reliability of supporting infrastructure. In Nigeria, issues such as frequent network downtimes, unreliable internet coverage, and irregular power supply significantly affect transaction processes. Customers often experience failed transactions at ATMs or POS terminals, leading to frustration and reduced confidence in the system. These infrastructural weaknesses may not only limit adoption rates but also distort transaction volume data, since failed transactions are sometimes recorded without reflecting customer dissatisfaction. Therefore, the impact measured in this study could be confounded by the underlying inefficiency of technological infrastructure rather than actual willingness or ability to use digital payment platforms.

**5. Behavioral and Cultural Factors**

The adoption of digital payment technologies is not solely determined by availability or accessibility; cultural and behavioral dynamics play an equally important role. In many parts of Nigeria, people continue to show strong preference for cash

transactions due to habits, mistrust of digital systems, or lack of exposure to financial education. Low levels of digital literacy, fear of fraud, and resistance to change all act as barriers to the uptake of e-payment platforms. These behavioral and cultural limitations are not easily quantifiable in transaction data, yet they significantly influence financial inclusion outcomes. By relying mainly on transaction volume data, the study may not fully capture these subtle but powerful social dynamics that shape people's choices in financial services.

### 1.9 Definition of Terms

For the purpose of this study, the following key terms are operationally defined to ensure clarity and consistency in their use:

**1. Digital Payment Technologies**: Digital payment technologies refer to electronic platforms and systems that facilitate the transfer of money and settlement of transactions without the direct exchange of physical cash. In this study, digital payment technologies are operationalized through four specific channels: Automated Teller Machines (ATMs), Point-of-Sales (POS) terminals, Web Pay services, and Mobile Payment platforms. These technologies represent the primary independent variables under investigation.

**2. Automated Teller Machine (ATM) Transactions**: ATM transactions involve the use of card-based machines provided by financial institutions to withdraw cash, check account balances, transfer funds, or carry out other banking services. For this study,

ATM transaction volume is measured as the total number of transactions processed through ATMs in Nigeria within the study period, as reported by the Nigeria Inter-Bank Settlement System (NIBSS) and the Central Bank of Nigeria (CBN).

**3. Point-of-Sales (POS) Transactions**: POS transactions refer to payments made using electronic terminals provided by merchants to accept debit or credit card payments from customers. In this study, POS transaction volume represents the total number of purchases or payments conducted through POS terminals across Nigeria, capturing the extent to which electronic merchant payments contribute to financial inclusion.

**4. Web Pay Transactions**: Web Pay transactions are defined as payments carried out over the internet using online gateways, typically involving debit/credit cards or direct bank integration. They reflect e-commerce and online service payments. In this study, the volume of Web Pay transactions denotes the total number of electronic transactions executed via online platforms, serving as an indicator of the role of internet-based payments in enhancing financial inclusion.

**5. Mobile Payments**: Mobile payments refer to financial transactions conducted using mobile devices, including mobile banking apps, USSD codes, and mobile money services provided by banks and fintech firms. For this study, mobile payment transaction volume is measured as the total number of transactions carried out

through mobile channels within Nigeria. This variable is used to assess the growing importance of mobile technology in broadening access to financial services.

**6. Financial Inclusion:** Financial inclusion is defined as the extent to which individuals and businesses, particularly those in underserved and rural communities, have access to and make effective use of formal financial services. In this study, financial inclusion is operationalized through the usage dimension, measured by the volume of digital payment transactions (ATM, POS, Web Pay, and Mobile payments) that signify active participation in the financial system.

**7. Nigeria Inter-Bank Settlement System (NIBSS)**: The NIBSS is the central electronic platform responsible for managing inter-bank payments and settlement systems in Nigeria. For this study, NIBSS data serve as the primary source of transaction volume statistics for digital payment technologies.

**8. Central Bank of Nigeria (CBN)**: The CBN is Nigeria's apex financial regulator responsible for formulating monetary policies and overseeing financial institutions. In this study, CBN publications and reports are used as official data sources to measure the variables under investigation.

# CHAPTER TWO

# LITERATURE REVIEW

## 2.1 Conceptual Clarifications

### 2.1.1 Financial Inclusion

Financial inclusion, as defined by the World Bank (2023), involves expanding access to and the use of financial services, particularly for low-income households, microenterprises, women, and other regularly marginalized groups. The concept extends beyond the mere possession of a financial account to encompass the effective utilization of affordable financial products and services tailored to individuals' and businesses' needs in a responsible and sustainable manner. Financial inclusion is widely recognized for its ability to reduce poverty and promote global development objectives, although empirical evidence on its effectiveness in lifting individuals out of poverty remains mixed (World Bank, 2023).

A critical driver of economic development, financial inclusion enables individuals and enterprises to access essential financial services such as savings accounts, loans, insurance, and payment systems. In this context, digital payments have emerged as transformative tools, creating opportunities for millions of unbanked individuals to connect with formal financial systems. The COVID-19 pandemic accelerated the shift toward digital payment methods, highlighting their role in promoting economic stability (Shoba, 2025).

Affordable and accessible financial offerings—including transactions, payments, savings, credit, and insurance—allow individuals to manage risks, accumulate wealth, and invest in businesses. Such services foster entrepreneurship, enhance business growth, and increase productivity by integrating more people and enterprises into the formal economy (World Bank, 2022). Access to credit and capital supports small business expansion and job creation, while insurance products improve resilience against unforeseen risks, enabling business owners and households to plan with greater confidence.

Financial inclusion also promotes women's empowerment by removing barriers to economic participation.

### 2.1.2 Indicators of Financial Inclusion

Financial inclusion reflects the extent to which individuals and businesses can access and effectively use a meaningful range of financial services such as payments, savings, credit, insurance, and transfers. Its measurement typically centers on three interrelated dimensions: **access**, **usage**, and **quality**, with additional emphasis sometimes placed on the outcomes or impacts derived from inclusion (Leemann, 2022).

1. **Access Indicators**

Access measures capture the reach and availability of financial services. Common examples include the **number of bank branches, Automated Teller Machines**

**(ATMs), and Point-of-Sale (POS) terminals per population or geographic area**, which indicate the physical and digital infrastructure supporting financial access (Anifowose, 2022). Broader definitions also include mobile money agents, particularly in regions where traditional banking infrastructure remains sparse.

2. **Usage (Utilization) Indicators**

Usage indicators reveal how financial services are actually utilized by individuals or businesses. Metrics often include **the percentage of adults with a formal account**, **number of deposit and loan accounts per 1,000 adults**, transaction volumes, and **frequency of digital payments**. For instance, regional studies have used indicators such as **ATMs per 1,000 people, deposit accounts per 1,000 adults, loan accounts per 1,000 adults**, and borrowers per 1,000 adults as proxies for financial inclusion in Sub-Saharan Africa (Author retained six-indicator model). Surveys such as the Global Findex further measure digital usage metrics like the share of adults making or receiving digital payments (Demirgüç-Kunt et al., 2022.

3. **Quality and Suitability of Services**

Quality indicators assess whether the available services align with users' needs. These include the **range of financial products offered, appropriateness of service design, affordability, and user understanding or financial literacy** (Anifowose, 2022).

Essentially, financial inclusion is not only about access, but also about offering services that are relevant, affordable, and trusted.

4. **Outcome Indicators**

Beyond measuring supply and demand, some models include **outcome indicators**—looking into how financial inclusion translates into tangible improvements such as enhanced household welfare, firm performance, or human capital outcomes (Anifowose, 2022). In some studies, financial inclusion has been linked to greater financial resilience, economic growth, or reduction in inequality (Global Findex evidence).

5. **Digital Financial Inclusion Indicators**

Given the surge in digital payments and fintech, digital-specific indicators have grown crucial. These include **mobile money account ownership**, **use of digital payments (e.g. via mobile or online platforms)**, and **possession of digital payment instruments like debit or credit cards** (Findex trends in Nigeria). In Nigeria, for example, women's digital inclusion has been tracked through indicators like ownership of mobile money accounts, involvement in digital payments, and card ownership (debit/credit)

### 2.1.3 Digital Payment Technology

Digital payment technology refers to the electronic systems and platforms that enable financial transactions—ranging from peer-to-peer transfers and mobile wallets to real-time national payment systems and central-bank digital currencies (CBDCs). Over the past few years, these innovations have reshaped how individuals, businesses, and institutions transact, offering enhanced speed, accessibility, and inclusion. A prime example of such systems is India's Unified Payments Interface (UPI), through which nearly 80% of digital payments are conducted—its adoption has skyrocketed since 2021, with January 2024 seeing over 12 billion transactions valued in the trillions of rupees (NPCI, 2024). This explosive growth highlights how user-friendly interfaces and real-time settlement can drive mass adoption.

In Sub-Saharan Africa, mobile money platforms lead the digital payments transformation. By 2021, about 55% of adults in the region had a financial account, and 33% held mobile money accounts—far exceeding the global average of 10%. These platforms are not confined to simple transfers; around three-quarters of users utilize mobile money for bill payments, school fees, or merchant purchases, while a portion engage in saving and borrowing through these accounts. For example, across the region, 835 million mobile wallet accounts transacted nearly USD 2.5 billion daily in 2023—driven in part by regulatory adaptation and partnerships between mobile and banking services.

Despite such advancements, the uptake of CBDCs like Nigeria's eNaira has been sluggish. Disincentives include infrastructure challenges, limited trust, low digital financial literacy, and weak incentives for wallet activation—within a year of its October 2021 introduction, fewer than 0.5% of Nigerians had active eNaira wallets.

Crucially, simply deploying digital payment infrastructure is insufficient without corresponding improvements in digital literacy. A 2025 study in Nigeria found that, although FinTech adoption has expanded among rural populations, financial literacy had greater influence on financial inclusion than access alone—highlighting the pivotal role of education in enabling effective usage (Ibrahim et al., 2025). Moreover, network effects strongly influence adoption. A study examining mobile payments in Nigeria showed that network externalities—the increased utility as more people adopt the system—are among the strongest drivers of uptake, surpassing conventional factors like performance expectations or ease of use

### 2.1.4 Indicators of Digital Payment Technologies

Digital payment technology encompasses a variety of systems—such as real-time transfers, mobile money, web transfers, POS terminals, and digital wallets—through which financial transactions are conducted electronically. Understanding its effectiveness hinges on key indicators that reflect adoption, usage, infrastructure, and economic impact.

One primary indicator is the volume and value of digital transactions across different channels. In Nigeria, e-payment data from the Central Bank demonstrates that between January and June 2024, Internet/web transfers accounted for an astounding 11.6 billion transactions valued at over ₦825 trillion, while mobile app transfers and mobile money operators handled 3.49 billion and 7.18 billion transactions, respectively. Yearly comparisons show that in 2023, Internet (web) transfers totaled 21.75 billion transactions, and mobile app transfers were 5.26 billion, marking significant growth over previous years.

Beyond sheer numbers, growth rates in specific channels are insightful indicators. Online transfer values ballooned from ₦545 trillion in 2021 to ₦784 trillion in 2022—a year-on-year increase of nearly 44%. Meanwhile, mobile app transfers and mobile money both more than doubled in both volume and value during the same period, showing remarkable uptake.

A third indicator concerns the decline of traditional channels. ATM transaction volumes fell from 4.45 billion in 2021 to 4.07 billion in 2022, even as their value increased modestly—highlighting shifts in user behavior away from cash withdrawal and toward digital methods.

Better still, the penetration of payment devices and usage patterns offers another performance signal. As of 2022, just 36% of Nigerians above age 15 owned a debit

card, while fintech-powered POS terminals, mobile wallets, and online transfers have rapidly risen in prominence. Launch of domestic schemes like AfriGo Pay further signals progress, offering contactless debit, credit, virtual, and prepaid cards to expand digital payment options in Nigeria.

Finally, the economic implications of digital payment adoption are captured through macro indicators. ACI Worldwide's 2022 report estimates that Nigeria processed 3.7 billion real-time transactions in 2021, unlocking US$3.2 billion in additional GDP—representing 0.67% of national output; projections suggest this impact may nearly double to US$6 billion by 2026.

### 2.1.5 Recent Trends in Digital Payment Systems in the Globe

Digital payment systems worldwide have entered a period of rapid diffusion and consolidation, led by fast (instant) payments, expanding mobile and wallet ecosystems, and the push for interoperability across borders. Central banks and policymakers increasingly view modern payments as critical digital infrastructure, with more than 90% of central banks exploring central bank digital currencies (CBDCs)—and a sharp uptick in wholesale CBDC pilots during 2023—signaling continued experimentation alongside already-mature retail rails (Di Iorio et al., 2024).

A first hallmark of the period is the globalisation of fast payment systems (FPS). Over 100 jurisdictions now operate or are launching FPS, with common design motifs—24/7 real-time clearing, alias addressing, and open APIs—supporting

merchant acceptance, P2P, and bill payments (BIS, 2024a). Beyond domestic reach, authorities are working to interlink FPS across borders, an agenda elevated under the G20 Roadmap to enhance cross-border payments; technical and governance blueprints published in 2024 outline models for linking schemes while maintaining safety and oversight (FSB/CPMI, 2024; BIS, 2024a).

Interoperability also advances through data and messaging standardisation, most notably the migration to ISO 20022, which provides richer, structured payment data that improves reconciliation, compliance screening, and automation. Major reserve-currency systems (e.g., CHAPS, Fedwire/FedNow, TARGET services, BOJ-NET) have adopted or are migrating, positioning ISO 20022 as the de facto standard for real-time and cross-border payments (CPMI, 2024; Bank of England, 2023).

In emerging markets, mobile money and wallet ecosystems continue to deepen inclusion and usage. The Global Findex 2021 shows broad gains in account ownership and the use of accounts to make or receive digital payments, trends that persisted beyond the pandemic and increasingly involve women and rural users (Demirgüç-Kunt et al., 2022). These adoption patterns are reinforced by user-side drivers identified in recent literature: perceived usefulness, ease of use, network effects, and trust each shape both intention and actual use of digital payments (Ramayanti et al., 2024).

A complementary trend is the rise of QR-code payments and regional interoperability. In ASEAN, regulators and payment networks are building cross-border QR corridors (e.g., bilateral linkages across Southeast Asia), illustrating a low-cost path to merchant acceptance and travel-related payments at scale (IDE-JETRO, 2025).

### 2.1.6 Overview of Financial Inclusion in Nigeria

The Central Bank of Nigeria (C. B. N.) defines financial inclusion in the Nigerian context as a desirable condition "when adult Nigerians can easily access a wide array of formal financial services that fulfill their needs." Providing financial services to a wide range of a nation's population would hasten the speed of economic growth and development. This occurs as a greater number of individuals will be empowered to engage in economic activities, thus enhancing the business landscape, generating employment, developing skills, sharing knowledge and technology, and fostering a competitive market where innovation can flourish. The advantages of economic activity and the influence of access to financial services have been extensively recorded, and the body of literature on economic growth and development is filled with success narratives from nations that have fostered entrepreneurship by establishing a supportive financial system that enhances access to finance suited to the requirements of every income segment of the population.

A study carried out in Nigeria in 2008 by the Enhancing Financial Innovation and Access, a development finance organization, showed that approximately 53.0% of adults lacked access to financial services. The worldwide effort for financial inclusion

as a means for economic growth positively impacted Nigeria, with the exclusion rate decreasing from 53.0% in 2008 to 46.3% in 2010. Motivated by the favorable progress, the Central Bank of Nigeria, in partnership with stakeholders, initiated the National Financial Inclusion Strategy on 23rd October 2012, intending to lower the exclusion rate to 20% by 2020. Particularly, the percentage of adult Nigerians having access to payment services is expected to rise from 21.6% in 2010 to 70% in 2020, while access to savings should grow from 24.0% to 60%; Credit from 2% to 40%, Insurance from 1% to 40%, and Pensions from 5% to 40%, over the same period. (Central Bank of Nigeria, 2024).

