

The Assessment of Digital Banking on Financial Inclusion in Ethiopia: A Case Study of Selected Commercial Banks

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ABSTRACT

Digital banking involves the digitization of traditional banking services and activities, allowing customers to access financial services through internet-connected devices. Financial inclusion refers to ensuring that individuals and businesses have access to affordable and useful financial products and services such as transactions, savings, credit, and insurance, delivered responsibly and sustainably. These two concepts are closely linked, as digital banking provides an important pathway for enhancing financial inclusion by reducing geographic and financial barriers. It offers convenient and low-cost access to essential services, particularly for people in remote or underserved areas. This study examined the impact of digital banking on financial inclusion in Ethiopia, focusing on selected private commercial banks. Ten banks were chosen from the population of all commercial banks, covering the period 2018 to 2023. A descriptive research design and quantitative approach were applied, using both descriptive statistics and econometric methods, including panel regression analysis. Data were gathered directly from bank records and reports. The findings indicate that internet banking, ATM services, and loan provision each have a significant and positive effect on financial inclusion. However, mobile banking and total assets were found to have no significant effect. The regression model explained 88.9% of the variation in financial inclusion, showing that the combined influence of the examined variables is substantial. The study recommends that banks strengthen efforts to promote internet banking and ATM services, as these are the most impactful drivers of financial inclusion in Ethiopia's private banking sector.

Keywords: Digital Banking, Financial Inclusion, Internet Banking, ATM Usage, Ethiopia

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1. Introduction

1.1. Background of the Study

Access to financial services is a key driver of economic growth and poverty reduction. Financial services enable households and businesses to invest, create jobs, and save for the future. In Liberia, where poverty remains high, and in Ethiopia where financial inclusion reached 46% in 2022, improving access to finance is essential for inclusive development (World Bank, 2021). Ethiopia's revised financial inclusion strategy targets 70% account ownership by 2025.

Globally, 1.4 billion adults remain unbanked, with women disproportionately excluded, though the gender gap has narrowed. In low-income countries, account ownership is still below 30%, compared to over 90% in high-income countries. Financial exclusion is strongly tied to income

levels. Expanding access to finance improves investment, productivity, household welfare, and resilience to shocks.

Financial innovation plays a critical role in expanding inclusion. It involves new products, institutions, and technologies that increase efficiency and outreach (Schumpeter, 2008). Digital innovations such as mobile money, ATMs, internet banking, and agency banking have lowered costs and improved convenience. However, innovations also raise security concerns if digital systems are not adequately protected.

Digital banking transforms traditional banking by enabling remote access to services and reducing reliance on physical branches. It expands access to savings, credit, and insurance, especially in underserved regions (Morse, 2007; Narain, 2019). Mobile banking, using SMS, apps, or mobile internet, has become a powerful tool in emerging economies, reducing transaction costs and extending financial services to previously excluded groups (Daniyan-Bagudu et al., 2016).

Agency banking extends services through authorized agents, lowering branch construction costs and improving rural access. In Ethiopia, a regulatory framework for agent and mobile banking was introduced in 2013, representing a major step toward financial inclusion. Similarly, e-banking enables customers to manage accounts and payments through electronic platforms, providing efficiency and convenience.

Financial inclusion is defined as access to affordable and useful financial services, including savings, payments, credit, and insurance (World Bank, 2020). Evidence shows it directly reduces poverty: in Kenya, access to savings accounts improved small-scale business outcomes (Dupas & Robinson, 2013). Women's financial access increases household welfare in health and education (Duflo, 2012).

In Ethiopia, digital banking is expanding rapidly to bridge access gaps, especially in rural areas. Services such as mobile banking and internet banking are growing, but challenges persist, including low financial literacy, limited smartphone use, poor connectivity, and regulatory restrictions. Addressing these barriers is critical for Ethiopia to meet its financial inclusion goals and unlock the economic potential of its unbanked population.

1.2.Statement of the Problem

Financial inclusion remains a critical challenge in Ethiopia, where a significant portion of the population, particularly in rural areas, lacks access to formal financial services. According to the World Bank 2018, small percentage of Ethiopians banking access as a result of limited physical bank branches, low financial literacy, and poor infrastructure and these challenges are extended the existing income inequalities.

As a solution to the financial gap in Ethiopia, digital banking has been implemented. Some projects including mobile money platforms of telebirr show digital banking to increase financial inclusion. It has provided efficient banking services to different including undeserved communities. However the adoption and utilization of digital banking services in Ethiopia has remained limited other countries like Kenya. This discrepancy raises questions about the effectiveness and impact of digital banking on improving financial inclusion in Ethiopia (Demirguç-Kunt et al., 2020).

Though there are some private commercial banks in Ethiopia have implemented digital banking solutions, researches on this is limited. Henok (2015) has studied financial inclusion through mobile banking: challenges and prospects. Zewudie and Yohann (2023) studied the effect of internet banking on financial inclusion: the case of commercial banks in jimma zone, Ethiopia.

Those researches are limited in time, location and samples size and this research tries to address these gaps by examining the impact of digital banking on financial inclusion in Ethiopia, focusing on selected private commercial banks using the period 2018 to 2023 and including important variables.

1.3. Research Objectives

1.3.1. General Objective

The general objective of this study is to examine the impact of digital banking on financial inclusion in Ethiopia, focusing on selected private commercial banks.

1.3.2. Specific Objectives

The specific objectives of this research are as follows:

- I. To evaluate the extent of using digital banking services by customers in selected private commercial banks in Ethiopia.
- II. To assess the impact of mobile banking on financial inclusion in selected private commercial banks in Ethiopia.
- III. To determine the impact of internet banking on financial inclusion in selected private commercial banks in Ethiopia.
- IV. To determine the impact of ATM banking on financial inclusion in selected private commercial banks in Ethiopia.

