

## **The Impact of Digital Finance on Financial Inclusion in East African Countries**

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### **Abstract**

The many of billion Grown-ups globally absence of access to a record including a bank through a financial institution or a smartphone-based monetary services provider. Still, billions of potential customers are still unmet, and there is a considerably more need for financial services than there is supply at the moment. Digital finance with finance inclusion has varied definitions according to different academics and not linked together for solution. This research was carried out to close the gap. This study foremost goal is to empirically investigate impacts of digital finance on financial inclusion across East African Countries. The study selected participants by using purposive sampling and secondary data from nine East African Countries which covering the periods from 2008 to 2022 for fifteen years. Based on a quantitative research methodology, this study makes use of balanced statistic panel information which means that fixed effect model and published data intended for fifteen years are gathered by employing secondary information from the IMF and World Bank. The researcher employed STATA version 18.0 to carry out an analysis. The investigation discovered that digital finance, automatic teller machine, are positive significant effect and individual using internet, population density, rural populace growth devise negative substantial impact on the financial inclusion. The study showed that digital finance impact on financial accessibility and partake a favorable connection with together. Therefore Researcher recommends that to make on digital finance in EAC is like infant age in the region which wants to work on mobile banking, individual using internet and literacy is assignment for government and policy maker in the East African Countries. The requirements of the poor financial standing people ought to be specifically conversed with this development, ensuring that financial goods and services are available, accessible, and easy to use. It is recommended that governments and policymakers implement effective measures to improve financial services' accessibility, especially in rural regions.

**Keywords:** East Africa, Digital Finance, Financial Inclusion, Fixed Effect and Panel Data

## 1. Introduction

Currently, a number of the principal international economic institutions are very concerned about financial inclusion (FI). Reducing poverty is one of the goals pursued in developing nations, and this can be accomplished by raising FI. Financial inclusion primary mission is to facilitate disadvantaged populations that have historically been denied access to inexpensive financial services and products(Gallego-Losada et al., 2023). One tools of financial inclusion to inclusive is digital finance. Global social and economic systems have undergone tremendous transformation as a result of the fourth Industrial Revolution. Decision-making is now faster and of higher quality because to Industry 4.0's enhanced data delivery and processing(Al-Smadi, 2023). Furthermore, Industry 4.0 has brought about new machine and human skills that are solely dependent on the technological infrastructure supporting the digital transformation of the financial sector, resulting in the creation of new electronic marketing channels and financial services(Mhlanga, 2020). Nowadays, technological advancements including those in the financial sector are a driving force and a crucial component of economic success for companies looking to extend the life of their products (Shofawati, 2019). The financial sector's technological advancements are thought to have prompted the development of digital finance (DF). It encompasses all digitally supplied financial information as well as investing, payment, insurance, and financing services and products(Ozili, 2018). In the perspective of a practitioner, digital finance refers to financial services offered by smartphones, laptops, the internet, or cards linked to a safe digital payment system. According to a McKinsey report, digital finance refers to financial services that are provided through cards, the internet, or mobile devices. Fin-tech enterprises and innovative financial service providers offer new forms of customer contact and interaction, software, financial firms, and new financial products. This is all included in the category of digital finance(Gujral, 2021). Low-income and impoverished individuals in developing nations can save and borrow in the official financial system and generate income thanks to digital financial services, which can often be more practical and cost-effective than traditional banking services. The public needs it since it increases the security of their cash and makes traveling with cash less convenient than leaving it at home(Haider, 2018). Through lowering the cost of providing financial services, financial technology serves as a tool to create possibilities and advance financial inclusion. The process of making financial services accessible and inexpensive for all individuals and organizations, irrespective of their wealth or size of enterprise, is known as financial inclusion(Agelyne & Musau, 2021).

The impoverished can now have access to digital finance. Banks and conventional microfinance still play a significant role in society, but there is a lot of room for the poor to benefit from new technology-based platforms. Specifically, compared to traditional full service bank branches, the utilization of several indirect channels and the coverage of digital financial networks lower expenses. As a result, digital financial inclusion goes beyond simple financial access; quality and utilization are equally crucial. Despite the fact that many individuals have inexpensive access to digital financial services, many choose not to use them for cultural or religious reasons(Thaddeus & Ngong, 2020). Integration of digital finance to lessen poverty. The Sustainable Development Goals (SDGs) of 2030 must be aligned with and supported by developments and initiatives that advance digital financial inclusion(Tay et al., 2022). Growth inclusively is encouraged by financial inclusion. It is less efficient to promote inclusive growth solely through financial stability. In order to further accelerate inclusive growth, financial stability and financial inclusion work together harmoniously(Iddrisu et al., 2023). Enabling financial services to be accessible to different social classes is made possible in large part by financial technology. Financial access and economic progress are facilitated by financial literacy, which facilitates the use of financial services(Neelam & Bhattacharya, 2022). The public needs digital financial services because they improve cash security and are more convenient than carrying cash around with you. In order to provide services that are affordable, safe, and easy to use, digital banking systems also require infrastructural improvements(Michelle, 2016). There are many advantages to digital financing and financial inclusion for governments, businesses, individuals, and consumers of financial services. However, there are still certain problems that need to be resolved before digital finance can become more beneficial to all parties involved and which are pertinent to the ongoing discussion about digital finance and to national initiatives aimed at increasing financial inclusion through this medium in emerging and developing countries(Ozili, 2022). Accelerating financial inclusion is facilitated by the rapid use of mobile money(Ebong & George, 2021). With the help of financial technology, financial institutions may now more effectively and economically reach a larger population, revolutionizing the way financial services are provided. By providing quick and easy access to financial products and services via digital platforms, fin-tech solutions are revolutionizing financial inclusion(Banna. B and Roy, 2023). . Digital technology for finance can help the under-banked and underserved in emerging countries have easier access to financial services. In addition to offering financial services companies a profitable, long-term business opportunity, the