The implementation of the Strategy is impacting positively on the rate of access to financial services. The adult exclusion rate reduced from 46.3% in 2010 to 39.7% in 2012. All the geopolitical zones in Nigeria equally recorded improvements with exclusion rate declining between 2010 and 2012 as follows: North East, 68.3% to 59.5%, North West, 68.1% to 63.8%, North Central, 44.2% to 32.4%, South East, 31.9% to 25.6%, South West, 33.1% to 24.8% and South South, 36.4% to 30.1% (Central Bank of Nigeria, 2024).

### 2.1.7 Types of Digital Payments

1. **Payment Cards**

The most frequently used types of payment cards are debit cards and credit cards. Payment cards are typically raised plastic cards measuring 85.60 × 53.98 mm. Typically, a payment card is electronically associated with an account or accounts of

the cardholder. These accounts can be either deposit accounts or loan or credit accounts, and the card serves to verify the cardholder's identity. To use payment cards, the necessary information includes the Card Verification Value (CVV number) and the card's expiry date. The CVV number is a set of characteristics utilized in credit and debit cards to verify the owner’s identity and reduce the likelihood of fraud. Payment cards necessitate two-factor authentication. Authentication involves comparing the supplied credentials to those stored in a database of authorized user information within a local operating system. Authentication factors consist of Knowledge factor (PIN), Possession factor (ID card, smartphone), and Inherence factor (fingerprint, face, or voice). Typically, payment cards can be categorized based on their characteristics (Sahayaselvi, 2019)

2. **Unstructured Supplementary Service Data (USSD)**

USSD is sometimes referred to as "Quick Codes" or "Feature codes", is a protocol used by GSM cellular telephones to communicate with the service provider's computers. A typical USSD message starts with an asterisk (*) followed by digits that comprise commands or data. Groups of digits may be separated by additional asterisks. The message is terminated with a number sign (#).The innovative payment service *99# works on Unstructured Supplementary Service Data (USSD) channel. This service allows mobile banking transactions using basic feature mobile phone, there is no need to have mobile internet data facility for using USSD based mobile banking. USSD is generally associated with real-time or instant messaging services.

USSD is sometimes used in conjunction with SMS. The user sends a request to the network via USSD, and the network replies with an acknowledgement of receipt: "Thank you, your message is being processed. A message will be sent to your phone." Mobile Banking Personal Identification Number (MPIN) works as a password when we perform any transaction using Mobile. (Sahayaselvi, 2019).

3. **Digital Wallets**

A Digital wallet is a way to carry cash in digital format. Credit card or debit card information should be linked to digital wallet application or money can be transferred in online to mobile wallet. Instead of using physical plastic card to make purchases, it can be paid through smartphone, tablet, or smart watch. The Services offered by Digital Wallets are Balance Enquiry, Passbook/ Transaction history, Add money, Accept Money, Pay money etc. Digital wallets are composed of both digital wallet devices and digital wallet systems. A mobile wallet is simply the digital wallet on the mobile handset. Most banks have their e-wallets and some private companies. e.g., O-pay, Palm pay. Moniepoint etc. (Sahayaselvi, 2019).

4. **Point of Sale machines**

The point of sale (POS) or point of purchase (POP) is the time and place where a retail transaction is completed. It is the point at which a customer makes a payment to the merchant in exchange for goods or after provision of a service. After receiving payment, the merchant may issue a receipt for the transaction, which is usually printed but is increasingly being dispensed with or sent electronically. A retail point

of sale system typically includes a cash register (which in recent times comprises a computer, monitor, cash drawer, receipt printer, customer display and a barcode scanner) and the majority of retail POS systems also include a debit/credit card reader (Sahayaselvi, 2019).

5. **Mobile Banking**

Mobile banking is a service provided by a bank or other financial institution that allows its customers to conduct different types of financial transactions remotely using a mobile device such as a mobile phone or tablet. It uses software, usually called an app, provided by the banks or financial institution for the purpose. Each Bank provides its own mobile banking App for Android, Windows and iOS mobile platform(s).The earliest mobile banking services used SMS, a service known as SMS banking. With the introduction of smart phones with Wireless Application Protocol (WAP) support enabling the use of the mobile web in 1999, the first European banks started to offer mobile banking on this platform to their customers. Mobile banking is known as M-banking or SMS Banking. The european company called PayBox supported financially by Deutsche Bank, in 1999 started mobile banking. The cost of mobile devices has been reduced drastically and is still being reduced. Network speed is much better than before and data plans are not as costly. All of these changes have provided necessary raw materials for the growth of mobile banking and the numbers of people using mobile banking is increasing day by day. Users, who were using

computers/laptops for online banking, are moving towards mobile banking because of ease of use and fast access (Sahayaselvi, 2019).

6. **Internet Banking**

Internet banking, also known as online banking, e-banking or virtual banking, is an electronic payment system that enables customers of a bank or other financial institution to conduct a range of financial transactions through the financial institution's website. Online banking was first introduced in the early 1980s in New York, United States (Sahayaselvi, 2019).

### 2.1.8 Relationship Between Digital Payment Systems and Financial Inclusion

Digital payment systems are broadening access to financial services globally. In numerous nations, they are assisting in integrating the previously unbanked into the formal economy. By doing so, they certainly enhance living standards and promote creativity and economic development.

In the past ten years, digital financial services (DFS) have developed to grant more accessible financial services that were once limited to a certain group of individuals and companies. Utilizing technology and data, digital finance guarantees that a significantly greater number of Nigerians can more easily access various products and services such as credit options, investment opportunities, insurance, savings, and retirement plans, among others. These are delivered via different channels such as mobile phones, point-of-sale systems, and agent networks, thereby enhancing

business transactions and operations in the nation and moving towards a genuinely cashless economy (Chioma, 2022).

Enhanced efforts have emerged to utilize digital financial services in bridging the divide between the unbanked/underbanked and the financially included segments of society. Consequently, the need for financial services among financially excluded Nigerians, who make up around 40.0 percent of the adult population, continues to be significant. In the 2016 State of the Market Report on Digital Financial Services in Nigeria, David-West *et al*. (2016) noted that "the unbanked and under-banked population in Nigeria mainly consists of women and young people aged 18 to 35 who have limited education and are either jobless or engaged in low-paying jobs." This observation highlights disparities related to gender, class, and age. Considering that mobile phone access and internet reach currently surpass bank availability, it is believed that utilizing mobile phones and various devices will act as technological catalysts for improving financial inclusion (Nartey and David-West, 2015). This awareness is evident in recent changes within Nigeria's digital financial services landscape as well as the provision of banking services, payments and service delivery solutions by telecommunication companies. Consumers of digital financial services face several challenges including lack of access to services, especially in rural areas, issues of affordability, and poor user experience (Chioma, 2022). The development has enabled Fintech companies to quickly step-in and take advantage of the

opportunities, with many developing enhanced propositions across the value chain to address pain points in affordable payments, quick loans, and flexible savings and investments, among others. Unfortunately, these efforts are hardly enough. While the market has targeted, built for, and marketed to the tech-inclined, educated and internet connected members of the market, reports show that more than 61.0 per cent of financially excluded Nigerians use a mobile phone, mostly feature phones (Chioma, 2022).

### 2.1.9 Automated Teller Machine (Atm) Transactions and Financial Inclusion

ATM is an electronic banking terminal that enables consumers to conduct simple transactions without the assistance of teller or branch personnel. In the usage of ATMs, anyone with a credit or debit card can get cash. ATMs are convenient because they allow customers to do self-service operations like cash withdrawals, bill payments, and account transfers. However, most ATMs are disabled from cash deposits in Nigeria. Cash withdrawal fees are frequently charged by some mischievous Deposit Money Banks (DMBs) irrespective of where the account is domiciled (Ehiedu *et al*., 2021).

#### 2.1.9.1 Emergence and Development of ATM Transactions in Nigeria

The previous Mechanical Cash Dispenser placed by the National Cash Registers (NCR) in 1989 for the defunct Societe Generale Bank of Nigeria (SGBN) can be traced back to the historical development of SGBN ATM in Nigeria. The SGBN ATM was known as "Cash Point 24". Two years after SGBN’s ATM, First Bank of

Nigeria (FBN) Plc launched their own named "First Cash." While the SGBN ATM was a drive-up machine, the First Bank ATM was a through-the-wall machine (Jegede, 2018). They were, nevertheless, considered a highbrow amenity at the time, created for individuals seeking special care. Today, the story is different, as ATM financial engineering is already generally used and accepted. The widespread acceptance of ATM financial engineering is attributed to the 2004 bank reforms and the country's earlier establishment of the Inter switch network in 2003. In cementing the reform program, money deposit banks installed ATMs in their premises and different critical areas to develop a cashless economy and ensure the efficiency of banks (Ehiedu *et al*., 2021). Consequently, Olatokun and Igbinedion (2009), referenced in Backjena and Gundimeda (2018), observed that bank transactions increased by 93 percent between January 2005 and March 2006, owing to aggressive roll-out initiatives by banks, powered by Inter-switch Network.

As a result, transactions volume increased from N1.6 million in 2006 to over N500 million in 2009, and the total number of ATMs increased dramatically from 500 in 2006 to over 8,000 in 2009. The number of ATMs was also 10,221 at the end of June 2012, with the value of ATM transactions increasing by 34.3 percent to N937.39 billion from N698.19 billion. From the initial N937.39 billion in June 2012, this sum had risen to N1.3 trillion by the end of the year. CBN recently announced that the number of financial transactions carried out through ATMs was N1.7 trillion in June 2014, up from N1.3 trillion in 2012. The number of ATMs increased from 10,727 in

2012 to 15,000 in June 2014 (Ehiedu *et al*., 2021). Rapid ATM transactions in Nigeria are, however, not linked to DMBs' heavy attention on the promotion of ATM awareness through several ATM promotional schemes. Banks have even gone so far as to penalize their clients for not using ATM cards by debiting their account for withdrawing less than a particular amount across the counter, (Memba and Njeru, 2018). Consequently, CBN's Bankers Committee recommended the immediate abolition of the N100 penalty for clients who used a different bank's ATM from November 6, 2012.

In a recent development, the CBN reintroduced ATM charges on September 1, 2014, and banks now charge consumers N65 for using remote-on-us ATMs after the third withdrawal within a month. Withdrawals performed from ATMs other than the bank where the account is domiciled are known as remote-on-us ATM withdrawals (Kumari, 2017). According to CBN N65 reintroduction was necessary since bank customers now use ATMs indiscriminately resulting in to decrease in profits and increased overhead costs. As a result, the reintroduction of the fee will assist to reduce bank costs (Ehiedu *et al*., 2021).

#### 2.1.9.2 Impact of Automated Teller Machines (ATMs) On Financial Inclusion (FINC)

Players in the formal financial services sector have over the years continued to increase the deployment of ATMs in all parts of the World to achieve different

objectives. However, in spite of what their objectives may be, the deployment cannot be said to be unconnected with FINC.

In an attempt to examine the effect of FINC on the economic growth and poverty reduction in Asia, Ratnawati (2020) found that ATMs density has significant positive influence on FINC, economic growth and poverty reduction in Asia. Also, in their studies on the impact of Technological variables on FINC in Nigeria, Ene *et al*. (2019) suggests that while ATMs exerts insignificant positive relationship with FINC, Point-of-Sales on the other hand significantly and positively impact FINC. Contrarily, in developing economies such as Africa, ATMs shows significant negative relationship to FINC which suggests the possible effect of obsolete ATMs and limited or absence of ATMs in the rural areas (Williams *et al*., 2017). A position that was agreed to by Raza *et al*. (2019) who found that ATMs per 1,000 km2 has a significant negative impact on FINC in Pakistan.

Emara and Said (2021) conducted a study on FINC and economic growth in the Middle East and North Africa region, the findings reveal that ATMs exerts significant positive effect on FINC and ultimately the economic growth of the region. This finding aligns with the findings in Sharma (2016) where it was argued that the spread of ATMs other than spread of bank branches has significant positive relationship with FINC and the economic growth of India from 2004-2013.

Attempts have been made to examine the contribution of foreign owned banks within an economy to FINC. One of such studies was Gopalan and Rajan (2018) who found

that the presence of foreign owned banks in 50 emerging and developing economies has significant positive impact on FINC through ATMs per capita and ATMs density rather than bank branches spread from 2004-2009. This is a departure from the findings in William *et al*. (2017) whose studies found significant negative impact of ATMs on FINC in developing economies as a result of obsolete and low-density of ATMs. This could also mean that foreign owned banks do have competitive advantage over the local banks in the areas of ATMs sourcing and access to adequate capital investment portfolio to finance their investment in ATMs deployment.

Sindani *et al.* (2019) investigates the effect ATMs and Internet banking on FINC in Kenya from 2012-2017. They found that both ATMs and Internet banking have significant positive relationship with FINC.

### 2.1.10 Point-Of-Sales (Pos) Transactions and Financial Inclusion

Point of Sale (POS) also sometimes referred to as Point of Purchase (POP) checkout is the location where a transaction occurs. A "checkout" refers to a POS terminal or more generally to the hardware and software used for checkouts, the equivalent of an electronic cash register.

A POS terminal manages the selling process by a sales person accessible interface. The same system allows the creation and printing of the receipt (Shittu, 2010). The term "Point of Sale (POS)" or "Point of Purchase (POP)" refers to the location and time where a retail transaction is completed (Okeke *et al*., 2017). The POS terminal is also known as a POP terminal and is used for instant payment of goods and services,

as it is user-friendly, easy to operate, and has multi-functional capabilities (Altunbas and Thornton, 2019). POS terminals allow customers to access their linked bank accounts in real-time through debit or credit cards (Iwedi, 2017). They are considered by Awoniyi (2022) as a virtual replacement for cash transactions.

The terminal keeps a record of customer purchases and deposit transactions, allowing customers to check their balance, pay for items, and perform funds transfer transactions without the need for physical cash (Ikpefan *et al*., 2018). In other words, the POS terminal facilitates virtual movement of funds to support merchants in monitoring their customers' transactions (Agbaje and Ayanbadejo, 2013). A POS terminal is a device deployed in a merchant location that allows users to swipe their electronic cards to make payments instead of using physical cash (Williams *et al*., 2018). The adoption of POS terminals has significantly reduced the volume of cash-based transactions, as such adoption of POS technology allows cardholders to make payments at sales or purchase outlets without the need for physical cash (Osang, 2017). The terminal offers many advantages, including ease of payments, convenience, and security (Morufu, 2016).

#### 2.1.10.1 POS and availability of Financial Services

Nguyen (2021) entails how consumers in the United States of America in southern California, have embraced concept of availability in banking as initiated POS, inside selected supermarkets operated by Ralph’s Grocery company. This means convenience for customers and profitability for the banker, shoppers at mega stores,

groceries can conduct banking at their convenience. Study conducted in the USA found out 63% of US adults would have to use POS due to availability, convenience, subsequently globally banks are becoming more innovative as per another study commissioned by Infosys and conducted by Efma, surveyed 148 banks in 66 countries, the study revealed that as global economy recovers many banks are turning to innovations as means of raising revenue, cutting costs thus creating convenience for the customer (Teller Vision, 2014).

In Africa the case for availability would arise based on cost of building, unsteady incomes, unemployment, distance to bank branches and maintaining branches in rural areas thus the need to adapt low-value, high volume transactional environment with numerous points of access, (Financial Services Survey in Nigeria, 2010). Fenuga (2010) emphasize that agents offer similar services as banks which range from cash deposits, withdrawals, disbursement, loan repayment, salary payment, transfer of funds, mini bank statements, balance inquiry, cash payment of bills and cash deposits. Survey conducted by Nnamani and Makwe (2019) found out that 99 percent of respondents said that they still use branches, however ATM's are becoming important in African banking systems; 85% respondents say they use ATM's and saying that they use them on weekly basis. Alternative channels have also attracted customer participation of point of sale (POS) enjoys 69% usage, conclusion is that the acceptance of POS across Africa is increasing in most markets.