1.4. Research Hypotheses

The hypotheses of this study are developed based on existing literature reviews on digital banking and financial inclusion as follows:

- Hypothesis (H_{01}): mobile banking doesn't have impact on financial inclusion in selected private commercial banks in Ethiopia.
- Hypothesis (H_{02}): internet banking doesn't have impact on financial inclusion in selected private commercial banks in Ethiopia.
- Hypothesis (H_{03}): ATM card banking doesn't have impact on financial inclusion in selected private commercial banks in Ethiopia.

1.5. Significance of the Study

The findings of this research can serve as a practical resource for financial institutions, including commercial banks in Ethiopia, by helping them identify the importance of digital banking services for their inclusion and customer base broadening, as well as further projecting their performance. It can aid banks in improving service delivery, expanding their customer base, and enhancing the overall user experience, ultimately contributing to the broader goal of financial inclusion.

This study is also important for policymakers, particularly those at the National Bank of Ethiopia, as it provides valuable insights into how digital financial services can be enhanced. It offers recommendations to improve digital banking for the betterment of financial inclusion across financial institutions, helping to shape policies that foster a more inclusive financial ecosystem.

Additionally, this research will contribute to the existing body of academic knowledge on digital banking and financial inclusion. It will pave the way for further investigation into how digital financial services can be leveraged to promote financial inclusion in Ethiopia.

1.6. Scope of the Study

For this study, the researcher will use 10 private commercial banks working in Ethiopia for the period between 2018 and 2023 due to Ethiopia's government has begun implementing policies to use digital financial services and increase financial inclusion, in 2018.

1.7. Limitation of the Study

This study is important but limited to urban and semi-urban areas where selected private commercial banks operate. The other is its exclusion of state owned commercial bank and only on private commercial banks.

2. Literature Review and Hypothesis Development

2.1. Theoretical Literature Review

Financial inclusion emphasizes making financial services accessible to low-income individuals and rural communities. It promotes access to savings, credit, insurance, and payments, contributing to equitable growth and economic stability (Karlan, 2007).

2.2. Technology Acceptance Model (TAM)

TAM argues that perceived usefulness and ease of use influence technology adoption, including digital financial services.

2.3. Diffusion of Innovations Theory

Rogers (1962) explains how innovations spread through society based on relative advantage, compatibility, complexity, trialability, and observability. Users are categorized as innovators, early adopters, majority, and laggards, reflecting adoption patterns

2.4. The Concept of Financial Inclusion

Financial inclusion allows individuals and businesses to use efficient financial products without barriers. It improves resilience, promotes participation in the economy, and supports poverty reduction (World Bank, 2020).

2.5. Types of Digital Banking

A digital banking service includes online banking: access via the internet for account management, mobile banking: financial transactions via mobile devices, key for inclusion in developing countries (Teferi & Tsegaye, 2021), ATM banking: Cash withdrawal and transfers through machines with 24/7 access. Telephone banking: Voice-based services for those with limited internet (Gizaw & Zerihun, 2020), Mobile wallets: Apps like M-Pesa and HelloCash enable secure digital transactions neobanks: Fully digital banks with low fees, favored by younger users (Ayele, 2019).

2.6. Benefits of Digital Banking

Digital banking provides accessibility, convenience, lower costs, efficiency, and customer satisfaction. It enables real-time transactions and expands financial services to underserved populations, particularly in rural areas (Kefale & Tadesse, 2021). It also supports gender inclusion and financial literacy, empowering women and low-income communities.

2.7. Barriers to Digital Banking in Ethiopia

Key barriers include poor infrastructure, low financial literacy, limited trust, and restrictive regulation (Ayele, 2019). Socio-economic and cultural factors, such as poverty and gender norms, also hinder adoption (Mekonnen, 2021). Overcoming these requires investment in infrastructure, financial education, and supportive policies.

2.8. Empirical Literature Review

Evidence from Africa confirms digital banking's role in financial inclusion. In Zimbabwe, Nigeria, Tanzania, and Kenya, mobile banking increased access to services (Mago & Chitokwindo, 2014; Etim, 2014). Studies in Ethiopia reveal similar trends, with mobile money improving access for SMEs and rural communities.

2.9. Conceptual Framework

A conceptual framework is necessary to develop on how the relation between digital banking and financial inclusion of the banking industry.

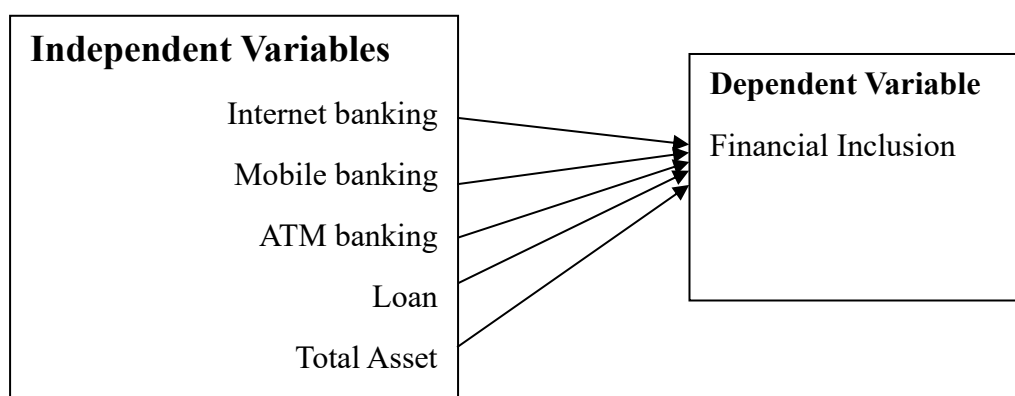


Figure 1. Conceptual Framework

3. Research Methodology

3.1. Data Type and Sources

The data for this research used quantitative type since the research focus on the general and national level. The data source for the research is secondary sources and used from bank records.