expansion of financial services by using digital technology for finance will close their investment throughout technological innovations gaps, empower women, lower poverty, and contribute to the creation of stronger, less corrupt institutions (Tafesework, 2020). (Chowdhury & Emon, 2023) Due to a lack of established financial institutions, people in less developed and emerging countries rely on unofficial financial services; lacking financial access, economic growth is weaker and wealth disparity increases.

The following research question was be well-thought-out in this study in accordance with the research problem: What is the impacts of digital finance on financial inclusion in East African countries? And purpose of this study foremost goal is to empirically investigate impact of digital finance on financial inclusion in East African countries.

## **2. Literatures Review**

### **2.1 Concept and definition of digital finance**

Financial services offered through mobile devices, mobile wallets, personal computers, the internet, debit cards, and credit cards that are connected to a dependable digital payment system are collectively referred to as digital finance (DF)(Durai & Stella, 2019). Digital finance's effects on financial integration in Kenya's banking sector As a result of banking institutions implementing digital financial services to reduce operational costs related to opening and operating divides in order to increase their earnings and financial efficiency, the research study determined that the use of digital finances has not been associated with financial inclusion in Kenya's banking sector (Michelle, 2016). The term "digital financial inclusion" describes the use of technical developments to increase the general public's access to official financial services provided by commercial and universal banks. Prior research has demonstrated that elements of inclusion in digital financial services include digital financial access and usage (Banna. B and Roy, 2023). **Digital currencies:** Digital currencies, like crypto-currencies, are new forms of money and decentralized payment systems that log transactions on an open ledger. These systems use cryptography to justify transactions.

The term "**digital financial inclusion**" describes the underprivileged and excluded population's use of and access to formal financial services via digital means. Put another way, it's a way to verify that vulnerable populations like low-income earners and members of weaker sections can affordably access financial services and products (bank user accounts, remittance and payment

services, financial advisory services, etc.) and sufficient credit when needed (Durai & Stella, 2019). According to (Koch & Siering, 2017), there are three key components of financial inclusion: the availability of financial services, the use of those services, and the caliber of those services as well as their delivery. The **digital economy**, defined by (Atkinson & Kay, 2007), is the ubiquitous use of IT (hardware, software, applications, and telecommunications) in all facets of the economy, including business, government, and nonprofit operations internally; transactions between organizations; and deals between individuals acting as both consumers and citizens, as well as organizations. **Fin-tech**, as defined by(Alt et al., 2018), is the fusion of technology and the application domain of finance. Technology for finance is a way to do jobs more effectively, organize items, and coordinate procedures. On the other side, the financial industry is made up of several businesses that offer financial services to various clientele, including bankers and non-bank financial institutions. It suggests that fin-tech refers to the efficient ways, whether digital or analog, that the financial services sector organizes its operations, manages its procedures, and completes its tasks. The history of the **banking system** dates back to the 13th century, where a team of Italian goldsmiths moved to what is now known as Lombardy Avenue in London after an Italian region called Lombardy. Before the seventeenth century, these goldsmiths developed a system of transactions that, via a number of revolutions, inventions, and reforms, gave rise to the current banking system (O et al., 2015). It is evident that the gold-smith hobby has developed into a thriving industry and profession. Which provide digital finance a wider definition, such as the fact that it facilitates and serves as a conduit for effective social and green finance(Ozili, 2021).

## 2.2 Theoretical Review

For the purpose of explaining financial inclusion and the acceptance of digital finance, the innovation acknowledgment model, the theory of financial developments, and the variability of development hypothesis will be used.