**2.1.10.2 POS and Affordability of Access to Financial Services**

Claessens (2006) in their analysis of the causal relationship between quality, customer satisfaction and purchase intention found that service quality was an antecedent of consumer satisfaction, consumer satisfaction had significant effect on purchase intention. In analysis, this then means that high service and customer satisfaction results in high level of purchase intentions. Nguyen (2021) says that the heart of service is in the value it gives to the stakeholders. The sustainability of service has two dimensions of core value; which is the fundamental nature of that service and super value; replacing other solutions by a more appropriate one. For example when one to travel he has choice of using train, taxi or doing it by self. Shifting the service boundary direction either to self-service or super service will effect changes in the resource arrangement and effort of running the change, however it may not change the service core business, (Irvin, Lain and Vishwanath, 2021).

Both the service provider and customer have to be responsible in discharging this relationship for example the customer is expected to have in mind his/her economic, social, political, ecological state while the provider has to outline the areas being covered by the service,(Claessens, 2006).

### 2.1.11 Mobile Payments and Financial Inclusion

The advent of Mobile Payments (MPs) has been heralded as a transformative development in the global financial ecosystem, with significant implications for enhancing Financial Inclusion (FI). Mobile banking (MB), unstructured supplementary service data (USSD), and e-wallets (EW) have emerged as pivotal

conduits for bridging the gap between formal financial services and unbanked or underbanked populations. FI, often measured through proxies such as total rural deposits (TRD), reflects the extent to which individuals and businesses in remote or underserved areas can access and utilize affordable, convenient, and secure financial services. In Nigeria, a country with a substantial rural population and pervasive financial exclusion challenges, the nexus between mobile payment systems and FI merits a detailed examination (Central Bank of Nigeria [CBN], 2022).

Mobile banking, defined as the use of mobile devices to access financial services, has seen rapid adoption globally, including in sub-Saharan Africa. Nigeria, with its burgeoning mobile phone penetration rate, has experienced an increase in mobile banking adoption, which has been facilitated by regulatory frameworks and collaborations between financial institutions and mobile network operators. According to recent data, mobile banking transactions in Nigeria accounted for over a quarter of all electronic payments in 2022, indicating a growing reliance on digital platforms for financial activities (Central Bank of Nigeria [CBN], 2022). This growth has been propelled by the ability of mobile banking to offer real-time account management, fund transfers, and bill payments, which are crucial for rural populations who face logistical and infrastructural barriers to accessing physical bank branches (Okafor *et al*., 2021).

Similarly, USSD technology has emerged as a cost-effective and user-friendly platform for FI.

USSD, a communication protocol used on GSM networks, enables users to perform financial transactions without the need for internet connectivity or sophisticated mobile devices. This feature makes USSD particularly relevant for Nigeria's rural and low-income demographics, where smartphone penetration remains relatively low. Studies have highlighted that USSD-based financial services significantly lower transaction costs and enhance accessibility, thereby incentivizing greater participation in the formal financial system (Adelakun *et al*., 2020). Moreover, the Nigerian Inter-Bank Settlement System (NIBSS) reported a 35% increase in USSD transaction volume in 2021, underscoring its growing role in the country's financial landscape (NIBSS, 2021).

E-wallets, another critical component of mobile payment systems, have gained prominence as digital tools that allow users to store, transfer, and receive money electronically. The flexibility and convenience offered by e-wallets have made them a popular choice among Nigeria's youth and entrepreneurial population, particularly in rural areas where traditional banking services are scarce. The proliferation of fintech companies in Nigeria has further accelerated the adoption of ewallets, with platforms such as Paga, Opay, and PalmPay becoming household names. Research indicates that e-wallets contribute to FI by fostering savings habits and enabling transactions, which are essential for the economic empowerment of rural communities (Akinola and Olayemi, 2022; Owolabi *et al*., 2021).

The linkage between mobile payment systems and FI is intricately tied to their capacity to mobilize savings and deposits, as captured by TRD. Rural deposits serve as a barometer for FI, reflecting the extent to which rural populations engage with formal financial institutions. In Nigeria, whereover 40% of the population resides in rural areas, the mobilization of rural deposits is critical for achieving sustainable development and poverty alleviation goals (World Bank, 2022). Mobile payment systems have demonstrated a significant impact on rural deposit mobilization by reducing the cost and complexity of financial transactions. For instance, USSD platforms allow farmers and small-scale traders to deposit money directly into their accounts, thereby promoting a culture of savings and financial discipline (Eze *et al*., 2021).

#### 2.1.11.1 Relationship between Mobile Banking and Financial Inclusion

Mobile banking (MB) involves using mobile devices to access financial services such as account management, fund transfers, and bill payments. It eliminates the need for physical bank visits, thus reducing costs and logistical barriers for rural users. Studies indicate that MB facilitates FI by providing real-time, accessible, and secure financial services (Okafor *et al*., 2021).

The Central Bank of Nigeria (CBN) has reported a steady increase in mobile banking adoption, with transaction volumes reaching unprecedented levels between 2020 and 2022, reflecting a growing trust in digital platforms (CBN, 2022). However, rural adoption of MB faces challenges such as low smartphone penetration and limited

internet access. To mitigate these challenges, partnerships between financial institutions and telecommunications providers have enabled MB innovations that operate efficiently even on low-bandwidth networks (Akinola and Olayemi, 2022).

For instance, mobile banking services integrated with voice-assisted technology have been deployed to cater to non-literate users in rural areas. Yet, gaps remain in understanding how MB directly impacts TRD in these regions, especially concerning the frequency and volume of deposits.

### 2.1.12 Unstructured Supplementary Service Data (USSD) and Financial Accessibility

Unstructured supplementary service data (USSD) is a mobile communication technology that does not require internet connectivity, making it particularly suited to rural environments where such infrastructure is scarce. USSD enables users to perform banking operations, such as transferring funds and checking account balances, using basic feature phones. Its simplicity and costeffectiveness have made it a popular tool for driving FI in Nigeria (Adelakun *et al*., 2020). Studies reveal that USSD has significantly improved rural financial transactions by reducing both time and financial costs associated with accessing banking services (Oluwaseun and Fadeyi, 2021). Furthermore, the interoperability of USSD platforms across banks and mobile network operators has enhanced their utility for rural users, contributing to increased deposit mobilization. However, challenges such as transaction failures and user interface complexity for older populations continue to limit its effectiveness.

Additionally, while USSD usage is positively associated with increased rural savings, there is limited empirical evidence linking it directly to measurable improvements in TRD.

### 2.1.13 Web/Online Banking and Financial Inclusion

Online banking, while instrumental in enhancing financial inclusion, faces several challenges that hinder its effectiveness. One major barrier is limited digital literacy, especially among low-income and rural populations, which impedes effective use of online banking services. Many potential users lack familiarity with digital platforms, which reduces adoption rates and risks marginalizing these groups further (Banna *et al*., 2022). Additionally, limited internet and mobile infrastructure in remote areas restrict access, especially in regions where network coverage and power supply are unreliable (Koomson *et al*., 2020). High transaction fees associated with online banking also pose a challenge, discouraging frequent use among low-income individuals. Privacy and security concerns around digital transactions further hinder user confidence, with cyber-attacks and fraud risks potentially deterring adoption. Addressing these challenges requires targeted interventions to improve digital literacy, expand infrastructure, and reduce costs to ensure inclusive access and user trust.

On the other hand, online banking offers numerous opportunities to advance financial inclusion. It provides a low-cost and efficient means for banks to extend services to previously underserved areas, eliminating the need for physical branches. This is particularly impactful in rural regions, where traditional banking infrastructure is

sparse (Demirgüç-Kunt *et al*., 2020). Online banking also offers convenience, allowing users to perform transactions anytime, which increases financial accessibility. Digital platforms can enable micro-loans, savings programs, and financial literacy initiatives tailored to low-income users, fostering greater economic empowerment. Moreover, the growing integration of mobile wallets with online banking creates further opportunities for collaboration between banks and fintech, expanding access to financial services beyond traditional banking customers (Tay *et al*., 2022). With supportive regulatory frameworks and continued technological innovation, online banking has the potential to make financial services more inclusive, particularly in developing regions.

## 2.2 Theoretical Framework

### Inclusive Growth and Financial Inclusion Models

The inclusive growth and financial inclusion models provide a strong theoretical foundation for understanding how digital payment technologies contribute to broad-based economic development. At the core of these models is the idea that sustainable economic growth cannot be achieved if large segments of the population are excluded from participating in the formal financial system (Claessens, 2006; Ratnawati, 2020). Financial inclusion, therefore, becomes a pathway to achieving inclusive growth by ensuring that individuals and businesses, particularly those in marginalized and rural areas, have access to affordable, reliable, and convenient financial services.

According to the World Bank (2022, 2023) and Demirgüç-Kunt et al. (2022), financial inclusion models emphasize three pillars: access, usage, and quality of financial services. Access refers to the ability of individuals to enter the financial system, usage denotes the regularity and volume of transactions, while quality concerns the suitability of financial products to meet the diverse needs of users. Digital payment technologies play a vital role in enhancing all three pillars. For instance, ATMs increase access by providing cash and deposit services beyond banking hours, POS systems expand usage by allowing merchants and customers to transact seamlessly, and mobile payment platforms improve quality by tailoring services (such as USSD codes) to populations with limited internet access.

The inclusive growth model further posits that when financial services are more widely available, individuals are empowered to save, invest, and manage risk, thereby reducing poverty and inequality (Altunbas & Thornton, 2019; Koomson et al., 2020). For example, mobile payments have been shown to increase women's participation in the financial system, enabling them to save securely and gain economic independence (Adeoye et al., 2022). Similarly, POS systems help small and medium enterprises (SMEs) join the digital economy by accepting cashless payments, thereby increasing their competitiveness and contributing to job creation.

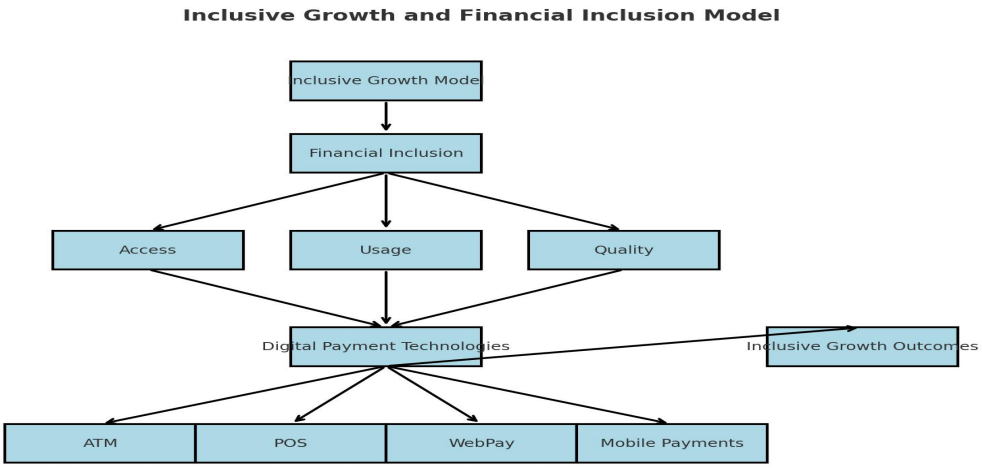


**Figure 2.1 Illustration of the Inclusive growth financial inclusion model (Demirgüç-Kunt et al., 2022)**

## 2.3 Empirical Review

Empirical studies provide evidence of the impact of digital payment systems on financial inclusion across various contexts.

1. **Effects of ATM Transactions on Financial Inclusion in Nigeria**

Jegede (2018) investigated the effect of Automated Teller Machines (ATMs) on the performance of Nigerian banks, with a focus on their contribution to financial inclusion. The study employed a quantitative method, using survey design alongside secondary banking transaction data. The data were collected from commercial banks across Nigeria covering the period between 2005 and 2015. The findings revealed that ATM usage significantly improved customer access to banking services, reduced

long queues in banking halls, and increased the number of previously unbanked individuals who could now perform financial transactions conveniently.

In a related study, Anifowose and Ekperiware (2022) examined the combined effect of ATMs, POS terminals, and online banking transactions on economic growth, with implications for financial inclusion. They adopted econometric modeling using time-series data obtained from the Central Bank of Nigeria (CBN) statistical bulletins. Covering the period 2012–2020, the study found that ATM transactions contributed positively to financial access and efficiency by expanding transactional reach, although infrastructural and network issues limited the full potential of ATMs in rural areas.

The Central Bank of Nigeria (2024), through its e-Payment statistics, provided descriptive evidence on ATM usage. The report, based on administrative data covering January–December 2023, showed a substantial rise in ATM transaction volumes, indicating sustained reliance on the channel despite the growth of other payment options. The findings emphasized that ATMs remain a critical entry point for financial inclusion in Nigeria, particularly in semi-urban and rural locations.

2. **Effects of POS Transactions on Financial Inclusion in Nigeria**

Okeke, Nwatu, and Ezeh (2017) analyzed consumer adoption of the POS e-payment system in Nigeria using an extended Technology Acceptance Model (TAM). The

study employed a survey research design with questionnaires distributed to retail customers in Enugu State. Data were collected in 2016 and analyzed using regression analysis. Findings revealed that perceived ease of use, trust, and social influence were major determinants of POS adoption, thus supporting the role of POS in enhancing financial inclusion.

Williams, Olalekan, and Timothy (2018) examined consumer trust and adoption of POS in selected business organizations within Lagos State. Using a mixed-method design, the study combined questionnaires and structured interviews administered to both merchants and customers in 2017. The results showed that trust in the reliability of POS terminals and transaction security significantly influenced adoption, which in turn promoted financial inclusion by encouraging more customers to use electronic payment platforms instead of cash.

Similarly, Anifowose and Ekperiware (2022), in their broader study of e-payment channels, reported that POS transactions had the highest direct effect on improving financial inclusion. Using CBN time-series data (2012–2020), their econometric analysis found that POS terminals expanded financial access for small businesses, informal traders, and rural communities by enabling cashless transactions outside traditional bank branches.

3. **Effects of Web Pay Transactions on Financial Inclusion in Nigeria**

Ene, Abba, and Fatokun (2019) studied the impact of electronic banking, including Web Pay, on financial inclusion in Nigeria. The study adopted a descriptive survey and secondary data approach, covering deposit money banks across Nigeria from 2010 to 2017. Findings showed that Web Pay platforms encouraged e-commerce participation and reduced the cost of transactions, thereby enhancing financial inclusion among urban populations and tech-savvy youth.

Ikpefan, Akpan, Godswill, Evbuomwan, and Ndigwe (2018) investigated electronic banking and the cashless policy in Nigeria with a focus on Web-based transactions. They employed econometric time-series analysis using CBN data from 2010–2016. Results demonstrated that the cashless policy increased the use of Web Pay services, particularly for bill payments and online retail, which positively influenced financial inclusion by reducing reliance on physical cash.

Agbaje and Ayanbadejo (2013), in a report for RTC Advisory Services, assessed the relationship between electronic payments and economic growth in Nigeria. Using CBN transaction records spanning 2007–2012, the study found that Web Pay transaction volumes grew steadily and played a complementary role in broadening financial inclusion, though challenges remained with internet penetration and cybersecurity.

4. **Effects of Mobile Payments on Financial Inclusion in Nigeria**

Okafor, Eze, and Chukwuma (2021) analyzed the impact of mobile banking on financial inclusion in Nigeria. The study used a quantitative design, applying regression analysis to survey data obtained from mobile banking users in major Nigerian cities between 2015 and 2020. Findings indicated that mobile banking significantly enhanced inclusion, particularly for the younger population, by reducing barriers to account ownership and enabling easy fund transfers.

Adeoye, Oladele, and Balogun (2022) examined the role of mobile payment platforms in promoting gender equality in financial inclusion. Employing a case study approach and survey data from female entrepreneurs across South-West Nigeria in 2021, the study found that mobile payments increased women's access to financial services, facilitated micro-business transactions, and contributed to narrowing gender gaps in financial participation.

Okeke and Alabi (2023) studied the influence of e-wallet services on rural deposit growth and financial inclusion in Nigeria. Using mixed-method research, the authors combined household surveys with transaction data from mobile network operators in 2022, focusing on rural communities in Northern Nigeria. Their findings highlighted that e-wallet adoption expanded deposit mobilization in rural areas and reduced the

distance barrier associated with traditional bank branches, thereby fostering deeper financial inclusion.