3.2. Target Population

The target population for the research is all 31 commercial banks in Ethiopia, as these institutions are pivotal in delivering a variety of banking services, including digital banking, to the population. Commercial banks in Ethiopia provide services such as savings accounts, loans,

mobile banking, and digital payment solutions, which are essential for enhancing financial inclusion. These banks are at the forefront of implementing digital banking technologies, making them a critical focus for investigating how these innovations contribute to increasing access to financial services for individuals and businesses, especially in underserved areas.

3.3. Research Design

The research for this study used descriptive research design which describes and analyzes the impact of mobile banking and internet banking on financial inclusion in Ethiopia. It focuses on some selected private commercial banks digital banking operations and its effects on financial inclusion.

3.4. Research Approach

The research will use quantitative approach which shows the extent to the correlation between mobile banking and internet banking and financial inclusion metrics.

3.5. Sample Size and Sampling Techniques

The sample size for the study will be 10 private commercial banks working in Ethiopia for the period between 2018 and 2023. These banks are selected purposively by their strength in digital banking and their list is as follows: Dashen Bank, Awash Bank, Bank of Abyssinia, Hibret Bank, Nib International Bank, Wogagen Bank, Zemen Bank, Berhan International Bank, Oromia Bank and Bunna International Bank

3.6. Method of Data Collection

Data collected from bank records and annual reports directly contacting using official website.

3.7. Methods of Data Analysis

The data collected and analyzed using descriptive statistics using graph and table. The other method is inferential statistics using correlation analysis and regression analysis to explore the relationships between digital banking usage and financial inclusion.

3.8. Econometrics Model

An econometric model can be used to analyse the impact of mobile banking and internet banking on financial inclusion in Ethiopia using panel data analysis using a fixed effects (FE) or random effects (RE) model. The econometric model:

$$FI_{it} = A_0 + A_1 MB_{it} + A_2 IB_{it} + A_3 ATMB_{it} + A_4 L_{it} + A_5 TA_{it} + E_{it}$$

Where

- FI_{it} : Financial inclusion indicator for bank i at time t . This is the number of active accounts. This is taken due to the fact that it is widely accepted, measurable or easy to quantify and track over time, comparable or allows cross-regional and demographic comparisons, foundational or gateway to other financial services like credit and savings, proxy for access meaning reflects formal financial system accessibility, helps for policy directly tied to financial inclusion strategies and available from financial institutions and secondary sources.

- MB_{it} : Mobile banking usage for bank i at time t . This is the number of mobile banking users. The reason is that it reflects adoption, quantifiability, shows change overtime and ease of data collection.
- IB_{it} : Internet banking usage for bank i at time t . This is the number of internet banking users. The reason is that it reflects adoption, quantifiability, shows change overtime and ease of data collection.
- $ATMB$: ATM banking usage for bank I at time t . This is the number of ATM banking users. This is the number of internet banking users. The reason is that it reflects adoption, quantifiability, shows change overtime and ease of data collection.
- TA_{it} : Total assets for bank i at time t bank size.
- Lit : Loan amount from bank i at time t .
- Eit : Error term capturing unobserved factors.
- $A0$: Intercept term/value of FI when other variables are zero
- $A1$: effect of mobile banking on FI assuming other variables are fixed
- $A2$: effect of internet banking on FI assuming other variables are fixed
- $A3$: effect of ATM banking on FI assuming other variables are fixed
- $A4$: effect of loan available on FI assuming other variables are fixed
- $A5$: effect of total asset on FI assuming other variables are fixed

The above main variable ATM users, mobile banking users, and internet banking users are selected among other variables of the research on digital banking's impact on financial inclusion due to these variables are the most widely used and accessible digital banking services, their representation of the primary ways individuals interact with digital financial systems, banks reliably track usage data for these services, ensuring consistent and accurate data collection, these channels are adopted across diverse demographics, making them representative of digital banking trends, they cater to both urban and rural populations, and addressing financial inclusion at multiple levels.

3.8.1. Choose Between FE and RE Models

By using Hausman test the researcher used fixed effect model.

- **H0**: Random effect is appropriate (unobserved effects are uncorrelated with regressors).
- **H1**: Fixed effect is appropriate (unobserved effects are correlated with regressors).

If $p\text{-value} < 0.05p$, use the FE model.

3.8.2. Tests and Conditions for the Model

Test for Heteroskedasticity

The researcher uses Breusch-Pagan Test to check if error variances are constant across observations.

Test for Serial Correlation

The researcher uses Wooldridge Test for serial correlation in panel data

Test for Multicollinearity

The researcher uses Variance Inflation Factor (VIF) Check for correlation between explanatory variables.

4. Data Presentation and Analysis

4.1. Descriptive Analysis

4.1.1. Financial Inclusion Over the Period 2018-2023

As Table 1 and Figure 2 shows, the growth in financial inclusion (using active accounts) is increasing over the period 2018 to 2023 G.C. across different banks. This indicates that there has been a steady rise in the number of active bank accounts from 2018 to 2023 across various the private commercial banks in Ethiopia. The use of active accounts as a metric reflects the increasing participation of individuals and businesses in the formal banking sector. Active accounts are typically those that have been used for regular transactions, such as deposits, withdrawals, or payments, and are considered a key indicator of financial inclusion. Financial inclusion is the process of ensuring that individuals, particularly those from low-income or marginalized groups, have access to and can effectively use affordable financial services. The data from Table 1 suggests that over the five-year period (2018-2023), the total number of active accounts in Ethiopia has been consistently increasing. This trend demonstrates a positive shift toward greater financial inclusion, where a growing portion of the population is gaining access to and actively using banking services. Over this period, there may be several key factors contributing to this rise like advancements in digital banking, initiatives to promote financial inclusion, and changes in consumer behavior.