### 2.2.1.1 Financial Revolution Theory

(Silber 1983) developed the concept of financial innovations, which is based on the notion that the main driver of financial inclusion is the extension of foundations associated to money(Ju et al., 2010). According to the hypothesis, the main inspiration for new inventions comes from the financial industry's flaws, which mostly include erroneous data, overhead costs, and exchange rates(Błach, 2011). The theory states that financial innovations can take the form of completely novel solutions or just conventional ways of offering the newest advancements, increasing firms'

liquidity and attracting a greater number of new applicants based on their suitability for the position(Ionescu, 2012). The theory states that innovation in finance is a key driver of the financial system, improving economic advantage from frequent and novel changes as well as economic competence. One tool for managing, transferring, and solving the whole additional burden is innovation. Through better allocation, increased efficiency, and a decrease in financial and administrative costs, the use of innovations fosters the growth of financial firms (Sekhar, 2013). Financial innovations are those that result in new methods of production, technological advancements, higher return rates, and an overall improvement in the nation's economy.

### **2.2.1.2 Theory of Transmission of Innovation**

The TOI theory investigates the mechanisms by which novel concepts are transmitted from one generation of humans to the next. The TOI hypothesis states that innovations are continuously shared among people who hold similar social views through a variety of channels (Abdelghani & Aziz, 2013). According to diffusion theory, the following factors are critical to the establishment of innovation implementation: total benefit, companionable, simplicity, trials, and ease of detection. According to (Abdelghani & Aziz, 2013), TOI also categorizes users as modernizers, early modernizers, timely mass, late mass, and stragglers. The goal of TOI theory is to clarify and provide examples of the processes by which digital financial services innovations are embraced and eventually succeed.

### **2.2.1.3 Classical of Technology Recognition**

Davies originally presented the technology acceptability model in 1986. This model was created to predict users' adoption of IT and willingness to use it in a work environment. Perception of Ease of Use and PU, or perceived usefulness, are two factors that influence customers' decisions when new technology advancements are offered. technology acceptability model contends that perceptions, not actual system usage, are what matter (Lule et al., 2012). According to the technology acceptability model, each user's behavioral purpose for system usage determines the system's actual utilization, which is influenced by each user's perception of the system. The idea also describes how a new technology's perceived usefulness and system simplicity are directly related to each other. The hypothesis also suggests that suspicions or acknowledgments of the advancement play a crucial role in enhancing the mental states that eventually lead to behavior related to system usage (Lim & Ting, 2014).

### 2.3 Empirical Review

(Menza et al., 2024) This study's methodology entails gathering information from Ethiopia's nine commercial banks between 2015 and 2020 in order to look into how financial technologies affect financial inclusion. Financial technologies used in the study included internet, mobile, ATM, point-of-sale, and agent banking. The total number for account users served as a proxy for financial inclusion. The number of holders of accounts was the dependent variable, and the study involved testing the statistical importance of several independent variables on it using data panel estimation techniques. (Banna. B and Roy, 2023) Measuring fintech-driven financial inclusion for developing countries using Panel data with GMM. The result shows how significantly technology-driven financial inclusion has impacted previously non-banking people's utilization of official banking and non-banking banking services. (Saraswati et al., 2020) The effect of financial inclusion and financial technology on effectiveness of the Indonesian monetary policy using the Vector Error Correction Model (VECM) for time series data. The findings show that the degree of financial inclusion has an impact on the inflation rate, which serves as a short- and long-term proxy for the success of Indonesian monetary policy. (Thaddeus & Ngong, 2020), Financial inclusion via the internet and economic development in Sub-Saharan Africa, using a Granger causality test and a vector error correction model. The study also emphasizes the necessity of appropriate awareness-raising and literacy initiatives in order to increase access to financial services. (Dara, 2018) Digital Financial Inclusion for Income Inequality and Poverty Alleviation in Developing Economies and by using Cross-sectional data analysis method. The decisions have policy implications for enhancing financial inclusion and lowering income disparity and poverty in emerging nations. (Lyons et al., 2020) Impacts of Financial and Digital Inclusion on Poverty in South Asia and Sub-Saharan Africa, Robustness checks for endogeneity and selection are conducted. The results show the significance of digital financial services in supporting and maintaining the elimination of poverty in emerging nations and offer compelling evidence for the ongoing growth of conventional and non-traditional financial services. (Tariq et al., 2022) Quantitative secondary yearly information gathered from the World Bank's World Development Indicators is used in the study. Ten emerging Asian countries' panel data over 2015 to 2021 is analyzed in this study. One of two models fixed or random effects is used to analyze the data. The study's conclusion is that whereas bank accounts have a strong positive link with CO2-EMS, mobile banking transactions, teller machines that are automated, and financial institution branches have a large negative relationship.

The report recommends that in order to achieve both economic prosperity and environmental sustainability, authorities should concentrate on expanding digital financial inclusion.

(Al-Smadi, 2023) The study examines the connection during digital finance and economic prosperity using information collected from 12 MENA nations between 2004 and 2020. Three sub-indices access to banking services, accessibility of banking offerings, and utilization of financial services combine to form the composite index used in the study to quantify FI. The amount of ATMs for every 100,000 people is used to calculate DF. In addition, five control factors are chosen in order to assess their impact on FI. Because the sample of nations in the study has country-specific effects, using system-generalized approach to moment is used. To make sure the results are robust, a number of tests are run, including the Sargan test, Arellano and Bond's test, multi-col-linearity test, and unit-root test.