### 2.4 Gaps in Literature

1. Existing studies on digital payments and financial inclusion in Nigeria show strong associations between electronic channels and inclusion outcomes, but several limitations remain. First, much of the Nigerian evidence measures financial inclusion narrowly through aggregate transaction volumes (e.g., total ATM, POS, or mobile transactions), rather than multidimensional indicators that also capture access, usage quality, affordability, and resilience. As a result, prior work often equates "more transactions" with "more inclusion," overlooking whether the poor, women, or rural residents actually experience lower costs, better service quality, or improved financial resilience (cf. Demirgüç-Kunt et al., 2022; World Bank, 2022, 2023).

2. There is a channel imbalance in the literature. Mobile money/USSD and POS have received the most attention, while Web Pay/online gateway transactions are typically folded into broad "e-banking" categories or treated incidentally. This leaves a gap in understanding how internet-based payments (which rely on connectivity and digital literacy) shape inclusion differently from mobile or card-present channels in Nigeria's heterogeneous context. Similarly, ATMs are often analyzed for bank performance or cash-management effects, with limited direct linkage to inclusion metrics beyond convenience.

3. Causal identification is weak in many studies. Findings are frequently based on contemporaneous correlations or simple regressions using national aggregates from CBN/NIBSS, making it hard to rule out endogeneity and reverse causality (e.g., more financially included areas may simply generate higher digital volumes). Few papers exploit policy shocks (cashless policy phases, interchange fee changes, agent banking rollouts) or use quasi-experimental strategies to isolate exogenous variation. Likewise, substitution vs. complementarity among channels is underexplored: do rising mobile payments reduce ATM/POS reliance, or do channels grow together and reach different user segments?

4. There is limited granularity and heterogeneity analysis. Many studies use national totals, masking important differences by region (urban–rural, North–South), income, gender, education, or merchant type (formal vs. informal SMEs). Micro-level data on users and merchants, or state/LGA-level transaction series, are rarely integrated with socioeconomic indicators. Consequently, we know little about who benefits most from each channel and where bottlenecks persist (e.g., network downtime zones, agent deserts, low-connectivity corridors).

5. The literature often underweights quality, reliability, and trust dimensions. Network failures, chargeback frictions, fraud exposure, and dispute-resolution performance can depress sustained usage even when adoption looks high. These frictions are typically not reflected in volume statistics and are seldom modeled

jointly with inclusion outcomes. Relatedly, digital literacy and behavioral factors—such as risk perceptions and habit persistence with cash—are discussed in qualitative terms but rarely integrated empirically alongside transaction data.

6. Temporal coverage is a moving target. Nigeria's payments mix has shifted rapidly, with the post-2020 surge in mobile/instant transfers, POS agent expansion, and changing ATM usage patterns. Many studies stop before these inflection points or do not incorporate recent regulatory developments (e.g., deepening agency banking, domestic card schemes, CBDC pilots), limiting the relevance of older estimates for today's environment.

7. There is a theory–measurement gap. Inclusive growth frameworks emphasize welfare channels—savings mobilization, risk sharing, entrepreneurial entry, women's economic participation—but empirical papers often do not trace mechanisms from a specific channel to these outcomes. Without mediators (e.g., lower transaction costs, reduced travel time, improved merchant acceptance), the pathway from "more digital volume" to "greater inclusion and welfare" remains assumed rather than demonstrated.

# CHAPTER THREE

# RESEARCH METHODS

## 3.1 Introduction

This chapter presents a detailed account of how the study will be conducted, outlining the research methods to be employed. This study focuses on the impact of digital payment technologies on financial inclusion in Nigeria. It is subdivided into a number of sections, which include research design, population and sampling, sources of data collection, model specification, operationalization of variables, and techniques of data analysis.

## 3.2 Research Design

This study adopted the Ex-Post-Facto research design, which is widely used in management and social sciences to examine relationships between factors and their effects without manipulating the variables. In this context, the study analyzed secondary data on the volume of ATM, POS, Web Pay, and mobile payment transactions and their impact on financial inclusion in Nigeria. Since the researcher cannot control or manipulate these digital payment variables—either because they are already established in the financial system or inherently non-manipulable—the Ex-Post-Facto design is particularly appropriate (Agbonifoh & Yomere, 1999). This approach allows for the investigation of causal relationships by observing naturally

occurring variations in digital payment usage and their effects on indicators of financial inclusion.

### 3.3 Population and Sample of the Study

The population of the study comprises all quarterly observations of digital payment transactions and financial inclusion indicators in Nigeria from the inception of comprehensive data collection in 2009 up to 2023. This study employs census sampling, taking the entire population as its sample size, covering the period from 2009Q1 to 2023Q4. This provides 60 quarterly observations, which is adequate for time series econometric analysis and allows for comprehensive examination of the impact of digital payment technologies on financial inclusion in Nigeria over a 15-year period.

### 3.4 Sources of Data

The study utilized secondary data obtained directly from the Central Bank of Nigeria (CBN) Statistical Bulletin and the Nigeria Inter-Bank Settlement System (NIBSS), covering a period of 15 years from 2009Q1 to 2023Q4, yielding 60 quarterly observations. This data provided comprehensive information on the volume of ATM, POS, Web Pay, and mobile payment transactions, as well as indicators of financial inclusion in Nigeria. The use of secondary data ensures accuracy and reliability, as it is sourced from authoritative and official financial institutions, allowing for robust analysis of trends and relationships over the selected period.

### 3.5 Theoretical Framework

This study is anchored on the Theory of Reasoned Action (TRA), as proposed by Fishbein and Ajzen (1975). The TRA framework comprises four general principles: behavioral attitudes, subjective norms, intention to use, and actual usage, which collectively explain behavior beyond mere technology acceptance. The theory posits that individuals evaluate the consequences of a given behavior and form intentions to act based on these evaluations. In turn, intentions serve as strong predictors of actual behavior, while attitudes and subjective norms shape these intentions. Specifically, attitudes are influenced by an individual's beliefs about the outcomes of their behavior, whereas subjective norms are shaped by perceptions of how significant others view the behavior (Pavlou, 2013).

In the context of digital payment technologies, TRA is particularly relevant. Factors such as system design, user characteristics (e.g., cognitive styles, personality traits), and task attributes can indirectly influence behavior by shaping attitudes and subjective norms. The theory's focus on subjective norms is especially valuable, as it highlights the social influence on technology adoption—an element often overlooked in other models. Consequently, TRA provides a robust framework for predicting and understanding the adoption of digital payment systems and their role in enhancing financial inclusion.

### 3.6 Model Specification

The model for this study examines the relationship between digital payment technologies and financial inclusion in Nigeria. Based on the theoretical framework and empirical literature, the functional form of the model is expressed as:

**FIC = f(ATM, POS, WEB, MOB)**

Where:

**FIC** = Financial Inclusion (measured as total savings as a ratio of GDP)

**ATM** = Volume of Automated Teller Machine transactions

**POS** = Volume of Point-of-Sale transactions

**WEB** = Volume of Web Pay transactions

**MOB** = Volume of Mobile Payment transactions

Based on theoretical and a priori expectations, the coefficients of the independent variables are hypothesized to be positive ($\beta > 0$), implying that increased transaction volumes across ATM, POS, Web Pay, and mobile payment channels are expected to **positively influence financial inclusion** in Nigeria.

### 3.7 Measurement of Variables

| VARIABLE | VARIABLE TYPE | MEASUREMENT | SOURCE | A PRIORI EXPECTATION |
|---|---|---|---|---|
| Financial Inclusion (FIC) | Dependent Variable | Total savings as a ratio of GDP (%) | CBN Statistical Bulletin | --- |
| ATM Transaction Volume (ATM) | Independent Variable | Total volume of ATM transactions (quarterly) | NIBSS & CBN | (+) |
| POS Transaction Volume (POS) | Independent Variable | Total volume of Point-of-Sale transactions (quarterly) | NIBSS & CBN | (+) |
| Web Pay Transaction Volume (WEB) | Independent Variable | Total volume of Web Pay/online banking transactions (quarterly) | NIBSS & CBN | (+) |
| Mobile Payment Volume (MOB) | Independent Variable | Total volume of mobile payment transactions (quarterly) | NIBSS & CBN | (+) |

**Note:** The dependent variable (FIC) measures the breadth and depth of financial inclusion through the savings mobilization channel, reflecting the extent to which digital payment technologies facilitate access to and usage of formal financial services.

### 3.8 Method of Data Analysis

This study adopts a comprehensive time series econometric approach to analyze the empirical model and examine the impact of digital payment technologies—specifically ATM, POS, Web Pay, and mobile payments—on financial inclusion in Nigeria. The analysis proceeds through several sequential stages:

### 3.8.1 Preliminary Analysis

**Graphical Analysis:** Visual inspection of time series plots will be conducted to identify trends, structural breaks, and patterns in the data for all variables.

**Descriptive Statistics:** Summary statistics, including mean, median, standard deviation, skewness, kurtosis, and Jarque-Bera test for normality, will be computed to understand the distributional properties of the variables.

**Correlation Analysis:** Pearson correlation coefficients will be estimated to examine the bivariate relationships among the study variables and detect potential multicollinearity issues.

### 3.8.2 Unit Root Testing

Given the time series nature of the data, stationarity tests will be conducted using the **Augmented Dickey-Fuller (ADF)** test to determine the order of integration of each variable. This is crucial to avoid spurious regression results. The null hypothesis of the ADF test is that the variable contains a unit root (non-stationary), while the alternative hypothesis is that the variable is stationary.

Variables will be tested at:

**Level** I(0)

**First difference** I(1)

**Second difference** I(2) (if necessary)

The optimal lag length for each test will be determined automatically using the Schwarz Information Criterion (SIC).

### 3.8.3 Cointegration Analysis

Following the unit root tests, if variables are found to be integrated of different orders, a cointegration test will be performed to determine whether a long-run equilibrium relationship exists among the variables. The study will employ the **Johansen Cointegration Test**, which includes:

**Trace Test:** Tests the null hypothesis that there are at most r cointegrating vectors against the alternative of more than r cointegrating vectors.

**Maximum Eigenvalue Test:** Tests the null hypothesis of r cointegrating vectors against the alternative of r+1 cointegrating vectors.

The presence of cointegration indicates that despite short-run deviations, the variables move together in the long run, justifying the use of an error correction framework.

### 3.8.4 Autoregressive Distributed Lag (ARDL) Model

The primary estimation technique for this study is the **Autoregressive Distributed Lag (ARDL)** approach to cointegration, also known as the Bounds Testing approach developed by Pesaran, Shin, and Smith (2001). The ARDL model is chosen for several reasons:

**Advantages of ARDL:**

It can be applied irrespective of whether the regressors are I(0), I(1), or a mixture of both.

It provides consistent estimates of the long-run coefficients that are asymptotically normal.

It allows for different lag lengths for different variables.

It is suitable for small sample sizes (the study has 60 observations).

It distinguishes between short-run and long-run effects through the Error Correction Model (ECM) representation.

### 3.8.5 Bounds Testing for Cointegration

The F-statistic (Wald test) will be computed to test for the existence of a long-run relationship. The null hypothesis is that there is no cointegration ($H_0$: $\theta_1 = \theta_2 = \theta_3 = \theta_4 = \theta_5 = 0$), while the alternative hypothesis is that cointegration exists.

The computed F-statistic will be compared with the critical values provided by Pesaran et al. (2001):

If F-statistic > upper bound critical value, reject $H_0$ (cointegration exists)

If F-statistic < lower bound critical value, fail to reject $H_0$ (no cointegration)

If F-statistic falls between bounds, the test is inconclusive

### 3.8.6 Long-Run and Short-Run Estimation

Once cointegration is established:

**Long-Run Model:** The long-run coefficients will be estimated, showing the equilibrium relationship between digital payment technologies and financial inclusion.

**Short-Run Dynamics (ECM):** The Error Correction Model will be estimated to capture the short-run dynamics and the speed of adjustment toward long-run equilibrium. The error correction term (ECT) should be negative and statistically significant, indicating the rate at which the system corrects disequilibrium.

### 3.8.7 Diagnostic Tests

Several post-estimation diagnostic tests will be conducted to validate the model:

**Serial Correlation Test:** Breusch-Godfrey LM test

**Heteroskedasticity Test:** Breusch-Pagan-Godfrey test or White's test

**Normality Test:** Jarque-Bera test on residuals

**Specification Test:** Ramsey RESET test

**Stability Test:** CUSUM (Cumulative Sum) and CUSUM of Squares tests to check for parameter stability over time

### 3.8.8 Hypothesis Testing

The hypotheses will be tested using the t-statistic for individual coefficients and the F-statistic for joint significance. The decision rule is:

If the p-value < 0.05 (5% significance level), reject the null hypothesis

If the p-value > 0.05, fail to reject the null hypothesis

**Statistical Software:** All estimations will be conducted using EViews 10 econometric software, which provides robust tools for time series analysis, cointegration testing, and ARDL modeling.

### 3.9 Decision Rule

The study adopts the conventional 5% level of significance ($\alpha = 0.05$) for all statistical tests. For hypothesis testing:

**Reject the null hypothesis** if p-value $\leq 0.05$ (statistically significant)

**Fail to reject the null hypothesis** if p-value $> 0.05$ (not statistically significant)

For the ARDL bounds test:

**Cointegration exists** if F-statistic > upper bound I(1) critical value

**No cointegration** if F-statistic < lower bound I(0) critical value

**Inconclusive** if F-statistic falls between the bounds

This comprehensive analytical framework ensures rigorous examination of both short-run dynamics and long-run equilibrium relationships between digital payment technologies and financial inclusion in Nigeria.

# CHAPTER FOUR

# DATA PRESENTATION AND ANALYSIS

The result of the estimation carried out in the study are presented in this section of the study. The main focus of the study is on examining the effect of digital payment system on financial inclusion in Nigeria. The variables used from digital payment infrastructures are automated teller machine, point of sales transaction, web payment transaction and mobile payment.

## 4.1 Data Presentation

The data for the study are presented in appendix A with other estimation being presented in appendix B. The data presented covers all the variables considered in the study.

## 4.2 Interpretation of Results

The result of the analyses is interpreted in this section. The estimations are conducted using the EViews 10 software and based on the formulated research questions.

### 4.2.1 Graphical Illustration of the Variables.

Following the graphical presentation of the data in figure 4.1, the variable FIC which proxy for financial inclusion shows that before 2010 the rate of financially included individuals in the economy follows a negative trend. After the financial reforms of

2010 and before 2010, there was a gradual increase in the rate of financially included individuals in the economy. This trajectory has been on the increase till the end of the data collected for this research.

On the application of automated teller machine as a digital financial infrastructure that have seek to deepen financial inclusion, from 2010, there was an increase in its use with a sharp fall in 20216 and 2022 consecutively. This fall in the application pf ATM have continued as there are other newer ways of doing financial transaction. But its advent has also contributed to the increase in financially included individuals as a way of easy access to financial services and products.

For the point of sales transaction, its application has shown an upward trajectory from the point of its application till the end of the data for this study. While it experienced a sharp decline before 2022, it has however continued to be on the increase till recent time as a major means of financial transaction and means of accessing financial services and products. Also, WEB and MOB are found to have significant increase in recent time than from inception. They are seen as the main digital platform for engineering financial inclusion through the diverse products and services that consumers of financial services and products can access.