The increase in active accounts is not confined to one or two large banks but spans across different banks in Ethiopia. This suggests that the growth in financial inclusion is widespread, with a variety of commercial banks ranging from the large, urban-based institutions to smaller, rural-oriented banks contributing to the overall increase in active accounts. The diversity in the types of banks providing services is significant because it means that financial inclusion is not limited to urban elites but is also extending to rural and underserved populations.

Table 1: Financial Inclusion over the Period 2018-2023 across 10 private commercial banks

Year	Bank ID	Financial inclusion growth (%)	Bank ID	Financial inclusion growth (%)
2018	1	-	6	-
2019	1	20	6	25
2020	1	19.04762	6	20
2021	1	16	6	22.22222
2022	1	6.896552	6	18.18182
2023	1	8.064516	6	15.38461
2018	2	-	7	-
2019	2	20	7	25
2020	2	25	7	30
2021	2	20	7	23.07692
2022	2	16.66667	7	25
2023	2	18.19048	7	25
2018	3	-	8	-
2019	3	11.11111	8	30
2020	3	20	8	23.07692

Year	Bank ID	Financial inclusion growth (%)	Bank ID	Financial inclusion growth (%)
2021	3	16.66667	8	18.75
2022	3	14.28571	8	21.05263
2023	3	12.5	8	17.3913
2018	4	-	9	-
2019	4	25	9	27.27273
2020	4	20	9	21.42857
2021	4	16.66667	9	17.64706
2022	4	14.28571	9	15
2023	4	12.5	9	17.3913
2018	5	-	10	-
2019	5	20	10	50
2020	5	22.22222	10	33.33333
2021	5	13.63636	10	25
2022	5	20	10	26.66667
2023	5	16.66667	10	21.05263

Source: Own Compilation, 2025 G.C

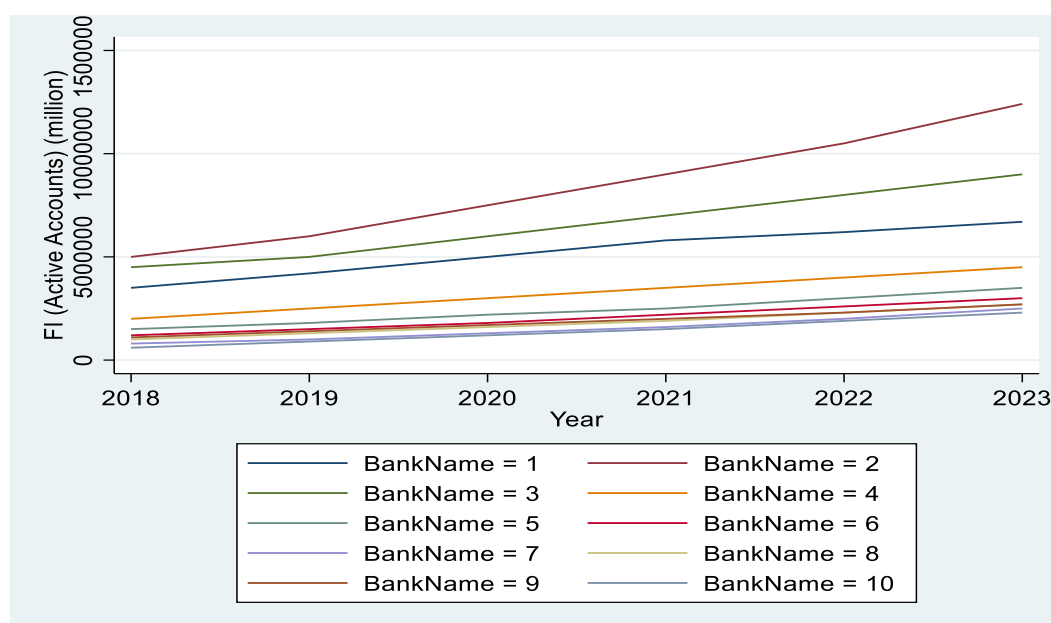


Figure 2: Financial Inclusion over the Period 2018-2023
Source: Own Compilation, 2025 G.C

4.1.2. Extent of Using Internet Banking Services by Customers in Selected Private Commercial Banks in Ethiopia

As depicted in Table 2 and Figure 3, the number of internet banking users has been steadily rising both over the years and across various commercial banks in Ethiopia. This trend highlights a significant shift in how individuals and businesses are interacting with their banks, with a growing number of customers opting for internet banking as their preferred mode of accessing financial services. The data presented in Table 2 and visually represented in Figure 3 underscore the expansion of internet banking usage among customers, reflecting broader patterns of digitalization in the financial sector. The rise in internet banking usage signifies several key factors contributing to its increased adoption.

The increase in the number of internet banking users over time, as shown in the data from Table 2, illustrates how technological advancements have played a pivotal role in the financial services sector. Over the past several years, the accessibility and convenience offered by internet banking have made it an attractive alternative to traditional banking methods. Customers now can perform a wide range of banking activities, such as checking balances, transferring funds, paying bills, and even applying for loans, all from the comfort of their homes or offices. The growth in internet banking usage is a direct result of increased internet penetration, the availability of smartphones, and improvements in mobile network coverage across Ethiopia.

The steady increase in the number of users over time could also reflect the growing trust and confidence customers have in online banking systems. Initially, many customers might have been hesitant to transition to internet banking due to concerns about security and usability. However, as security measures improved and more customers became familiar with the platform, internet banking became more widely adopted.

As depicted in Figure 3, the increase in internet banking users is not limited to one specific bank but is observed across a variety of commercial banks in Ethiopia. This suggests that internet banking is becoming a mainstream banking service, embraced by multiple banks across the country. The fact that this growth is happening across different banks indicates that the adoption of digital banking is not only the domain of large, urban-based banks with more extensive technological infrastructure, but also smaller and regional banks that are reaching out to underserved populations.