### **2.3.1 Stylized Facts**

(Ebong & George, 2021) potential to improve financial inclusion through the use of digital financial services (DFS). The results indicate that, while mobile banking penetration is critical for quickening the pace of financial inclusion, further channel innovations are required to capitalize on the expansion of mobile money and strengthen the role of banks in advancing financial inclusion. In this study there is a geographical gap and miss internet banking. Diverse estimation techniques were used, indifferent time those are: a generalized method for moment (GMM) (Vitenu-sackey & Hongli, 2020), regression panels with fixed or random (Pandey et al., 2023), vector Error Correction model (VECR) models (Saraswati et al., 2020), and (Haoudi, 2020) used cross sectional model. The connection between the developed and developing worlds, despite much focus on the former, is still up for debate. Still, a mixed bag of consistent and variable outcomes was noted and to filling the gaps of methodology. (Menza et al., 2024) This study's methodology entails gathering information from Ethiopia's nine commercial banks between 2015 and 2020 in order to look into how financial technologies affect financial inclusion. Financial technologies used in the study included internet, mobile, ATM, point-of-sale, and agent banking. Nevertheless, it was discovered that online banking had a negligible and unfavorable impact on financial integration in Ethiopia, defying the theory which that opposite finding with (Thaddeus & Ngong, 2020), indicate internet banking results.



### 3. Methodology

The main duty of this research is to choose a research methodology. When chosen, a technique must be able to both address the subject of the study at hand and be consistent with the research statement. This research is exploratory and deductive. The goal is to assess the digital finance impact on financial inclusion in East African countries by using secondary data which collected from WW and IMF for fifteen years(2008-2022). Panel data method and fixed effect model is employed.

Table 1 Components and dimension of FII and Digital Finance

No.	Components of FII	Dimension of FII
1.	Number of deposit accounts (per 1,000 adults)	Access
2.	Total number of commercial bank branches (per 100,000 adults)	Availability
3.	Number of a commercial bank borrowers per 1,000 adults	Usage
	<b>Components of Digital Finance</b>	<b>Dimension of Digital Finance</b>
1.	Fixed broadband subscriptions(FBBS)	Access
2.	Fixed telephone subscriptions (per 100 people)(FTS)	Availability
3.	Mobile cellular subscriptions (per 100 people)(MCS)	Usage
4.	Skill and ICT knowledge( measured by literacy using primary completion rate)(PCR)	Quality

Note: calculation using by using principal components analysis.

The model's fundamentally useful form:

$$Y_{ij} = \beta_0 + \beta_1 X_{ij} + \alpha_i + \epsilon_{ij} \quad (1)$$

Where as:

$Y_{ij}$  = represents the value of the dependent variable, measuring financial inclusion for the  $i$ th state and  $t$ th period.

$\beta_0$  = is the intercept term, showing the value of FII, when all the coefficient of the independent variables are zero

$\beta 1$  = the matrix of explanatory variables of financial inclusion

$X i j$  = is the vector of associated parameters

$\alpha i$  = is treated as fixed parameters in fixed effects model.

$\varepsilon i j$  = is the disturbance term/ error term of an FII i at time t.

Economtric model:

$$FII_{it} = \beta_0 + \beta_1 FBBS_{it} + \beta_2 FTS_{i,t} + \beta_3 MCS_{it} + \beta_4 PCR_{it} + \varepsilon_{it} \text{ --- --2}$$

Based the above question to check which components of digital finance impact on financial inclusion index before to see the digital finance imapct on financial inclusion index because of that the above equation is designed. The analysis's goal is to determine which aspects of digital finance have a major impact over the Financial Inclusion indexes (FII) beforehand evaluating the industry's overall influence on financial inclusion. Through an analysis of mobile cell phone subscriptions (MCS), fixed broadband subscriber (FBBS), fixed telephone subscribers (FTS), and principal completion rate (PCR), the research investigation seeks to identify the digital infrastructure components that are most important for improving financial inclusion.

$$FII_{it} = \beta_0 + \beta_1 DFI_{it} + \beta_2 ATM_{i,t} + \beta_3 IUI_{it} + \beta_4 INF_{it} + \beta_5 POD_{it} + \beta_6 RPG_{it} + \beta_7 INC_{it} + \beta_8 DCP_{it} + \varepsilon_{it} \text{ --- --3}$$

Where:

*Table 2: Independent Variables for financial inclusions*

Variables	Measurement	Code of variables	Unit
Digital finance	Principal components analysis	DF	Percentage
Automated teller machines	Account ownership	ATM	Automated teller machines per 100,000 adults.
Network	Individuals using internet	IUI	Percentage of population
Inflation	Inflation rate	INF	Annual percentage
Population density	Population density	PD	People per square kilometers of land area
Rural Population	Rural Population growth	RPG	Rural People per square kilometers of land area
Income	Wage and salary of worker	INC	Percentage of total employment
Domestic credit private sectors	Financial resources by corporation	DCP	Percentage of GDP

## 4. Empirical Result and Interpretation

### 1.1 Introduction

This study's primary goal is to find out how digital finance affects financial inclusion in Eastern African nations. This chapter provides a comprehensive explanation of the conclusions, data analysis, outcomes, and discussions that align with the goals of the research. There are three main sections to the chapter. the first description of the variables that are dependent and independent, the second correlation analysis, the third regression result, and the detailed interpretations.