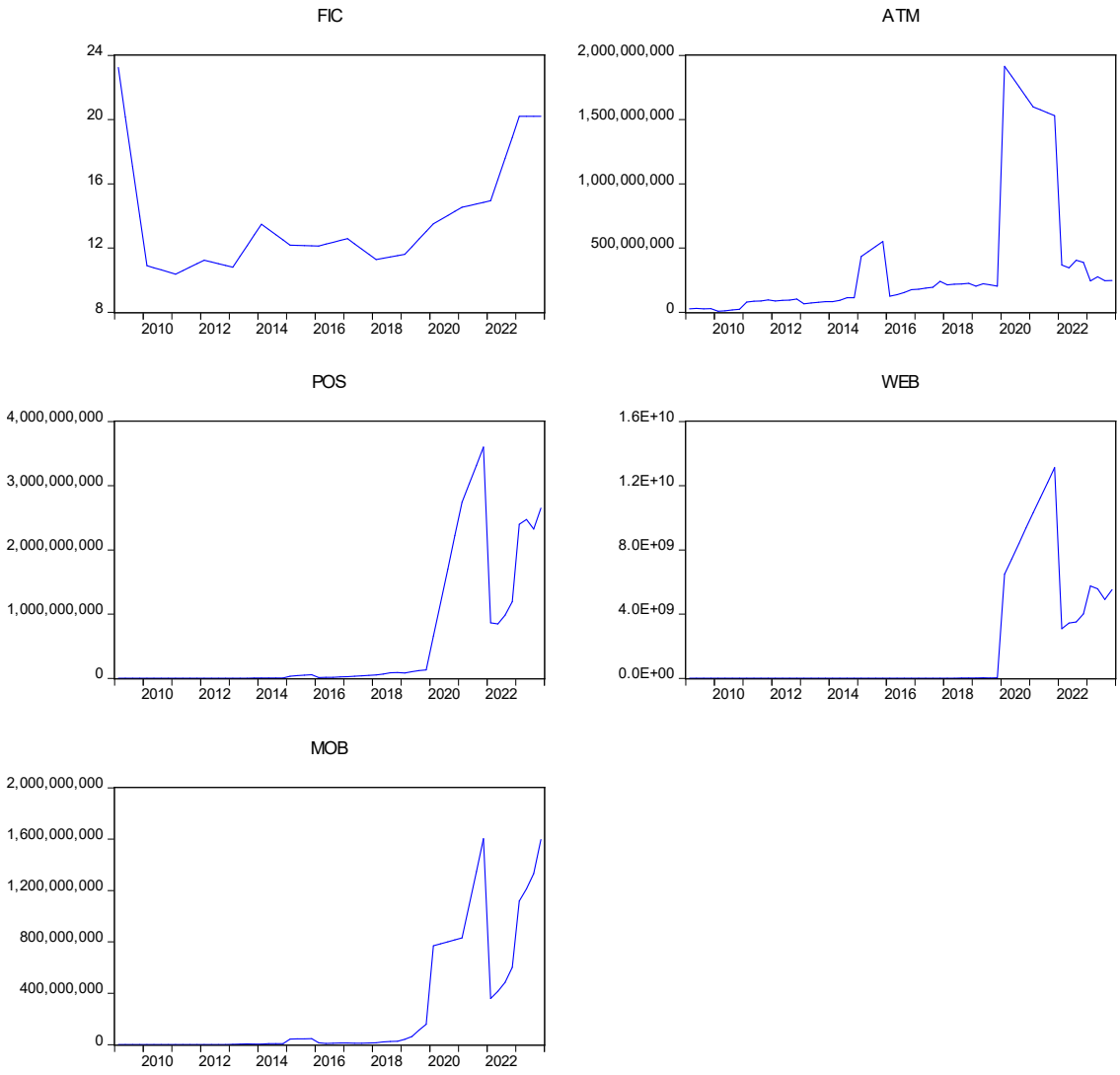


Figure 4.1: Graphical Illustration of the Variales

Source: Estimated from EViews 10, 2025.

### 4.2.2 Descriptive Statistics of the Variables.

The result of the descriptive statistic shows that FIC has a mean value of 13.4586 implying that on the average, 13 individuals are financially included with the deployment of the digital financial infrastructure in focus for this study. The variance to the mean point is seen to be very small but with poor performance from other measures of normality such as the value for skewness and Kurtosis and the value for the Jarque-Bera statistic and its probability shows evidently that the data is not normally distributed for FIC which will imply other test before its application for the test of hypothesis. Because of the nature of the data on ATM, the mean value s seen to be very large and also the standard deviation which all together shows the non-symmetric distribution of the data on ATM.

**Table 4.1: Descriptive Statistics**

| | FIC | ATM | POS | WEB | MOB |
|---|---|---|---|---|---|
| Mean | 13.45861 | 3.77E+08 | 5.56E+08 | 1.91E+09 | 2.66E+08 |
| Median | 12.30955 | 1.91E+08 | 33247831 | 6865445. | 13030924 |
| Maximum | 23.24536 | 1.91E+09 | 3.60E+09 | 1.31E+10 | 1.60E+09 |
| Minimum | 10.37134 | 7762869. | 118620.0 | 289326.0 | 110400.0 |
| Std. Dev. | 3.030770 | 5.33E+08 | 1.01E+09 | 3.59E+09 | 4.61E+08 |
| Skewness | 1.505887 | 1.967232 | 1.716574 | 1.760356 | 1.636199 |
| Kurtosis | 4.434978 | 5.308964 | 4.526082 | 4.904268 | 4.350569 |
| | | | | | |
| Jarque-Bera | 27.82486 | 52.02829 | 35.28859 | 40.05414 | 31.33158 |
| Probability | 0.000001 | 0.000000 | 0.000000 | 0.000000 | 0.000000 |
| | | | | | |
| Sum | 807.5164 | 2.26E+10 | 3.33E+10 | 1.15E+11 | 1.60E+10 |
| Sum Sq. Dev. | 541.9484 | 1.68E+19 | 6.00E+19 | 7.59E+20 | 1.25E+19 |
| | | | | | |
| Observations | 60 | 60 | 60 | 60 | 60 |

Source: Estimated from EViews 10, 2025.

All the variables were found to have positive skewness and were all found not to be normally distributed. This implied the need for further statistical test to ensure the data is suitable for use in hypothesis testing and drawing inferences from such estimation conducted on the data.

### 4.2.3 Analysis of Correlation Results

The result of the correlation shows that only ATM is not found to have significant relationship with FIC at 5% level of statistical significance. The other variables of POS, WEB, and MOB are found to have significant relationship with FIC at the 5% level of statistical significance. This shows that increase in financial inclusion in recent time is highly due to innovation in POS, WEB and MOB. Of all the variables, MOB is found to have the highest coefficient, implying that it may have more contribution to FIC.

**Table 4.2: Correlation Results**

| Correlation<br>Probability | FIC | ATM | POS | WEB | MOB |
|---|---|---|---|---|---|
| FIC | 1.000000 | | | | |
| | ----- | | | | |
| ATM | 0.142486 | 1.000000 | | | |
| | 0.2775 | ----- | | | |
| POS | 0.543143 | 0.682249 | 1.000000 | | |
| | 0.0000 | 0.0000 | ----- | | |
| WEB | 0.421150 | 0.863959 | 0.946064 | 1.000000 | |
| | 0.0008 | 0.0000 | 0.0000 | ----- | |
| MOB | 0.595505 | 0.656010 | 0.965665 | 0.904459 | 1.000000 |
| | 0.0000 | 0.0000 | 0.0000 | 0.0000 | ----- |

Source: Estimated from EViews 10, 2025.

### 4.2.4 Analysis of Unit Root Results

The result of the unit root shows that FIC is stationary at first difference. Also ATM is found to be stationary at first difference and WEB is also found to be stationary at first difference. This implied that with first differentials, the data used will generate results that will not be spurious. Of the data used, POS was found to be stationary at level which make the data appropriate for use without modification. The only variable found not to be stationary at level and at first difference is MOB which was found to be stationary at second difference. The presence of unit root as indicated by MOB implied that the regression technique to b applied is the cointegration regression technique. Hence the need to conduct and interpret a cointegration result.

**Table 4.3: Unit Root Results**

| | Augmented Dickey-Fuller test statistic | | |
|---|---|---|---|
| Series | Statistic | Prob.** | Remark |
| FIC | -1.471574 | 0.8272 | |
| D(FIC) | -2.568146 | 0.0111 | I(1) |
| ATM | -1.648345 | 0.0934 | |
| D(ATM) | -7.698703 | 0.0000 | I(1) |
| POS | -3.603985 | 0.0006 | I(0) |
| WEB | 1.045935 | 0.9999 | |
| D(WEB) | -10.49545 | 0.0000 | I(1) |
| MOB | 4.818707 | 1.0000 | |
| D(MOB) | -2.866557 | 0.1818 | |
| D(MOB, 2) | -3.603147 | 0.0399 | I(2) |

Source: Estimated from EViews 10, 2025.

### 4.2.5 Analysis of Cointegration Results

The result of the trace test shows that there is long-run relationship between the dependent and the independent variables. The result revealed that there is at least two cointegrating equation at the 0.05 level of significance. The result of the Trace test is presented in table 4.4.

**Table 4.4: Trace Test Results**

Date: 04/25/25 Time: 06:37
Sample (adjusted): 2009Q3 2023Q4
Included observations: 58 after adjustments
Trend assumption: Linear deterministic trend
Series: FIC ATM POS WEB MOB
Lags interval (in first differences): 1 to 1

Unrestricted Cointegration Rank Test (Trace)

| Hypothesized No. of CE(s) | Eigenvalue | Trace Statistic | 0.05 Critical Value | Prob.** |
|---|---|---|---|---|
| None * | 0.622080 | 110.0037 | 69.81889 | 0.0000 |
| At most 1 * | 0.392586 | 53.56542 | 47.85613 | 0.0132 |
| At most 2 | 0.244814 | 24.64985 | 29.79707 | 0.1743 |
| At most 3 | 0.129051 | 8.363992 | 15.49471 | 0.4273 |
| At most 4 | 0.006017 | 0.350051 | 3.841466 | 0.5541 |

Trace test indicates 2 cointegrating eqn(s) at the 0.05 level
* denotes rejection of the hypothesis at the 0.05 level
**MacKinnon-Haug-Michelis (1999) p-values

Source: Estimated from EViews 10, 2025.

In the same vein, the application of the maximum eigen value also shows that there is two cointegrating equation. This further confirms the long-run relationship of the variables used in the model.

**Table 4.5: Maximum Eigen Value Results**

Unrestricted Cointegration Rank Test (Maximum Eigenvalue)

| Hypothesized No. of CE(s) | Eigenvalue | Max-Eigen Statistic | 0.05 Critical Value | Prob.** |
|---|---|---|---|---|
| None * | 0.622080 | 56.43827 | 33.87687 | 0.0000 |
| At most 1 * | 0.392586 | 28.91557 | 27.58434 | 0.0336 |
| At most 2 | 0.244814 | 16.28586 | 21.13162 | 0.2086 |
| At most 3 | 0.129051 | 8.013942 | 14.26460 | 0.3773 |
| At most 4 | 0.006017 | 0.350051 | 3.841466 | 0.5541 |

Max-eigenvalue test indicates 2 cointegrating eqn(s) at the 0.05 level
* denotes rejection of the hypothesis at the 0.05 level
**MacKinnon-Haug-Michelis (1999) p-values

Source: Estimated from EViews 10, 2025.

### 4.2.6 Analysis of Regression Results

In conducting the ARDL result, two of the variables were not used in the level state but rather they were used in difference form that is after first difference. Of all the variables, only MOB is found to have significant impact on financial inclusion in Nigeria. The result of the ARDL is presented in table 4.6.

**Table 4.6: ARDL Results**

Levels Equation
Case 3: Unrestricted Constant and No Trend

| Variable | Coefficient | Std. Error | t-Statistic | Prob. |
|---|---|---|---|---|
| DATM | -1.84E-09 | 2.91E-09 | -0.631024 | 0.5310 |
| POS | -2.98E-09 | 3.43E-09 | -0.869240 | 0.3890 |
| DWEB | 3.26E-10 | 9.42E-10 | 0.345656 | 0.7311 |
| **MOB** | **1.06E-08** | **3.83E-09** | **2.773428** | **0.0078** |

EC = DFIC - (-0.0000*DATM -0.0000*POS + 0.0000*DWEB + 0.0000*MOB )

Source: Estimated from EViews 10, 2025.

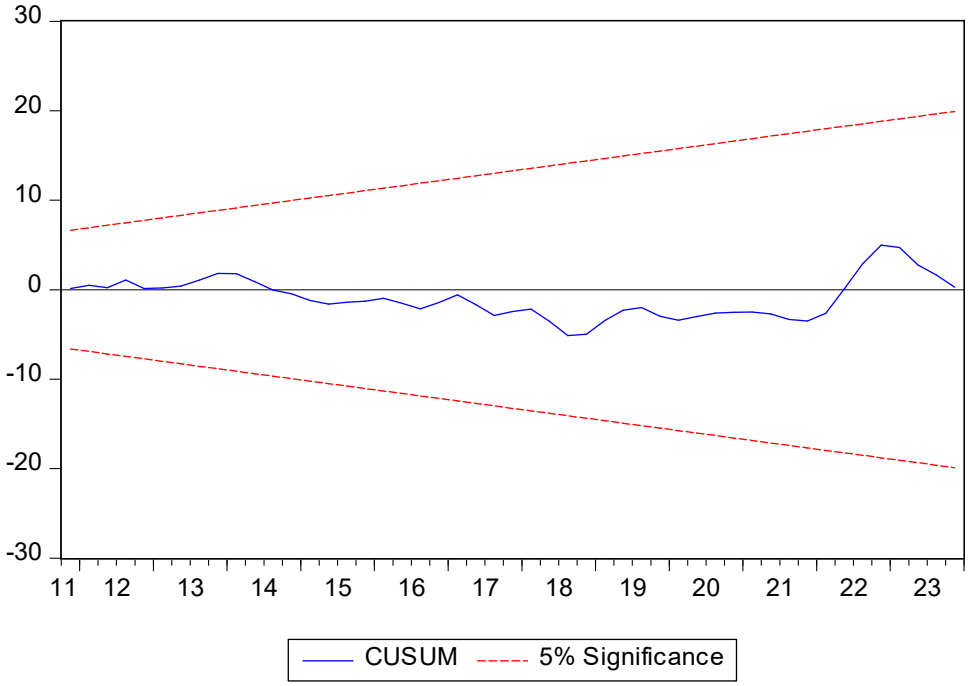


**Figure 4.2: CUSUM Diagnostic Test**

Source: Estimated from EViews 10, 2025.

The result of the CUSM shows that the residual is within the two bounds, hence there is no deviation from the critical line path which implied that we can rely on estimates from the model estimated for inferences and policy decisions.

## 4.3 Test of Hypothesis

The result of the hypothesis is based on the regression result presented in table 4.6. the result revealed that for the first hypothesis which is stated that the volume of ATM transaction does not have significant effect on financial inclusion in Nigeria.

The result shows that this hypothesis is not rejected and that we can conclude that the volume of ATM transaction does not have significant effect on financial inclusion in Nigeria.

The second hypothesis also states that the volume of POS transaction does not have significant effect on financial inclusion in Nigeria. The probability for this hypothesis is found to be greater than 5%. Hence the null hypothesis cannot be rejected. Then we conclude that the volume of POS transaction does not have significant effect on financial inclusion in Nigeria.

The third hypothesis is stated thus: the volume of Web pay transactions does not have significant effect on financial inclusion in Nigeria. The regression result shows that we cannot reject the null hypothesis.

And lastly, the fourth hypothesis is stated that the volume of Mobile payment does not have significant effect on financial inclusion in Nigeria. This result of the study shows that we fail to reject the alternate hypothesis in the study. Hence, we can assert that the volume of Mobile payment have significant effect on financial inclusion in Nigeria.

## 4.4 Discussion of Findings

### Finding 1: Insignificant Effect of ATM Transaction Volume on Financial Inclusion

ATM transaction volume does not significantly affect financial inclusion in Nigeria, consistent with recent empirical evidence. Abubakar (2024) found that while ATM transactions positively affected bank performance, their impact was not statistically significant long-term, suggesting ATMs primarily serve already-banked populations rather than extending services to the unbanked. Similarly, Oyadeyi (2024) noted that ATMs' influence on economic growth was lower compared to other digital channels. This limited impact stems from several factors: ATM infrastructure concentration in urban areas (Nnaomah et al., 2024), maintenance challenges including network failures and power supply issues (Akinola & Adekunle, 2014), and the fundamental requirement of bank accounts for ATM access (Central Bank of Nigeria, 2020). Poor electricity supply and limited internet connectivity in remote areas further undermine reliability (David-West et al., 2019).