Table 2: Growth in internet banking over 2018-2020 across 10 banks

Year	Bank ID	Internet banking users growth (percent)	Bank ID	Internet banking users growth (percent)
2018	1	-	6	-
2019	1	54.90196	6	33.33333
2020	1	51.89874	6	50
2021	1	25	6	33.33333
2022	1	33.33333	6	37.5
2023	1	25	6	27.27273
2018	2	-	7	-
2019	2	60	7	50
2020	2	87.5	7	66.66666
2021	2	66.66666	7	40

Year	Bank ID	Internet banking users growth (percept)	Bank ID	Internet banking users growth (percept)
2022	2	40	7	42.85714
2023	2	14.28571	7	20
2018	3	-	8	-
2019	3	30	8	33.33333
2020	3	38.46154	8	50
2021	3	22.22222	8	33.33333
2022	3	13.63636	8	37.5
2023	3	20	8	27.27273
2018	4	-	9	-
2019	4	40	9	50
2020	4	42.85714	9	66.66666
2021	4	30	9	40
2022	4	23.07692	9	42.85714
2023	4	25	9	30
2018	5	-	10	-
2019	5	25	10	100
2020	5	40	10	100
2021	5	42.85714	10	50
2022	5	30	10	50
2023	5	23.07692	10	22.22222

Source: Source: own compilation 2025GC

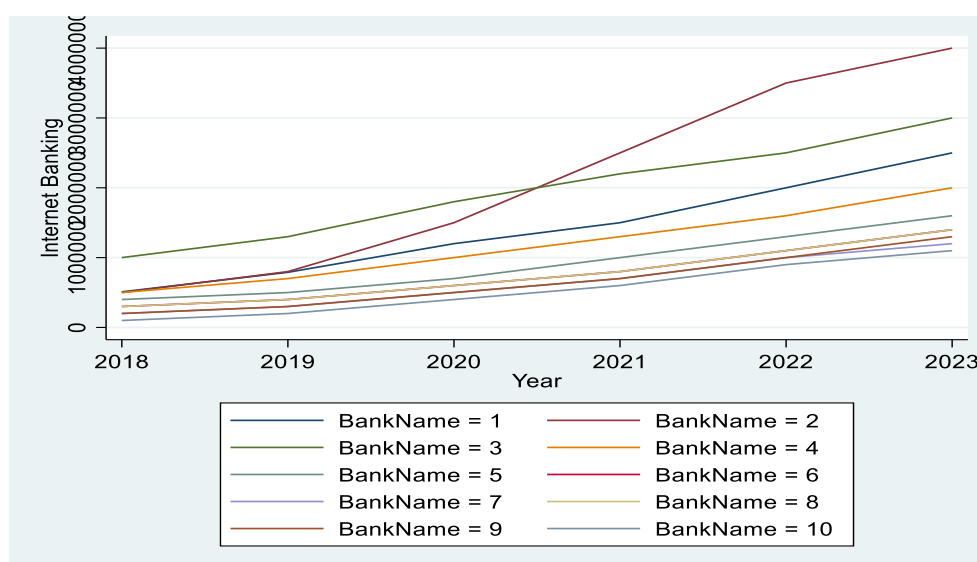


Figure 3: Internet banking users over the Period 2018-2023 across 10 private commercial banks

Source: own compilation 2025GC

4.1.3. Extent of Using Mobile Banking Services by Customers in Selected Private Commercial Banks in Ethiopia

The data presented in Table 3 and visually represented in Figure 4 highlight a clear and consistent increase in the number of mobile banking users across Ethiopia over the past several years. This trend illustrates the growing importance of mobile banking as a key tool for enhancing financial inclusion in the country. The upward trajectory of mobile banking adoption over time indicates that more customers are shifting toward mobile-based platforms to access a wide array of financial services, such as money transfers, payments, savings, and loans, all via their mobile devices. This transition reflects the broader digital transformation in the Ethiopian banking sector, driven by advances in technology, improved mobile network infrastructure, and government and institutional efforts to promote financial inclusion.

The steady rise in mobile banking users, as depicted in Table 3, signifies a broader shift in how customers are engaging with banking services. Mobile banking provides customers with the convenience of accessing their accounts and completing transactions without having to visit a physical branch. Over time, more individuals are turning to their smartphones and mobile devices as a primary means of managing their finances. This growing trend is particularly notable in Ethiopia, where mobile phones are widely accessible even in remote areas, where traditional banking infrastructure is limited or non-existent.

As shown in Figure 4, the growth in mobile banking users is not limited to one or two commercial banks but is observed across various institutions. This suggests that mobile banking has become a mainstream service offering by multiple banks, ranging from large national banks to smaller, regional banks. The increasing use of mobile banking across different commercial banks in Ethiopia indicates that banks are actively integrating mobile banking into their business models, recognizing its potential to attract a wider customer base and increase financial inclusion.

Table 3: Mobile banking users over the Period 2018-2023 Across 10 private commercial banks

Year	Bank ID	Mobile banking users growth(%)	Bank ID	Mobile banking users growth(%)
2018	1	-	6	-
2019	1	66.66666	6	50
2020	1	100	6	33.33333
2021	1	25	6	50
2022	1	20	6	50
2023	1	33.33333	6	22.22222
2018	2	-	7	-
2019	2	100	7	100
2020	2	50	7	50
2021	2	100	7	66.66666
2022	2	50	7	60
2023	2	33.33333	7	25
2018	3	-	8	-
2019	3	100	8	50

Year	Bank ID	Mobile banking users growth(%)	Bank ID	Mobile banking users growth(%)
2020	3	50	8	66.66666
2021	3	33.33333	8	40
2022	3	25	8	42.85714
2023	3	20	8	20
2018	4	-	9	-
2019	4	66.66666	9	50
2020	4	60	9	33.33333
2021	4	25	9	50
2022	4	30	9	33.33333
2023	4	30.76923	9	25
2018	5	-	10	-
2019	5	50	10	100
2020	5	66.66666	10	50
2021	5	60	10	66.66666
2022	5	25	10	60
2023	5	30	10	25