### 4.2 Descriptive statistics for both dependent and Independent variables

Digital Finance's Effect on Eastern Africa's Financial Inclusion nations that participated in this study's financial inclusion dependent variable. The financial inclusion index, as per (Sharma and Paris, 2008), is determined by various dimension variables and has been cut down to three in this study: the overall amount of branches of commercial banks per 100,000 adults, which indicates the availability of banking services; the total amount of deposit accounts per 1,000 adults, which indicates bank penetration; and the number of a commercial bank borrowers per 1,000 adults, which indicates the use of banking systems by calculating principal component analysis. Based on an overall amount of 135 observations, Table 2 displays the descriptive statistics as a result of the combined explained and explanatory factors for the chosen East African countries between 2008 up-to 2022. Summary of descriptive statistics is shown, including number of measurements, mean, standard deviation, and minimum and maximum values of the dependent variable. ATMs, internet-based networks, digital finance, inflation, density of population, rural population growth, income, and bank domestic credit to the private sector are independent variables and factors that affect financial inclusion. The total number of measurements, mean, standard deviation, and lowest and maximum values of the study's variables are displayed by the descriptive statistics. The standard deviation quantifies how far or near the results are from the mean, while the mean value indicates the typical value of the variables. The study's value range is indicated by the maximum and minimum.

Table 3: Descriptive statistics for both dependent and Independent variables

Summarize FII DF AMT IUI INF PD RPG INC, DCP

Variables	Observation	Man	Std. Dev.	Min	Max
FII	135	0.1133333	0.7812767	-1.555315	1.729925
DF	135	-4.44e-09	1.000001	-1.846987	2.809177
ATM	135	4.114074	3.363034	0.07	16.63
IUI	135	12.80016	13.62836	0.45	68.86318
INF	135	20.90485	50.74174	-6.687321	379.9996
PD	135	154.7483	165.7018	13.49547	558.4656
RPG	135	2.079181	1.130748	-4.069908	5.089191
INC	135	24.83332	13.66886	8.499292	48.67123
DCP	135	16.70456	8.870058	0.267842	42.23333

Source: STATA 18.0 Results, 2024

The study's nine Eastern African countries (EAC) had an average Financial Inclusion Index (FII) mean value of 0.1133333 throughout the period of 2008 to 2022. This indicates a low level of financial inclusion in these countries. According to various theories (Sarma and Pais (2008, 2011); (Sarma, 2015); (Sarma 2016); (Kumar and Mishra 2009), and (Tuesta and Camara2014), zero indicates no financial inclusion, while 0.3 under X less than or equal to 0.6 shows medium level financial inclusion, and 0.6 less than X less than or equal to one indicates high level financial inclusion. Therefore Eastern African countries (EAC) had an average Financial Inclusion Index (FII) mean value of 0.1133333 throughout the period of 2008 to 2022 which show that low level of financial inclusion. Comparative analysis of the medium level mean financial inclusion ratios in East Africa countries, including Kenya, Ethiopia, and Djibouti, revealed that these nations are medium level of financial inclusion and others are low level of financial inclusion. Among the East African countries included in the analysis, the yearly financial inclusion ranged from a minimum of -1.555315 to a maximum of 1.729925, with an average variation of 0.7812767.

There are 135 observations for every explanatory variable that is anticipated to have an effect on financial inclusion. A number of value components, including fixed-line broadband memberships (per 100 individuals), fixed cellphone memberships (per 100 individuals), cellular phone service (per 100 individuals) skill and ICT knowledge (which measures literacy using primary completion rate) are included in the calculation of digital finance value. These components were calculated using the principal component analysis method. The mean value of 0.00000444 indicates that there was negative use of digital finance in the Eastern African countries (EAC) from 2008 to 2022. This implies that digital finance in EAC is like infant age in the region. However, in terms of digital money usage, Kenya leads the pack, Ethiopia is in the middle, and the rest lag behind. The EAC's Digital Finance varies from the mean by 1.000001, with the largest value in the region being 2.809177 and the minimum being -1.846987. From 2008 to 2022, the average score for automated teller machines is 4.114074. The outcome of the descriptive statistics also displays a minimum value of 0.07 and a maximum value of 16.63, respectively. This suggests that automated teller machines (ATMs) are given greater weight than proportionate financial inclusion, which will greatly enhance financial inclusion policies in the area and within the region, the variance from the mean is 3.363034. The typical score for the period, as reported by the individual utilizing the internet, is 12.80016. The outcome of the descriptive statistics also indicates the lowest and maximum values, which, respectively, are 0.45 and 68.86318 and represent the various levels of financial inclusion in the East African countries.