### Finding 2: Insignificant Effect of POS Transaction Volume on Financial Inclusion

POS transaction volume does not significantly affect financial inclusion, despite some studies reporting positive relationships. While Garba et al. (2024) found POS

terminals significantly influenced banking industry efficiency, and Aruwa et al. (2025) demonstrated positive impacts in agency banking contexts, the lack of significance in this study reflects contextual realities. POS infrastructure expansion has concentrated in urban centers, with limited rural penetration where most financially excluded populations reside (Oti et al., 2022). The 2022 decline in POS machines raises sustainability concerns (Akintunde & Adegbie, 2023). Many POS transactions represent substitution effects—existing customers shifting from cash—rather than genuine expansion to previously excluded populations. Infrastructure constraints including poor electricity, unreliable telecommunications, and limited internet connectivity create operational challenges (David-West et al., 2019; Nnaomah et al., 2024).

**Finding 3: Insignificant Effect of Web Payment Transaction Volume on Financial Inclusion**

Web payment transaction volume does not significantly affect financial inclusion, reflecting well-documented infrastructure and literacy barriers. Abubakar (2024) found web banking played limited roles in achieving financial inclusion, while Akintunde and Adegbie (2023) reported negative relationships with bank assets. Structural barriers explain this limited impact: unreliable internet connectivity in rural areas (Central Bank of Nigeria, 2020; Nnaomah et al., 2024), low digital literacy levels (Wezel & Ree, 2023; Kass-Hanna et al., 2022), affordability constraints for

devices and data (David-West et al., 2019), and trust concerns regarding fraud and security (Efobi et al., 2016; Osabutey & Jackson, 2024). The digital divide means web payments primarily serve already-included urban populations, potentially widening disparities (Ahmad et al., 2020).

**Finding 4: Significant Effect of Mobile Payment Transaction Volume on Financial Inclusion**

Mobile payment transaction volume has a significant positive effect on financial inclusion—the study's most important finding. This is strongly supported by empirical evidence. Ogundipe et al. (2023) found mobile money adoption could increase financial inclusion to 95% and connect over 99% of adults to financial services. Abubakar (2024) confirmed positive relationships between mobile banking and financial inclusion, while Ayodeji (2025) found mobile money had significant positive impact in rural areas.

Mobile payments' superior performance stems from distinctive advantages. First, widespread mobile phone penetration (84% with over 200 million subscriptions) provides ready infrastructure for reaching excluded populations (Nigerian Communications Commission, 2024). Unlike other channels, mobile services operate on basic phones through USSD technology without requiring sophisticated infrastructure. Second, mobile payments reduce entry barriers through distributed

agent networks, minimal documentation under tiered KYC regulations, and accommodation of small-value transactions (Central Bank of Nigeria, 2015). Third, they address critical needs: secure transfers without travel, reduced theft exposure, remittance facilitation, and pathways to sophisticated services (Batista & Vicente, 2020; Demirgüç-Kunt et al., 2018). Fourth, regulatory support through Payment Service Banks licensing has enabled telecommunications participation (International Bar Association, 2020).

Kenya's M-PESA success demonstrates mobile payments' transformative potential, achieving over 80% inclusion rates (Wezel & Ree, 2023). COVID-19 accelerated adoption as contactless transactions became necessary (Batista & Vicente, 2020). However, challenges remain: infrastructure constraints (Lepoutre & Oguntoye, 2018), literacy limitations, trust issues, and regulatory refinement needs continue affecting service delivery.

# CHAPTER FIVE

# SUMMARY Of FINDINGS, CONCLUSION AND RECOMMENDATION

## 5.1 Summary of Findings

This study examined the relationship between digital payment systems and financial inclusion in Nigeria, focusing on four key channels: ATMs, POS systems, Web payments, and Mobile payments. The empirical analysis revealed that only mobile payments significantly affect financial inclusion. The findings are summarized as follows:

1. The volume of ATM transaction does not have significant effect on financial inclusion in Nigeria
2. The volume of POS transaction does not have significant effect on financial inclusion in Nigeria
3. The volume of Web pay transactions does not have significant effect on financial inclusion in Nigeria
4. The volume of Mobile payment have significant effect on financial inclusion in Nigeria.

## 5.2 Conclusion

This study examined the relationship between digital payment systems and financial inclusion in Nigeria, analyzing ATMs, POS systems, Web payments, and Mobile

payments. Among these channels, only mobile payment transaction volume demonstrated statistically significant positive effects on financial inclusion, highlighting mobile services' unique capacity to reach previously excluded populations through widespread phone penetration and low access barriers.

The insignificant effects of ATM, POS, and Web payments underscore context-specific challenges. These technologies primarily serve already-banked urban populations and depend on robust infrastructure—bank accounts for ATMs, internet for web payments, and reliable electricity for POS terminals—limiting reach to marginalized communities. Mobile payments demonstrate superior adaptability through USSD technology on basic phones, distributed agent networks, and small-value transaction accommodation suited to low-income users.

However, technology deployment alone proves insufficient. The insignificant results for three channels indicate that complementary interventions addressing infrastructure, literacy, affordability, trust, and regulation are essential. With 36% of Nigerian adults remaining financially excluded (EFInA, 2023), achieving inclusion goals requires prioritizing proven channels—particularly mobile payments—while addressing structural barriers limiting other technologies' effectiveness. Mobile payments represent the most promising pathway, but realizing their potential demands comprehensive strategies integrating supportive ecosystems that enable access, build capability, and foster trust.

## 5.3 Recommendations

Based on the empirical findings, this study offers the following recommendations:

**1. Prioritize Mobile Payment Infrastructure Development**

The Central Bank of Nigeria and regulatory authorities should fast-track Payment Service Banks implementation, encourage partnerships between mobile operators and financial institutions, support interoperable mobile payment platforms, and provide incentives for expanding services into underserved rural areas.

**2. Address Infrastructure Constraints**

Government should prioritize electricity and telecommunications investments in rural areas. The CBN should collaborate with the Nigerian Communications Commission to improve network coverage. Financial institutions should invest in alternative power solutions for ATMs and POS terminals. Policymakers should create incentive frameworks for private infrastructure investments.

**3. Enhance Financial and Digital Literacy**

The CBN, financial institutions, and civil society should implement financial literacy campaigns targeting excluded populations, emphasizing mobile payments. Programs should use local languages and accessible channels (radio, community meetings).

Financial institutions should provide user-friendly training and ongoing support. Digital literacy should be integrated into school curricula.

**4. Reform Regulatory Frameworks**

The CBN should refine tiered KYC requirements for simplified account opening while maintaining risk management. Regulatory authorities should establish clear consumer protection frameworks addressing fraud, dispute resolution, and agent accountability. Policies should incentivize innovation while ensuring oversight. Frameworks should be periodically updated for emerging technologies.

**5. Expand Agent Networks**

Mobile money operators and PSBs should build extensive agent networks reaching rural communities. Regulatory authorities should enforce agent conduct, training, and accountability standards. Financial incentives should support agents in remote areas. Technology solutions should improve agent liquidity management and service quality.

**6. Leverage Mobile Payments for Government Transactions**

Federal and state governments should prioritize mobile platforms for social transfers, pensions, and salaries. Successful state implementations should be studied and replicated. G2P programs should ensure payment accessibility regardless of recipients' financial inclusion status and be coupled with financial literacy initiatives.

## 5.4 Suggestions for Further Study

This study provides valuable insights, but several areas warrant further investigation:

1. **Longitudinal Studies**: Future research should employ longitudinal designs tracking financial inclusion changes over time to establish causal relationships between digital payment adoption and inclusion outcomes.
2. **Qualitative Research**: Qualitative studies exploring lived experiences of users and non-users could provide insights into barriers, motivations, and contextual factors influencing adoption, particularly among excluded rural populations.
3. **Regional Comparative Studies**: Nigeria's geographic, economic, and cultural diversity suggests financial inclusion dynamics vary across regions. Comparative studies examining different states could identify context-specific success factors.
4. **Gender-Disaggregated Analysis**: Future studies should examine how digital payment systems affect male and female financial inclusion differently, investigating whether mobile payments reduce or exacerbate gender disparities.
5. **Policy Impact Evaluation**: Rigorous impact evaluations of specific interventions (PSB licenses, tiered KYC, agent banking regulations) using quasi-experimental designs could isolate causal effects of particular policies.

6. **Economic and Social Outcomes**: Research should examine downstream impacts of digital payment-based financial inclusion on poverty reduction, income stability, business growth, women's empowerment, and household welfare.
7. **Cross-Country Comparisons**: Comparative research examining why mobile money succeeded more rapidly in Kenya and Tanzania than Nigeria could identify policy, regulatory, or market factors facilitating or hindering mobile payment-based inclusion.
8. **Agent Network Effectiveness**: Studies investigating agent network performance, examining factors affecting agent liquidity, customer satisfaction, and service quality, are critical for optimizing mobile money delivery.

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## APPENDIX A: DATA FOR THE STUDY

| | Total Savings as Ratio of GDP | ATM Vol | POS Vol | WEBPAY Vol | Mobile Pay Vol |
|---|---|---|---|---|---|
| YEAR | DFIC | DATM | POS | DWEB | MOB |
| 2009Q1 | 23.24536 | 26103483 | 251785 | 302491 | 484175 |
| 2009Q2 | 20.15972 | 29947212 | 238387 | 338676 | 1093426 |
| 2009Q3 | 17.07408 | 25725223 | 210017 | 1142722 | 110400 |
| 2009Q4 | 13.98843 | 27385728 | 218067 | 919627 | 121250 |
| 2010Q1 | 10.90279 | 7762869 | 253484 | 331787 | 170458 |
| 2010Q2 | 10.76993 | 11192073 | 237435 | 353120 | 243381 |
| 2010Q3 | 10.63707 | 18449864 | 256637 | 414390 | 306739 |
| 2010Q4 | 10.5042 | 22728804 | 324870 | 501789 | 435955 |
| 2011Q1 | 10.37134 | 79612004 | 383541 | 670187 | 517694 |
| 2011Q2 | 10.58929 | 85143051 | 425574 | 532849 | 677765 |
| 2011Q3 | 10.80724 | 87537528 | 590646 | 289326 | 1142533 |
| 2011Q4 | 11.02519 | 95277416 | 700912 | 439993 | 1311382 |
| 2012Q1 | 11.24314 | 86689804 | 118620 | 374409 | 212195 |
| 2012Q2 | 11.13427 | 91802445 | 485173 | 723755 | 417380 |
| 2012Q3 | 11.0254 | 94995190 | 767858 | 456286 | 608574 |
| 2012Q4 | 10.91652 | 1.02E+08 | 1183394 | 722014 | 1059539 |
| 2013Q1 | 10.80765 | 64818941 | 1435005 | 533142 | 2092982 |
| 2013Q2 | 11.47718 | 71844072 | 1772783 | 575343 | 3889243 |
| 2013Q3 | 12.14671 | 76702510 | 2509913 | 810699 | 5309067 |
| 2013Q4 | 12.81623 | 81927417 | 3684554 | 981289 | 4521143 |
| 2014Q1 | 13.48576 | 82803301 | 4359237 | 1122046 | 4878633 |
| 2014Q2 | 13.157 | 92703631 | 4612264 | 1108307 | 8227939 |
| 2014Q3 | 12.82825 | 1.12E+08 | 5129326 | 1597394 | 8184003 |
| 2014Q4 | 12.49949 | 1.12E+08 | 6716596 | 1759334 | 7865831 |
| 2015Q1 | 12.17073 | 4.34E+08 | 33720933 | 7981361 | 43933362 |
| 2015Q2 | 12.15965 | 4.73E+08 | 41219501 | 9508083 | 44713335 |
| 2015Q3 | 12.14856 | 5.12E+08 | 48718068 | 11034804 | 45493307 |
| 2015Q4 | 12.13747 | 5.51E+08 | 56216636 | 12561526 | 46273280 |
| 2016Q1 | 12.12639 | 1.25E+08 | 11745556 | 2728415 | 14092005 |
| 2016Q2 | 12.24203 | 1.36E+08 | 13592049 | 2658016 | 8643518 |
| 2016Q3 | 12.35768 | 1.53E+08 | 16028115 | 3526717 | 10865588 |
| 2016Q4 | 12.47333 | 1.76E+08 | 22349483 | 5175099 | 13452141 |

| | | | | | |
|---|---|---|---|---|---|
| 2017Q1 | 12.58897 | 1.79E+08 | 26646982 | 5520058 | 12609706 |
| 2017Q2 | 12.26143 | 1.88E+08 | 32774728 | 5965106 | 11559108 |
| 2017Q3 | 11.93388 | 1.94E+08 | 39310184 | 7765783 | 11363080 |
| 2017Q4 | 11.60633 | 2.4E+08 | 47535262 | 9740150 | 12272667 |
| 2018Q1 | 11.27878 | 2.12E+08 | 53562765 | 9634256 | 15254677 |
| 2018Q2 | 11.35892 | 2.17E+08 | 67229919 | 9834247 | 20686865 |
| 2018Q3 | 11.43907 | 2.2E+08 | 86038267 | 13965044 | 24897948 |
| 2018Q4 | 11.51921 | 2.25E+08 | 89059216 | 17382354 | 26246770 |
| 2019Q1 | 11.59935 | 2.03E+08 | 83762144 | 20382111 | 41473006 |
| 2019Q2 | 12.07739 | 2.22E+08 | 1.04E+08 | 27594789 | 63300927 |
| 2019Q3 | 12.55544 | 2.13E+08 | 1.21E+08 | 26692867 | 1.13E+08 |
| 2019Q4 | 13.03348 | 2.02E+08 | 1.3E+08 | 28827240 | 1.59E+08 |
| 2020Q1 | 13.51152 | 1.91E+09 | 6.56E+08 | 6.48E+09 | 7.69E+08 |
| 2020Q2 | 13.76693 | 1.84E+09 | 1.18E+09 | 7.44E+09 | 7.85E+08 |
| 2020Q3 | 14.02233 | 1.76E+09 | 1.7E+09 | 8.4E+09 | 8E+08 |
| 2020Q4 | 14.27773 | 1.68E+09 | 2.22E+09 | 9.36E+09 | 8.16E+08 |
| 2021Q1 | 14.53314 | 1.6E+09 | 2.74E+09 | 1.03E+10 | 8.32E+08 |
| 2021Q2 | 14.63568 | 1.58E+09 | 3.03E+09 | 1.13E+10 | 1.09E+09 |
| 2021Q3 | 14.73822 | 1.55E+09 | 3.31E+09 | 1.22E+10 | 1.35E+09 |
| 2021Q4 | 14.84076 | 1.53E+09 | 3.6E+09 | 1.31E+10 | 1.6E+09 |
| 2022Q1 | 14.9433 | 3.68E+08 | 8.63E+08 | 3.09E+09 | 3.58E+08 |
| 2022Q2 | 16.25982 | 3.45E+08 | 8.46E+08 | 3.45E+09 | 4.16E+08 |
| 2022Q3 | 17.57633 | 4.06E+08 | 9.84E+08 | 3.51E+09 | 4.85E+08 |
| 2022Q4 | 18.89285 | 3.88E+08 | 1.19E+09 | 4.02E+09 | 6.02E+08 |
| 2023Q1 | 20.20936 | 2.43E+08 | 2.4E+09 | 5.75E+09 | 1.12E+09 |
| 2023Q2 | 20.20936 | 2.77E+08 | 2.47E+09 | 5.57E+09 | 1.21E+09 |
| 2023Q3 | 20.20936 | 2.46E+08 | 2.33E+09 | 4.91E+09 | 1.33E+09 |
| 2023Q4 | 20.20936 | 2.47E+08 | 2.65E+09 | 5.53E+09 | 1.6E+09 |

Source: CBN BULLETIN, 2023.