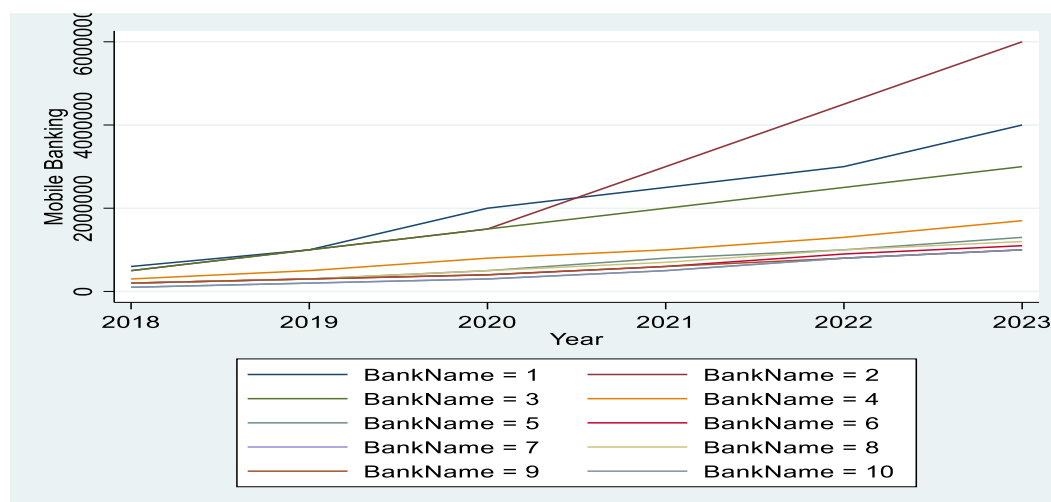


Figure 4: Mobile banking users over the Period 2018-2023

Source: own compilation 2025GC

4.1.4. Extent of using ATM banking services by customers in selected private commercial banks in Ethiopia.

The data from Table 4 and Figure 5 show a noticeable upward trend in the number of individuals using ATM banking services across Ethiopia over a period of time. This consistent

increase indicates that more and more customers are turning to Automated Teller Machines (ATMs) as their preferred method for conducting financial transactions. The growth of ATM banking users is a critical indicator of the broader shift toward digital and automated financial services in Ethiopia. The rising number of ATM users reflects the country's gradual but steady using of self-service banking, which is becoming a cornerstone of modern banking practices.

Table 4: Growth in ATM Banking Users Over 2018-2023 the 10 years across the 10 private commercial banks, Ethiopia

Year	Bank ID	ATM banking users growth (%)	Bank ID	ATM banking users growth (%)
2018	1	-	6	-
2019	1	42.85714	6	40
2020	1	20	6	28.57143
2021	1	25	6	22.22222
2022	1	13.33333	6	27.27273
2023	1	17.64706	6	21.42857
2018	2	-	7	-
2019	2	33.33333	7	33.33333
2020	2	50	7	50
2021	2	33.33333	7	33.33333
2022	2	37.5	7	25
2023	2	27.27273	7	30
2018	3	-	8	-
2019	3	25	8	20
2020	3	20	8	33.33333
2021	3	22.22222	8	25
2022	3	13.63636	8	30
2023	3	20	8	23.07692
2018	4	-	9	-
2019	4	25	9	50
2020	4	30	9	33.33333
2021	4	23.07692	9	25
2022	4	18.75	9	20
2023	4	15.78947	9	25
2018	5	-	10	-
2019	5	28.57143	10	50
2020	5	22.22222	10	66.66666
2021	5	27.27273	10	40
2022	5	21.42857	10	42.85714

Year	Bank ID	ATM banking users growth (%)	Bank ID	ATM banking users growth (%)
2023	5	17.64706	10	30

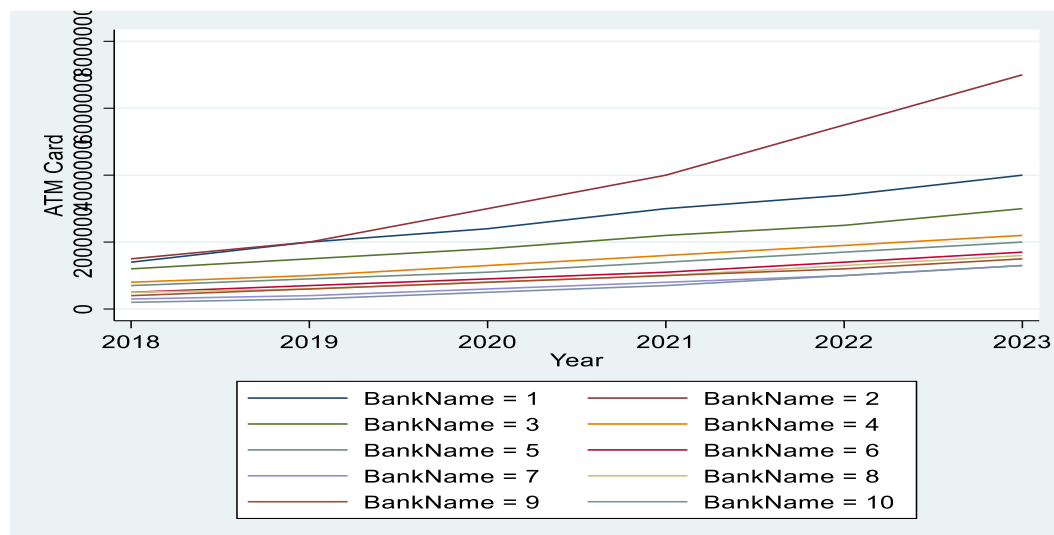


Figure 5: Growth in ATM Banking Users Over 2018-2023 the 10 years across the 10 private commercial banks, Ethiopia

4.1.5. Financial Inclusion and Banking Services Variables Summary statistics

Based on the summary statistics provided in the Table 5, the following observations can be made regarding financial inclusion and its related variables:

The mean number of active accounts is 3,453,500, indicating a substantial level of engagement with formal banking systems. Active accounts serve as a key indicator of financial inclusion, as they represent individuals or entities actively participating in the banking sector.