### **4.3 Correlation Analysis**

To make sure that the explanatory variables are correlated, a matrix of correlations is utilized. According to (Cooper & Schindler, 2009), which (Bedada, 2020) cited, a coefficient of correlation over 0.8 between explanatory factors indicates a multi-co linearity problem and should be investigated. According to (Brooks 2008), the degree of linear relationship between two variables is measured by their correlation. In order to examine the relationship between the dependent variable, financial inclusion, and the independent variables, population density, growth in rural areas, income, domestic credit from private sectors (GDP), digital finance, automated teller machines, individual Internet users, inflation, and so on, the study used the product time of correlation coefficient.

Table 4 Correlation Analysis

	FII	DF	ATM	IUI	INF	PD	RPG	INC	DCP
FII	1								
DF	0.46***	1							
ATM	0.56***	0.53***	1						
IUI	0.43***	0.38***	0.74***	1					
INF	0.05	-0.23**	-0.03	-0.12	1				
PD	0.38***	0.11	-0.19*	-0.15	0.07	1			
RPG	-0.1	-0.07	-0.21*	-0.28**	0.08	0.26**	1		
INC	0.58***	0.40***	0.68***	0.61***	-0.28**	-0.16	-0.11	1	
DCP	0.69***	0.31***	0.36***	0.24**	0.17*	0.27**	-0.05	0.32***	1

\*\*\* p<0.01, \*\* p<0.05, \* p<0.1

Source: STATA 18.0 Results, 2024

Table 3 above confirmations that the financial inclusion index has positive correlation with digital finance, automatic teller machine, individual using internet, inflation, population density, income and domestic credit private sectors. And has negative correlation with rural population growth. The digital finance has a negative correlation with inflation and the growth of the rural population, while the digital finance has a positive correlation with ATM usage, individual Internet users, population density, income, and domestic financing from private sectors (GDP). Inflation, population density, and rural population growth have negative correlations with automated teller machines, but individual Internet users, income, and GDP from the private sector have favorable correlations. There is a positive link between individual Internet users and inflation, income, and GDP from the private sector. However, there is a negative correlation between individual Internet users and density of population and rural population growth. Income has positive correlation coefficient to the Inflation and domestic credit from private sectors (GDP), population density and rural population growth whereas it has negative correlation coefficient to the Inflation. Domestic credit from private sectors (GDP), and rural population growth has positive correlation coefficient to the population density and income whereas it has negative correlation coefficient to the population density. Domestic credit from private sectors (GDP), and income whereas it has negative correlation coefficient to the rural population growth. Income and GDP (private sector domestic credit), however there is a favorable association.

#### 4.4 Analysis of regression outcomes

##### 4.4.1 Impact of Digital Finance on Financial Inclusion regression analysis

The following table shows that there is a statistically significant negative correlation between East African countries' financial inclusion and their use of the internet, income growth, population density and rural population growth. However, there is a statistically significant positive correlation between financial inclusion and digital finance and automated teller machines. Stated differently, R-squared is a useful metric for determining how well a suggested model incorporating explanatory factors truly explains fluctuations in the variables that are dependent (Brooks, 2008). With an R-squared of 62%, the expected outcome of the fixed effect modeling is at a pretty decent level. Nevertheless, other variables not included in the regression line account for the remaining 38% of the variation in the Financial Inclusion regression model. A clear rejection of the null hypothesis is possible in this regression model, as demonstrated by the F-statistics that were used to gauge the model's overall test of significance. The model fits the data well at the 1 percent significance level because the p-value was 0.000000, which is appropriately small. As per the Haus-man test results below, the model with fixed effects is deemed suitable for regression analysis in this particular study.

Test of H0: Difference in coefficients not systematic

$$\begin{aligned} \text{chi}^2(7) &= (b-B)'[(V_b - V_B)^{-1}](b-B) \\ &= 36.55 \end{aligned}$$

Prob > chi2 = 0.0000

Table 5 Regression results of components digital finance impact on Financial Inclusion

The goal of this analysis is to identify which components of digital finance have a significant impact on the Financial Inclusion Index (FII). By examining variables such as fixed broadband subscriptions (FBBS), fixed telephone subscriptions (FTS), mobile cellular subscriptions (MCS), and primary completion rate (PCR), the study provides insights into how various aspects of digital infrastructure contribute to financial inclusion. The findings reveal that mobile cellular subscriptions (MCS) and fixed telephone subscriptions (FTS) display a strong and statistically significant positive impact on FII, underscoring the importance of connectivity through mobile and fixed-line services in enhancing financial inclusion. In contrast, fixed broadband subscriptions (FBBS) and primary completion rate (PCR) do not show a direct significant effect, indicating that while these factors remain relevant, their influence on financial inclusion may depend on



additional policies or broader integration with financial systems. The analysis places of interest the importance of prioritizing investments in mobile and fixed-line infrastructure to foster financial inclusion.