# APPENDIX B: OUTPUT

Unit Root Results
Null Hypothesis: FIC has a unit root
Exogenous: Constant, Linear Trend
Lag Length: 5 (Automatic - based on SIC, maxlag=10)

| | | t-Statistic | Prob.* |
|---|---|---|---|
| Augmented Dickey-Fuller test statistic | | -1.471574 | 0.8272 |
| Test critical values: | 1% level | -4.137279 | |
| | 5% level | -3.495295 | |
| | 10% level | -3.176618 | |

*MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(FIC)
Method: Least Squares
Date: 04/25/25 Time: 06:38
Sample (adjusted): 2010Q3 2023Q4
Included observations: 54 after adjustments

| Variable | Coefficient | Std. Error | t-Statistic | Prob. |
|---|---|---|---|---|
| FIC(-1) | -0.045283 | 0.030772 | -1.471574 | 0.1479 |
| D(FIC(-1)) | 0.741142 | 0.131147 | 5.651221 | 0.0000 |
| D(FIC(-2)) | 0.005919 | 0.112620 | 0.052559 | 0.9583 |
| D(FIC(-3)) | 0.018070 | 0.118058 | 0.153061 | 0.8790 |
| D(FIC(-4)) | -0.174758 | 0.120043 | -1.455788 | 0.1522 |
| D(FIC(-5)) | 0.103188 | 0.091090 | 1.132820 | 0.2632 |
| C | 0.362833 | 0.318332 | 1.139792 | 0.2603 |
| @TREND("2009Q1") | 0.008550 | 0.004536 | 1.884955 | 0.0658 |

| | | | |
|---|---|---|---|
| R-squared | 0.557608 | Mean dependent var | 0.174804 |
| Adjusted R-squared | 0.490287 | S.D. dependent var | 0.423919 |
| S.E. of regression | 0.302653 | Akaike info criterion | 0.583496 |
| Sum squared resid | 4.213554 | Schwarz criterion | 0.878160 |
| Log likelihood | -7.754389 | Hannan-Quinn criter. | 0.697136 |
| F-statistic | 8.282874 | Durbin-Watson stat | 1.869197 |
| Prob(F-statistic) | 0.000002 | | |

Null Hypothesis: D(FIC) has a unit root
Exogenous: None
Lag Length: 4 (Automatic - based on SIC, maxlag=10)

| | t-Statistic | Prob.* |
|---|---|---|

| | | | |
|---|---|---|---|
| Augmented Dickey-Fuller test statistic | | -2.568146 | 0.0111 |
| Test critical values: | 1% level | -2.608490 | |
| | 5% level | -1.946996 | |
| | 10% level | -1.612934 | |

*MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(FIC,2)
Method: Least Squares
Date: 04/25/25 Time: 06:40
Sample (adjusted): 2010Q3 2023Q4
Included observations: 54 after adjustments

| Variable | Coefficient | Std. Error | t-Statistic | Prob. |
|---|---|---|---|---|
| D(FIC(-1)) | -0.259681 | 0.101116 | -2.568146 | 0.0133 |
| D(FIC(-1),2) | 0.044401 | 0.083251 | 0.533333 | 0.5962 |
| D(FIC(-2),2) | 0.044401 | 0.083251 | 0.533333 | 0.5962 |
| D(FIC(-3),2) | 0.050443 | 0.088996 | 0.566805 | 0.5734 |
| D(FIC(-4),2) | -0.130156 | 0.088996 | -1.462497 | 0.1500 |

| | | | |
|---|---|---|---|
| R-squared | 0.182255 | Mean dependent var | 0.002460 |
| Adjusted R-squared | 0.115501 | S.D. dependent var | 0.329375 |
| S.E. of regression | 0.309770 | Akaike info criterion | 0.582046 |
| Sum squared resid | 4.701907 | Schwarz criterion | 0.766211 |
| Log likelihood | -10.71525 | Hannan-Quinn criter. | 0.653072 |
| Durbin-Watson stat | 1.833730 | | |

Null Hypothesis: ATM has a unit root
Exogenous: None
Lag Length: 0 (Automatic - based on SIC, maxlag=10)

| | | t-Statistic | Prob.* |
|---|---|---|---|
| Augmented Dickey-Fuller test statistic | | -1.648345 | 0.0934 |
| Test critical values: | 1% level | -2.604746 | |
| | 5% level | -1.946447 | |
| | 10% level | -1.613238 | |

*MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(ATM)
Method: Least Squares
Date: 04/25/25 Time: 06:41

Sample (adjusted): 2009Q2 2023Q4
Included observations: 59 after adjustments

| Variable | Coefficient | Std. Error | t-Statistic | Prob. |
|---|---|---|---|---|
| ATM(-1) | -0.090675 | 0.055010 | -1.648345 | 0.1047 |

| | | | |
|---|---|---|---|
| R-squared | 0.044579 | Mean dependent var | 3737932. |
| Adjusted R-squared | 0.044579 | S.D. dependent var | 2.83E+08 |
| S.E. of regression | 2.76E+08 | Akaike info criterion | 41.72853 |
| Sum squared resid | 4.43E+18 | Schwarz criterion | 41.76374 |
| Log likelihood | -1229.992 | Hannan-Quinn criter. | 41.74228 |
| Durbin-Watson stat | 1.949616 | | |

Null Hypothesis: D(ATM) has a unit root
Exogenous: None
Lag Length: 0 (Automatic - based on SIC, maxlag=10)

| | | t-Statistic | Prob.* |
|---|---|---|---|
| Augmented Dickey-Fuller test statistic | | -7.698703 | 0.0000 |
| Test critical values: | 1% level | -2.605442 | |
| | 5% level | -1.946549 | |
| | 10% level | -1.613181 | |

*MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(ATM,2)
Method: Least Squares
Date: 04/25/25 Time: 06:41
Sample (adjusted): 2009Q3 2023Q4
Included observations: 58 after adjustments

| Variable | Coefficient | Std. Error | t-Statistic | Prob. |
|---|---|---|---|---|
| D(ATM(-1)) | -1.019522 | 0.132428 | -7.698703 | 0.0000 |

| | | | |
|---|---|---|---|
| R-squared | 0.509762 | Mean dependent var | -57215.29 |
| Adjusted R-squared | 0.509762 | S.D. dependent var | 4.07E+08 |
| S.E. of regression | 2.85E+08 | Akaike info criterion | 41.79161 |
| Sum squared resid | 4.63E+18 | Schwarz criterion | 41.82713 |
| Log likelihood | -1210.957 | Hannan-Quinn criter. | 41.80544 |
| Durbin-Watson stat | 2.001530 | | |

Null Hypothesis: POS has a unit root
Exogenous: None
Lag Length: 9 (Automatic - based on SIC, maxlag=10)

| | | t-Statistic | Prob.* |
|---|---|---|---|
| Augmented Dickey-Fuller test statistic | | -3.603985 | 0.0006 |
| Test critical values: | 1% level | -2.612033 | |
| | 5% level | -1.947520 | |
| | 10% level | -1.612650 | |

*MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(POS)
Method: Least Squares
Date: 04/25/25 Time: 06:42
Sample (adjusted): 2011Q3 2023Q4
Included observations: 50 after adjustments

| Variable | Coefficient | Std. Error | t-Statistic | Prob. |
|---|---|---|---|---|
| POS(-1) | -0.589520 | 0.163574 | -3.603985 | 0.0009 |
| D(POS(-1)) | 1.109214 | 0.231434 | 4.792783 | 0.0000 |
| D(POS(-2)) | 0.826665 | 0.200868 | 4.115454 | 0.0002 |
| D(POS(-3)) | 0.718869 | 0.185079 | 3.884123 | 0.0004 |
| D(POS(-4)) | 0.330701 | 0.169083 | 1.955848 | 0.0575 |
| D(POS(-5)) | 1.211189 | 0.156517 | 7.738370 | 0.0000 |
| D(POS(-6)) | 0.389060 | 0.089437 | 4.350116 | 0.0001 |
| D(POS(-7)) | 0.148264 | 0.074523 | 1.989509 | 0.0535 |
| D(POS(-8)) | -4.647069 | 0.455925 | -10.19262 | 0.0000 |
| D(POS(-9)) | 8.452256 | 0.667073 | 12.67067 | 0.0000 |

| | | | |
|---|---|---|---|
| R-squared | 0.927637 | Mean dependent var | 52972615 |
| Adjusted R-squared | 0.911355 | S.D. dependent var | 4.65E+08 |
| S.E. of regression | 1.39E+08 | Akaike info criterion | 40.50886 |
| Sum squared resid | 7.68E+17 | Schwarz criterion | 40.89126 |
| Log likelihood | -1002.721 | Hannan-Quinn criter. | 40.65448 |
| Durbin-Watson stat | 1.891664 | | |

Null Hypothesis: WEB has a unit root
Exogenous: Constant, Linear Trend
Lag Length: 8 (Automatic - based on SIC, maxlag=10)

| | | t-Statistic | Prob.* |
|---|---|---|---|
| Augmented Dickey-Fuller test statistic | | 1.045935 | 0.9999 |
| Test critical values: | 1% level | -4.148465 | |

| | | |
|---|---|---|
| | 5% level | -3.500495 |
| | 10% level | -3.179617 |

*MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(WEB)
Method: Least Squares
Date: 04/25/25 Time: 06:44
Sample (adjusted): 2011Q2 2023Q4
Included observations: 51 after adjustments

| Variable | Coefficient | Std. Error | t-Statistic | Prob. |
|---|---|---|---|---|
| WEB(-1) | 0.092550 | 0.088485 | 1.045935 | 0.3019 |
| D(WEB(-1)) | -0.105616 | 0.094721 | -1.115018 | 0.2715 |
| D(WEB(-2)) | -0.081671 | 0.094535 | -0.863924 | 0.3928 |
| D(WEB(-3)) | -0.103179 | 0.094273 | -1.094465 | 0.2803 |
| D(WEB(-4)) | -0.180945 | 0.092074 | -1.965217 | 0.0564 |
| D(WEB(-5)) | -0.036374 | 0.089770 | -0.405192 | 0.6875 |
| D(WEB(-6)) | 0.005301 | 0.089755 | 0.059064 | 0.9532 |
| D(WEB(-7)) | -0.088032 | 0.090135 | -0.976664 | 0.3346 |
| D(WEB(-8)) | -1.806649 | 0.190641 | -9.476714 | 0.0000 |
| C | -6.30E+08 | 4.45E+08 | -1.415190 | 0.1648 |
| @TREND("2009Q1") | 31118660 | 15537531 | 2.002806 | 0.0520 |

| | | | |
|---|---|---|---|
| R-squared | 0.747507 | Mean dependent var | 1.08E+08 |
| Adjusted R-squared | 0.684383 | S.D. dependent var | 1.75E+09 |
| S.E. of regression | 9.81E+08 | Akaike info criterion | 44.43404 |
| Sum squared resid | 3.85E+19 | Schwarz criterion | 44.85071 |
| Log likelihood | -1122.068 | Hannan-Quinn criter. | 44.59326 |
| F-statistic | 11.84199 | Durbin-Watson stat | 1.890152 |
| Prob(F-statistic) | 0.000000 | | |

Null Hypothesis: D(WEB) has a unit root
Exogenous: Constant, Linear Trend
Lag Length: 7 (Automatic - based on SIC, maxlag=10)

| | | t-Statistic | Prob.* |
|---|---|---|---|
| Augmented Dickey-Fuller test statistic | | -10.49545 | 0.0000 |
| Test critical values: | 1% level | -4.148465 | |
| | 5% level | -3.500495 | |
| | 10% level | -3.179617 | |

*MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(WEB,2)
Method: Least Squares
Date: 04/25/25 Time: 06:45
Sample (adjusted): 2011Q2 2023Q4
Included observations: 51 after adjustments

| Variable | Coefficient | Std. Error | t-Statistic | Prob. |
|---|---|---|---|---|
| D(WEB(-1)) | -2.962341 | 0.282250 | -10.49545 | 0.0000 |
| D(WEB(-1),2) | 1.909286 | 0.265616 | 7.188151 | 0.0000 |
| D(WEB(-2),2) | 1.879669 | 0.247573 | 7.592385 | 0.0000 |
| D(WEB(-3),2) | 1.828027 | 0.228563 | 7.997916 | 0.0000 |
| D(WEB(-4),2) | 1.693834 | 0.211774 | 7.998292 | 0.0000 |
| D(WEB(-5),2) | 1.697793 | 0.195030 | 8.705301 | 0.0000 |
| D(WEB(-6),2) | 1.743388 | 0.177203 | 9.838357 | 0.0000 |
| D(WEB(-7),2) | 1.696355 | 0.159003 | 10.66870 | 0.0000 |
| C | -9.09E+08 | 3.57E+08 | -2.545516 | 0.0148 |
| @TREND("2009Q1") | 43479203 | 10099022 | 4.305289 | 0.0001 |

| | | | |
|---|---|---|---|
| R-squared | 0.871539 | Mean dependent var | 12193468 |
| Adjusted R-squared | 0.843340 | S.D. dependent var | 2.48E+09 |
| S.E. of regression | 9.82E+08 | Akaike info criterion | 44.42181 |
| Sum squared resid | 3.95E+19 | Schwarz criterion | 44.80060 |
| Log likelihood | -1122.756 | Hannan-Quinn criter. | 44.56656 |
| F-statistic | 30.90701 | Durbin-Watson stat | 1.774924 |
| Prob(F-statistic) | 0.000000 | | |

Null Hypothesis: MOB has a unit root
Exogenous: Constant, Linear Trend
Lag Length: 8 (Automatic - based on SIC, maxlag=10)

| | | t-Statistic | Prob.* |
|---|---|---|---|
| Augmented Dickey-Fuller test statistic | | 4.818707 | 1.0000 |
| Test critical values: | 1% level | -4.148465 | |
| | 5% level | -3.500495 | |
| | 10% level | -3.179617 | |

*MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(MOB)
Method: Least Squares
Date: 04/25/25 Time: 06:46
Sample (adjusted): 2011Q2 2023Q4
Included observations: 51 after adjustments

| Variable | Coefficient | Std. Error | t-Statistic | Prob. |
|---|---|---|---|---|
| MOB(-1) | 0.499270 | 0.103611 | 4.818707 | 0.0000 |
| D(MOB(-1)) | -0.175045 | 0.104207 | -1.679778 | 0.1008 |
| D(MOB(-2)) | -0.226274 | 0.103756 | -2.180827 | 0.0351 |
| D(MOB(-3)) | -0.288244 | 0.102884 | -2.801632 | 0.0078 |
| D(MOB(-4)) | -0.518265 | 0.101783 | -5.091839 | 0.0000 |
| D(MOB(-5)) | -0.453698 | 0.107617 | -4.215860 | 0.0001 |
| D(MOB(-6)) | -0.397187 | 0.102603 | -3.871092 | 0.0004 |
| D(MOB(-7)) | -0.435094 | 0.099030 | -4.393569 | 0.0001 |
| D(MOB(-8)) | -2.903330 | 0.283427 | -10.24365 | 0.0000 |
| C | -26054237 | 54716788 | -0.476165 | 0.6365 |
| @TREND("2009Q1") | 1207789. | 1962091. | 0.615562 | 0.5417 |

| | | | |
|---|---|---|---|
| R-squared | 0.770939 | Mean dependent var | 31288705 |
| Adjusted R-squared | 0.713673 | S.D. dependent var | 2.22E+08 |
| S.E. of regression | 1.19E+08 | Akaike info criterion | 40.21127 |
| Sum squared resid | 5.64E+17 | Schwarz criterion | 40.62794 |
| Log likelihood | -1014.387 | Hannan-Quinn criter. | 40.37049 |
| F-statistic | 13.46257 | Durbin-Watson stat | 1.931936 |
| Prob(F-statistic) | 0.000000 | | |

Null Hypothesis: D(MOB) has a unit root
Exogenous: Constant, Linear Trend
Lag Length: 8 (Automatic - based on SIC, maxlag=10)

| | | t-Statistic | Prob.* |
|---|---|---|---|
| Augmented Dickey-Fuller test statistic | | -2.866557 | 0.1818 |
| Test critical values: | 1% level | -4.152511 | |
| | 5% level | -3.502373 | |
| | 10% level | -3.180699 | |

*MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(MOB,2)
Method: Least Squares
Date: 04/25/25 Time: 06:47
Sample (adjusted): 2011Q3 2023Q4
Included observations: 50 after adjustments

| Variable | Coefficient | Std. Error | t-Statistic | Prob. |
|---|---|---|---|---|
| D(MOB(-1)) | -2.121664 | 0.740144 | -2.866557 | 0.0067 |
| D(MOB(-1),2) | 1.667938 | 0.624995 | 2.668723 | 0.0110 |
| D(MOB(-2),2) | 1.653799 | 0.622888 | 2.655049 | 0.0114 |
| D(MOB(-3),2) | 1.590474 | 0.611238 | 2.602052 | 0.0130 |

| | | | | |
|---|---|---|---|---|
| D(MOB(-4),2) | 1.305220 | 0.588674 | 2.217218 | 0.0325 |
| D(MOB(-5),2) | 1.179664 | 0.536878 | 2.197268 | 0.0340 |
| D(MOB(-6),2) | 1.096546 | 0.481955 | 2.275203 | 0.0285 |
| D(MOB(-7),2) | 0.933146 | 0.432471 | 2.157707 | 0.0372 |
| D(MOB(-8),2) | -1.337466 | 0.433431 | -3.085763 | 0.0037 |
| C | -1.15E+08 | 58064989 | -1.986694 | 0.0540 |
| @TREND("2009Q1") | 5152874. | 1884552. | 2.734269 | 0.0094 |

| | | | |
|---|---|---|---|
| R-squared | 0.860209 | Mean dependent var | 5275728. |
| Adjusted R-squared | 0.824365 | S.D. dependent var | 3.21E+08 |
| S.E. of regression | 1.35E+08 | Akaike info criterion | 40.46451 |
| Sum squared resid | 7.06E+17 | Schwarz criterion | 40.88515 |
| Log likelihood | -1000.613 | Hannan-Quinn criter. | 40.62469 |
| F-statistic | 23.99870 | Durbin-Watson stat | 2.080422 |
| Prob(F-statistic) | 0.000000 | | |

Null Hypothesis: D(MOB,2) has a unit root
Exogenous: Constant, Linear Trend
Lag Length: 8 (Automatic - based on SIC, maxlag=10)

| | | t-Statistic | Prob.* |
|---|---|---|---|
| Augmented Dickey-Fuller test statistic | | -3.603147 | 0.0399 |
| Test critical values: | 1% level | -4.156734 | |
| | 5% level | -3.504330 | |
| | 10% level | -3.181826 | |

*MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(MOB,3)
Method: Least Squares
Date: 04/25/25 Time: 06:47
Sample (adjusted): 2011Q4 2023Q4
Included observations: 49 after adjustments

| Variable | Coefficient | Std. Error | t-Statistic | Prob. |
|---|---|---|---|---|
| D(MOB(-1),2) | -5.663780 | 1.571898 | -3.603147 | 0.0009 |
| D(MOB(-1),3) | 4.369741 | 1.500185 | 2.912801 | 0.0060 |
| D(MOB(-2),3) | 4.405146 | 1.449820 | 3.038409 | 0.0043 |
| D(MOB(-3),3) | 4.393836 | 1.347952 | 3.259638 | 0.0024 |
| D(MOB(-4),3) | 4.152526 | 1.204062 | 3.448765 | 0.0014 |
| D(MOB(-5),3) | 3.874734 | 1.019265 | 3.801499 | 0.0005 |
| D(MOB(-6),3) | 3.672636 | 0.830566 | 4.421849 | 0.0001 |
| D(MOB(-7),3) | 3.473043 | 0.672554 | 5.163964 | 0.0000 |
| D(MOB(-8),3) | 0.916587 | 0.470698 | 1.947293 | 0.0589 |
| C | -41580376 | 56764142 | -0.732511 | 0.4684 |

| | | | | |
|---|---|---|---|---|
| @TREND("2009Q1") | 1775642. | 1551557. | 1.144426 | 0.2596 |

| | | | |
|---|---|---|---|
| R-squared | 0.948056 | Mean dependent var | 2931925. |
| Adjusted R-squared | 0.934387 | S.D. dependent var | 5.58E+08 |
| S.E. of regression | 1.43E+08 | Akaike info criterion | 40.58936 |
| Sum squared resid | 7.77E+17 | Schwarz criterion | 41.01406 |
| Log likelihood | -983.4394 | Hannan-Quinn criter. | 40.75049 |
| F-statistic | 69.35595 | Durbin-Watson stat | 2.048524 |
| Prob(F-statistic) | 0.000000 | | |

Date: 04/25/25 Time: 06:37
Sample (adjusted): 2009Q3 2023Q4
Included observations: 58 after adjustments
Trend assumption: Linear deterministic trend
Series: FIC ATM POS WEB MOB
Lags interval (in first differences): 1 to 1

Unrestricted Cointegration Rank Test (Trace)

| Hypothesized No. of CE(s) | Eigenvalue | Trace Statistic | 0.05 Critical Value | Prob.** |
|---|---|---|---|---|
| None * | 0.622080 | 110.0037 | 69.81889 | 0.0000 |
| At most 1 * | 0.392586 | 53.56542 | 47.85613 | 0.0132 |
| At most 2 | 0.244814 | 24.64985 | 29.79707 | 0.1743 |
| At most 3 | 0.129051 | 8.363992 | 15.49471 | 0.4273 |
| At most 4 | 0.006017 | 0.350051 | 3.841466 | 0.5541 |

Trace test indicates 2 cointegrating eqn(s) at the 0.05 level
* denotes rejection of the hypothesis at the 0.05 level
**MacKinnon-Haug-Michelis (1999) p-values

Unrestricted Cointegration Rank Test (Maximum Eigenvalue)

| Hypothesized No. of CE(s) | Eigenvalue | Max-Eigen Statistic | 0.05 Critical Value | Prob.** |
|---|---|---|---|---|
| None * | 0.622080 | 56.43827 | 33.87687 | 0.0000 |
| At most 1 * | 0.392586 | 28.91557 | 27.58434 | 0.0336 |
| At most 2 | 0.244814 | 16.28586 | 21.13162 | 0.2086 |
| At most 3 | 0.129051 | 8.013942 | 14.26460 | 0.3773 |
| At most 4 | 0.006017 | 0.350051 | 3.841466 | 0.5541 |

Max-eigenvalue test indicates 2 cointegrating eqn(s) at the 0.05 level
* denotes rejection of the hypothesis at the 0.05 level
**MacKinnon-Haug-Michelis (1999) p-values

Unrestricted Cointegrating Coefficients (normalized by b'*S11*b=I):

| FIC | ATM | POS | WEB | MOB |
|---|---|---|---|---|
| -0.157180 | 4.02E-10 | -7.55E-09 | 9.89E-10 | 8.03E-09 |
| 0.534536 | 2.50E-10 | -1.57E-09 | 1.96E-10 | -1.16E-09 |
| -0.231876 | -7.51E-09 | -3.91E-09 | 1.36E-09 | 6.48E-09 |
| 0.121386 | -1.25E-09 | -2.22E-09 | 8.30E-10 | 1.34E-09 |
| -0.111807 | 2.66E-09 | 2.74E-09 | -1.90E-09 | 8.39E-09 |

Unrestricted Adjustment Coefficients (alpha):

| | | | | | |
|---|---|---|---|---|---|
| D(FIC) | 0.047985 | -0.144309 | 0.052552 | 0.019433 | 0.023117 |
| D(ATM) | 3742900. | 61505784 | -17272056 | -82762213 | 9410914. |
| D(POS) | -22200601 | 1.64E+08 | -61091261 | 2468518. | 21260387 |
| D(WEB) | -56866741 | 4.93E+08 | -3.13E+08 | -2.32E+08 | 77013519 |
| D(MOB) | -41390055 | 69982452 | -33082458 | -16756854 | 10749191 |

1 Cointegrating Equation(s): Log likelihood -4739.630

Normalized cointegrating coefficients (standard error in parentheses)

| FIC | ATM | POS | WEB | MOB |
|---|---|---|---|---|
| 1.000000 | -2.56E-09 | 4.80E-08 | -6.29E-09 | -5.11E-08 |
| | (5.4E-09) | (6.4E-09) | (1.9E-09) | (8.1E-09) |

Adjustment coefficients (standard error in parentheses)

| | |
|---|---|
| D(FIC) | -0.007542 |
| | (0.00873) |
| D(ATM) | -588309.0 |
| | (6172842) |
| D(POS) | 3489490. |
| | (8777818) |
| D(WEB) | 8938314. |
| | (3.4E+07) |
| D(MOB) | 6505688. |
| | (4366826) |

2 Cointegrating Equation(s): Log likelihood -4725.172

Normalized cointegrating coefficients (standard error in parentheses)

| FIC | ATM | POS | WEB | MOB |
|---|---|---|---|---|
| 1.000000 | 0.000000 | 4.95E-09 | -6.63E-10 | -9.73E-09 |
| | | (2.4E-09) | (5.2E-10) | (3.4E-09) |
| 0.000000 | 1.000000 | -16.84358 | 2.200243 | 16.17164 |

| | | | | |
|---|---|---|---|---|
| | | (2.07941) | (0.44592) | (2.93349) |

Adjustment coefficients (standard error in parentheses)

| | | |
|---|---|---|
| D(FIC) | -0.084680 | -1.68E-11 |
| | (0.02884) | (2.5E-11) |
| D(ATM) | 32288744 | 0.016895 |
| | (2.1E+07) | (0.01815) |
| D(POS) | 91047921 | 0.032061 |
| | (2.8E+07) | (0.02412) |
| D(WEB) | 2.72E+08 | 0.100392 |
| | (1.2E+08) | (0.09791) |
| D(MOB) | 43913825 | 0.000868 |
| | (1.4E+07) | (0.01231) |

3 Cointegrating Equation(s): Log likelihood -4717.029

Normalized cointegrating coefficients (standard error in parentheses)

| FIC | ATM | POS | WEB | MOB |
|---|---|---|---|---|
| 1.000000 | 0.000000 | 0.000000 | 1.61E-11 | -4.92E-09 |
| | | | (3.4E-10) | (3.0E-09) |
| 0.000000 | 1.000000 | 0.000000 | -0.110402 | -0.203667 |
| | | | (0.03664) | (0.32782) |
| 0.000000 | 0.000000 | 1.000000 | -0.137183 | -0.972198 |
| | | | (0.01624) | (0.14529) |

Adjustment coefficients (standard error in parentheses)

| | | | |
|---|---|---|---|
| D(FIC) | -0.096866 | -4.12E-10 | -3.42E-10 |
| | (0.03092) | (3.9E-10) | (4.4E-10) |
| D(ATM) | 36293724 | 0.146648 | -0.057113 |
| | (2.3E+07) | (0.28784) | (0.33073) |
| D(POS) | 1.05E+08 | 0.490994 | 0.149885 |
| | (3.0E+07) | (0.37782) | (0.43412) |
| D(WEB) | 3.45E+08 | 2.450921 | 0.881675 |
| | (1.2E+08) | (1.52078) | (1.74740) |
| D(MOB) | 51584862 | 0.249392 | 0.332288 |
| | (1.5E+07) | (0.19255) | (0.22124) |

4 Cointegrating Equation(s): Log likelihood -4713.022

Normalized cointegrating coefficients (standard error in parentheses)

| FIC | ATM | POS | WEB | MOB |
|---|---|---|---|---|
| 1.000000 | 0.000000 | 0.000000 | 0.000000 | -4.90E-09 |
| | | | | (8.7E-10) |
| 0.000000 | 1.000000 | 0.000000 | 0.000000 | -0.340114 |
| | | | | (0.32115) |
| 0.000000 | 0.000000 | 1.000000 | 0.000000 | -1.141744 |
| | | | | (0.37376) |
| 0.000000 | 0.000000 | 0.000000 | 1.000000 | -1.235913 |
| | | | | (2.67173) |

Adjustment coefficients (standard error in parentheses)

| | | | | |
|---|---|---|---|---|
| D(FIC) | -0.094507 | -4.36E-10 | -3.85E-10 | 1.07E-10 |
| | (0.03149) | (3.9E-10) | (4.6E-10) | (9.7E-11) |
| D(ATM) | 26247586 | 0.250408 | 0.126647 | -0.076448 |
| | (2.2E+07) | (0.27808) | (0.32540) | (0.06878) |
| D(POS) | 1.06E+08 | 0.487899 | 0.144404 | -0.071026 |
| | (3.1E+07) | (0.38302) | (0.44819) | (0.09473) |
| D(WEB) | 3.17E+08 | 2.741659 | 1.396572 | -0.578422 |
| | (1.2E+08) | (1.52169) | (1.78061) | (0.37635) |
| D(MOB) | 49550822 | 0.270400 | 0.369494 | -0.086192 |
| | (1.6E+07) | (0.19438) | (0.22745) | (0.04807) |

## ARDL

ARDL Long Run Form and Bounds Test
Dependent Variable: D(DFIC)
Selected Model: ARDL(1, 1, 1, 1, 1)
Case 3: Unrestricted Constant and No Trend
Date: 04/25/25 Time: 11:53
Sample: 2009Q1 2023Q4
Included observations: 59

Conditional Error Correction Regression

| Variable | Coefficient | Std. Error | t-Statistic | Prob. |
|---|---|---|---|---|
| C | 3.144871 | 0.630499 | 4.987905 | 0.0000 |
| DFIC(-1)* | -0.263292 | 0.046516 | -5.660282 | 0.0000 |
| DATM(-1) | -4.83E-10 | 7.86E-10 | -0.615384 | 0.5411 |
| POS(-1) | -7.85E-10 | 9.02E-10 | -0.869730 | 0.3887 |
| DWEB(-1) | 8.58E-11 | 2.49E-10 | 0.344456 | 0.7320 |
| MOB(-1) | 2.80E-09 | 1.06E-09 | 2.638569 | 0.0111 |
| D(DATM) | 3.50E-10 | 1.20E-09 | 0.291171 | 0.7721 |
| D(POS) | 5.24E-10 | 1.12E-09 | 0.466634 | 0.6428 |
| D(DWEB) | -4.04E-10 | 4.51E-10 | -0.896484 | 0.3744 |
| D(MOB) | 3.01E-09 | 2.86E-09 | 1.053536 | 0.2973 |

* p-value incompatible with t-Bounds distribution.

Levels Equation
Case 3: Unrestricted Constant and No Trend

| Variable | Coefficient | Std. Error | t-Statistic | Prob. |
|---|---|---|---|---|
| DATM | -1.84E-09 | 2.91E-09 | -0.631024 | 0.5310 |
| POS | -2.98E-09 | 3.43E-09 | -0.869240 | 0.3890 |

| | | | | |
|---|---|---|---|---|
| DWEB | 3.26E-10 | 9.42E-10 | 0.345656 | 0.7311 |
| MOB | 1.06E-08 | 3.83E-09 | 2.773428 | 0.0078 |

EC = DFIC - (-0.0000*DATM -0.0000*POS + 0.0000*DWEB + 0.0000*MOB )

F-Bounds Test — Null Hypothesis: No levels relationship

| Test Statistic | Value | Signif. | I(0) | I(1) |
|---|---|---|---|---|
| | | | Asymptotic: n=1000 | |
| F-statistic | 7.480487 | 10% | 2.45 | 3.52 |
| k | 4 | 5% | 2.86 | 4.01 |
| | | 2.5% | 3.25 | 4.49 |
| | | 1% | 3.74 | 5.06 |
| | | | Finite Sample: n=60 | |
| Actual Sample Size | 59 | | | |
| | | 10% | 2.568 | 3.712 |
| | | 5% | 3.062 | 4.314 |
| | | 1% | 4.176 | 5.676 |
| | | | Finite Sample: n=55 | |
| | | 10% | 2.578 | 3.71 |
| | | 5% | 3.068 | 4.334 |
| | | 1% | 4.244 | 5.726 |

t-Bounds Test — Null Hypothesis: No levels relationship

| Test Statistic | Value | Signif. | I(0) | I(1) |
|---|---|---|---|---|
| t-statistic | -5.660282 | 10% | -2.57 | -3.66 |
| | | 5% | -2.86 | -3.99 |
| | | 2.5% | -3.13 | -4.26 |
| | | 1% | -3.43 | -4.6 |