The mean number of internet banking users is 874,895.5, highlighting the adoption of digital banking channels. This figure demonstrates the growing reliance on internet-based financial services for convenient and efficient banking transactions.

The mean number of mobile banking users is 1,096,687, showing a similar level of usage as internet banking. Mobile banking plays a crucial role in improving financial access, especially in areas with limited physical banking infrastructure, by leveraging mobile technologies.

The mean number of ATM banking users is 1,036,667, slightly higher than internet and lower than mobile banking. ATM banking remains a vital component of financial inclusion, offering accessible cash withdrawal and account services, particularly in regions with limited digital connectivity.

The mean loan availability is 3.82e+10 (38.2 billion), reflecting the substantial volume of credit provided by financial institutions. Loans are essential for economic development, enabling individuals and businesses to invest, grow, and enhance their financial well-being.

The mean total assets are 5.73e+10 (57.3 billion), indicating the overall financial capacity and stability of the banking sector. Higher total assets typically imply greater resources available to support financial inclusion initiatives, such as expanding banking infrastructure and offering diverse financial products.

Table 5: Summary statistics of the variables

Variable	Observation	Mean	Standard deviation	Minimum	Maximum
FI (Active Accounts)	60	3453500	2607383	600000	1.24e+07
Internet banking	60	874895.5	672021.1	57220	2500000
Mobile banking	60	1096687	1110885	100000	5501200
ATM banking	60	1036667	587042.8	100000	3000000
Loan available	60	3.82e+10	3.39e+10	5.00e+09	1.62e+11
Total asset	60	5.73e+10	4.54e+10	1.15e+10	2.24e+11

Source: own compilation 2025

4.2. Econometric Analysis

4.2.1. Check for Multicollinearity

Based on the VIF values presented in Table 6, which are all less than 10, there is no indication of **multicollinearity** in the model. This suggests that the independent variables are not highly correlated with each other, ensuring that the estimated regression coefficients are reliable and not inflated by multicollinearity. As a result, the standard errors of the coefficients are not distorted, and the individual effects of each predictor on the dependent variable can be accurately assessed. This absence of multicollinearity supports the validity of the regression model and the precision of its estimates.

Table 6: Check for Multicollinearity

Variable	VIF	1/VIF
Loanavailable	4.06	0.246211
Totalasset	3.50	0.286113
ATMCard	3.28	0.305106
MobileBank~g	3.00	0.333308
InternetBa~g	2.62	0.382322
Mean VIF	3.29	

4.2.2. Check for Heteroskedasticity

Heteroskedasticity refers to a situation in which the variance of the residuals (error terms) in a regression model is not constant across observations. Such a condition violates one of the key assumptions of regression analysis, specifically the assumption of homoskedasticity, which requires that the residuals exhibit constant variance. The presence of heteroskedasticity can lead to inefficient estimates and unreliable inference, as it distorts the accuracy of standard errors and, consequently, the validity of hypothesis testing. The conclusion that there is no heteroskedasticity and it is based on the results of a heteroskedasticity test reported in Table 3, where the p-value is greater than 0.05.

To test for heteroskedasticity, various methods can be employed. In the context of panel data, the Modified Wald Test for groupwise heteroskedasticity is one commonly used approach. The

test evaluates whether the variance of residuals is constant across the cross-sectional units in the dataset.

Table 7: Heteroskedasticity check

. xttest3	
Modified Wald test for groupwise heteroskedasticity in fixed effect regression model	
H0: $\sigma(i)^2 = \sigma^2$ for all i	
chi2 (10) =	22.33
Prob > chi2 =	0.5320

4.2.3. Check for Crossectional Dependence

The conclusion that there is no cross-sectional dependence is based on the results of the cross-sectional dependence test, where the p-value = 0.422 is greater than the typical significance threshold of 0.05. Cross-sectional dependence refers to the situation where the residuals (error terms) from different entities are correlated at the same point in time, violating the assumption of independence across entities. The null hypothesis of the test assumes that there is no cross-sectional dependence, while the alternative suggests its presence. Since the p-value exceeds 0.05, we fail to reject the null hypothesis, indicating that there is no significant evidence of cross-sectional dependence in the model. This suggests that the residuals are independent across entities, and the model's estimates are not affected by contemporaneous correlations, ensuring the reliability of the regression results.

Table 8: Check for Crossectional Dependence

.xtcsd, pesaran abs	
Pesaran's test of cross sectional independence =	2.807, Pr = 0.0050
Average absolute value of the off-diagonal elements =	0.422

4.2.4. Choose Between Fixed Effect and Random Effect Model

The selection of the Fixed Effects (FE) model is based on the results of the Hausman test, which evaluates whether the Fixed Effects or Random Effects model is more appropriate for the panel data analysis. In the context of the table provided, the p-value = 0.0022, which is less than the significance threshold of 0.05, provides strong evidence for favouring the Fixed Effects model.

Table 9: Hausman test

	-----coefficients-----	
	(b) fixed	(B) random
Internet banking	0.68	0.28
Mobile banking	-0.28	-0.99
ATM card	0.76	1.53
Loan Available	0.000044	-0.000012
Total asset	0.000022	0.0000318
Prob > chi2 = 0.0022		

4.2.5. Fixed Effect Model Regression Result

Based on the regression results presented in Table 10, both **internet banking** and **ATM card usage** have shown to be significant contributors to enhancing financial inclusion, with their positive and statistically significant coefficients underscoring the strength of their impact. These findings suggest that increasing the availability and usage of these banking services directly influences individuals' ability to access and engage with formal financial systems. The results are further supported by the magnitudes of the coefficients, indicating the relative importance of these services in driving financial inclusion.