Variables	(1) FII
FBBS	0.108 (0.999)
FTS	0.663*** (6.070)
MCS	0.0173*** (6.076)
PCR	0.000871 (0.225)
Constant	-1.411*** (-3.898)
Observations	135

Z-statistics in parentheses

\*\*\* p<0.01, \*\* p<0.05, \* p<0.1

Table 6 Regression results for the Financial Inclusion

VARIABLES	(1) FII
DF	0.139** (2.216)
ATM	0.135*** (8.061)
IUI	-0.0178*** (-5.155)
INF	0.00842* (1.697)
PD	4.33e-08*** (8.234)
RPG	-0.0668*** (-3.165)
INC	-0.0573*** (-3.350)
DCP	0.00606 (0.927)
Constant	-0.488 (-1.112)
Observations	135
Number of Country	9
R-squared	0.622

T-statistics in parentheses  
 \*\*\* p<0.01, \*\* p<0.05, \* p<0.1

Source: STATA 18.0 Results, 2024

#### 4.4.2 Regression analysis and results interpretations

The following discussion pertains to each independent variable's interpretation based on the model result above. For the study period, having a higher percentage of digital finance promotes financial inclusion for East African countries, as indicated by the positive coefficient of digital finance (0.1389) and statistical significance at 5%. In other words, if digital finance is increased by one unit, financial inclusion will grow by the same coefficient, rejecting the null assumption of digital finance has a detrimental impact on financial inclusion in East African countries. According to (Ozili, 2018), (Ugwuanyi & Efang, 2020), (Yue et al., 2022), (Tariq et al., 2022), and (Rahman, 2023) research, the outcomes are consistent. This suggests that in East Africa, the majority of the population would need access to digital money for financial inclusion to occur.

Automatic Teller Machines (ATMs) track how many East African nations provide their clients with high-quality services. Every nation in East Africa is active in the way that it provides ATM credit services to a sizable consumer base. The Automatic Teller Machines' coefficient is significant (0.135) and statistically important at 5%, meaning that for every unit increase in Automatic Teller Machines, Financial Inclusion increases by a factor of 0.135. The results align with the findings of (Ebong & George, 2021), (Neelam & Bhattacharya, 2022) and (Banna. B and Roy, 2023) and the result is contradicted with the findings of (Ugwuanyi & Efanga, 2020) according to this author financial inclusion and automatic teller machine have negative relationship which contradicted with this study. Demonstrates the positive correlation between an extensive client base and automated tellers, which is important for financial inclusion. Therefore, researcher rejected the null hypothesis, which was developed to demonstrate the lack of a meaningful association between Automatic Teller Machine and the Financial Inclusion of Eastern African Countries, based on the study's regression result. When comparing a network's use of the internet to financial inclusion, a decline is generally seen as desirable as it means increased efficiency. The reasoning behind this is that as more people use financial inclusion, the efficiency of the network for customer's decreases. This puts East African countries at risk because they must prioritize making network installation easier and taking ICT into account while considering financial inclusion. The financial consequences of the integration for East African countries can be ascertained by analyzing the regression outcome for the network using the internet, which demonstrates a substantial negative correlation and a fall in FII of -0.0178211 for every unit rise in IUI. This suggests that there is proof that the financial inclusion of East African nations depends on their internet-based network's ability to quickly cover the financing system. Nonetheless, a different study's results for this variable showed a strong, substantial negative association with financial inclusion. This result is consistent with those of (Michelle, 2016) and (Risman et al., 2021), which demonstrate that the use of the internet by a network has a substantial negative association with FII of EAC and (Evans & Adeoye, 2016), (Abel et al., 2018), (Lyimo & Academy, 2022) and (Agrawaal, 2022) shows that contradicted with this finding in case of sign relationship in this study. Therefore, the null hypothesis that there is no link at all between the FI and the IUI is rejected. The population density coefficient for the study period is significant (0.00000433) and is statistically significant at 5%, suggesting that a higher percentage of assets in a given density boosts the financial status of East African countries. In other words, raising population density by

one unit results in a coefficient-based gain in financial inclusion, rejecting the null assumption that population density significantly lowers financial inclusion in East African nations. This outcome is in line with studies by (Evans & Adeoye, 2016), (Uddin et al., 2017) and (Abel et al., 2018) which show that FII of EAC is significantly positively correlated with population density. The outcome (Le et al., 2019) findings are at odds which it indicate insignificant and negative for financial inclusion. This suggests that the population density in the area where they operate determines the financial sustainability of their inclusive influence. The term "rural population" describes the number of people who live in rural areas as reported by national statistics offices using data from the International Monetary Fund (IMF) for all nations worldwide. It is determined by subtracting the population of urban areas from the total population. The statistical significance level at 5% for rural population development coefficient  $-0.0667619$  during the study period, indicating that a greater degree of inclusion of money in a particular rural population growth enhances the financial standing of East African nations. Stated otherwise, the null hypothesis that rural population increase considerably reduces the level of financial inclusion in Eastern African countries is rejected when increasing rural growth in population by one unit, leading to a coefficient-based decline in financial inclusion. The results of this study conflict with those of (Yue et al., 2022), which show that financial inclusion is significant and improving. This indicates that the rate of growth in the rural population in the region where they operate is increasing by one unit, while the rate of financial inclusion is decreasing by a coefficient of  $-0.0667619$ . Significant at 5%, the income coefficients for the research period is negative ( $0.0572836$ ), indicating that a greater proportion of assets in a given income improves East African countries' financial situation for infrastructures, contrary to what the relationship indicates. Stated differently, an increase of one unit in income is associated with a coefficient-based decline in financial inclusion which the result is contradicted with the findings of (Sarma & Pais, 2011), (Zins & Weill, 2016) and (Abel et al., 2018) this because of different factors that researcher suggesting Often, inclusive progress is hampered by structural barriers in underdeveloped nations.