Specifically, a **1-unit increase in internet banking users** is associated with a **0.68-unit increase** in financial inclusion, while holding other factors constant. This substantial relationship emphasizes the transformative role of internet banking in expanding access to financial services.

Similarly, a **1-unit increase in ATM card user's** results in a **0.762-unit increase** in financial inclusion, all else being equal. This shows that the expansion of **ATM networks** has a direct and positive effect on people's ability to access cash, perform financial transactions, and participate in the formal banking sector. ATM cards provide a **convenient and secure** method of withdrawing funds, making it easier for individuals to manage their finances without having to rely on physical branch visits. The widespread use of ATM cards also offers a higher degree of **financial security**, as users can withdraw cash from machines rather than carrying large amounts of cash, which may be subject to theft or loss.

Loan affects financial inclusion positively by a coefficient of 0.0000448. Access to loans plays a significant role in improving financial inclusion, as evidenced by studies indicating that increasing loan availability can boost individuals' participation in the formal financial system. For instance, a **positive association** between loans and financial inclusion means that providing loans helps individuals engage more actively with formal banking services. Loans enable economic mobility by allowing people to invest in businesses or education, thus reducing reliance on informal financial systems. This contributes to greater financial stability and inclusion, as borrowers gain access to additional financial services such as savings accounts and insurance, promoting long-term financial well-being.

Table 10: Regression result

Financial Inclusion (Active Accounts)	Coefficients	Std error	t	p> t
Internet banking	0.68	0.16	4.17	0.000
Mobile banking	-0.28	0.16	-1.78	0.082
ATM card	0.76	0.18	4.19	0.000
Loan available	0.000044	0.0000152	2.96	0.005
Total asset	0.000022	0.0000128	-1.76	0.085
Constant	1407980	147499.5	9.55	0.000
n = 60 $R^2 = 0.889$ Number of groups = 10 Prob> F = 0.000				

5. Summary, Conclusion and Recommendation

5.1. Summary

The objective of this study was to assess the impact of digital banking on financial inclusion in Ethiopia in the case of selected private commercial banks. A causal study was adopted to measure the extent of the relationship between the variables. The data collected was analyzed using descriptive and econometrics regression model, while the financial inclusion was measured using number of active accounts. Fixed effect model was developed to the impact of digital banking on financial inclusion in Ethiopia in the case of selected private commercial banks. The dependent variable is financial inclusion, and the independent variables (determinants) are mobile banking usage, internet banking usage ATM banking usage, total assets for bank and loan amount from bank, and 88.9% of the variation in financial inclusion is explained by these determinants. The results of the study show from simple graphic manipulation shows that, financial inclusion is increasing over the period 2018 to 2023 has an increasing pattern across different banks.

The model was found to be useful and at least one of the predictors is useful for predicting financial inclusion. Both internet banking and ATM card usage significantly contribute to enhancing financial inclusion. The determinants of financial inclusion do not have multicollinearity problems and no heteroscedasticity and autocorrelation problem in residual term.

5.2. Conclusion

This study concludes the impact of digital banking on financial inclusion in Ethiopia in the case of selected private commercial banks as follows. Internet banking and ATM card usage were found to be positively and significantly related to significantly contribute in improving financial inclusion. The improvement in these variables will subordinate the financial inclusion in the financial sector especially banks.

5.3. Recommendations

Banks in Ethiopia are responsible to make strong decisions in the improvement process of financial inclusion using the digital banking. Basically from this study Internet banking and

ATM card usage are the significant variables to make progress on financial progress across banks through time.

Expand internet banking services with user-friendly and secure platforms. It is recommended to expand internet banking services by developing user-friendly and secure platforms that cater to individuals with varying levels of digital literacy. Ensuring easy navigation and robust security measures, such as two-factor authentication and encryption, will build trust among users and encourage adoption, particularly among rural populations and individuals with limited access to traditional banking services.

Increase the number and distribution of ATMs, especially in rural areas. To improve accessibility, it is recommended to increase the number of ATMs, particularly in rural and remote areas where banking infrastructure is limited. This will facilitate access to cash, allow for basic financial transactions, and promote financial inclusion by reducing reliance on informal financial systems, enabling individuals in underserved areas to participate in the formal financial system.

Collaborating with telecommunication providers to improve network coverage and internet quality in underserved and rural regions will enable users to access mobile banking platforms without interruptions, fostering greater engagement with digital financial services.

Launch financial literacy campaigns about the benefits and safety of digital banking. It is essential to launch financial literacy campaigns that focus on educating the public about the benefits and safety of digital banking. These campaigns should aim to build trust in online banking by highlighting its convenience, efficiency, and security, as well as providing information on how to protect oneself from fraud and scams, particularly among elderly and low-income groups.

Provide digital training programs targeting rural populations and older generations. To increase adoption, digital training programs should be specifically designed for rural populations and older generations who may not be familiar with digital banking. Offering these programs at community centers or through local cooperatives can help bridge the gap in digital literacy, empowering these groups to make the most of digital banking services.

Design tailored internet banking and ATM solutions for small businesses and rural households. Developing tailored banking solutions for small businesses and rural households is crucial. These solutions could include micro-loans, small business accounts, and specialized ATM services that meet the specific financial needs of these groups, such as cash deposits for agriculture or small business transactions, making financial services more relevant and accessible to their daily activities.

Introduce multifunctional ATM cards combining debit, credit, and loyalty features. To enhance user engagement, it is recommended to introduce multifunctional ATM cards that combine debit, credit, and loyalty program features. This would simplify the banking experience for users by consolidating various financial functions into one card, encouraging frequent use of formal financial services and fostering financial inclusion through reward systems that incentivize card usage.

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