#### **4.5 Robustness Check**

Robust check is a technique used in empirical studies, including economic statistics as well as statistical evaluation, to evaluate the stability and dependability of a study's primary findings or conclusions. It entails determining if the results are consistent with alternative hypotheses, models,

or data requirements. standard component of high-quality research is robustness checks, which show how comprehensive and resilient the findings are to change or other circumstances. Several related checks were carried out in the present investigation in order to properly accomplish the robustness. The hypothesis was initially re-estimated using the fixed-effects modelling strategy, and what happened appears with the estimator follows. The findings show that digital finance along with the proposed financial inclusion index have a significantly positive influence.

**Table 7. Robustness check**

VARIABLES	(1) FII Robust check
DF	0.456*** (2.212)
ATM	0.104** (2.076)
IUI	-0.0121** (-1.918)
INF	0.00662* (2.064)
PD	-0.00487 (-1.210)
RPG	-0.0460*** (-6.575)
INC	-0.0456 (-1.366)
DCP	0.0214*** (2.444)
Constant	1.238 (1.207)
Observations	135
Number of Country	9
F	1521

Robust t-statistics in parentheses \*\*\* p<0.01, \*\* p<0.05, \* p<0.1

Source: STATA 18.0 Results, 2024

Notes: Model 1 is estimated by the approach of the robust fixed effect panel regression. The numbers in parentheses are robust t- statistics, and \*\*\*, \*\*, and \* denote the significance level of 1%, 5%, and 10%, respectively.

#### 4.6 Conclusion

Conclusions of the study, derived from the data analysis, highlight the significant impact of various factors on financial inclusion in East African nations. The analysis of the empirical results reveals important understandings regarding the relationship between digital finance and financial inclusion in Eastern African countries. The study, which spans from 2008 to 2022 and includes nine East African countries, climaxes both positive and negative correlations between various factors affecting financial inclusion.

**Impact of Digital Finance Components on Financial Inclusion:**

- Fixed Telephone Subscriptions (FTS):** The coefficient of 0.663 for FTS is statistically significant ( $p < 0.01$ ), indicating a positive and strong relationship with financial inclusion. This suggests that access to fixed-line telephony plays a crucial role in supporting financial inclusion, likely due to its role in connectivity, which is essential for mobile and internet banking services.
- Mobile Cellular Subscriptions (MCS):** shows a significant positive impact (coefficient = 0.0173,  $p < 0.01$ ), reinforcing the importance of mobile connectivity in enhancing financial inclusion. Mobile phones are key platforms for digital finance services like mobile money, which are widely used in many East African countries.
- Impact Digital Finance on Financial Inclusion:** Digital Finance is the positive and statistically significant coefficient of 0.139 ( $p < 0.05$ ) indicates that higher levels of digital finance are associated with improved financial inclusion. This result is consistent with previous research (Ozili, 2018; Ugwuanyi & Efanga, 2020; Yue et al., 2022), affirming that digital finance positively impacts access to financial services.
- Automatic Teller Machines (ATM):** The availability of ATMs also has a positive and significant relationship with financial inclusion, with a coefficient of 0.135 ( $p < 0.01$ ). However, this contrasts with Ugwuanyi & Efanga (2020), who found a negative relationship between ATMs and financial inclusion.
- Internet Usage Index (IUI):** The negative coefficient of -0.0178 ( $p < 0.01$ ) suggests that higher internet usage, particularly for digital finance services, may reduce the efficiency of financial inclusion efforts. This result aligns with some studies (Michelle, 2016; Risman et al., 2021) but contradicts others (Evans & Adeoye, 2016; Agrawaal, 2022), who found a positive relationship between internet usage and financial inclusion.
- Income (INC):** The negative coefficient of -0.0573 ( $p < 0.01$ ) indicates that income growth does not correlate with improved financial inclusion in East African countries. This contradicts findings from high-income settings (Sarma & Pais, 2011; Zins & Weill, 2016), where higher income levels are generally linked with better financial inclusion outcomes.
- Rural Population Growth (RPG):** The negative coefficient of -0.0668 ( $p <$

0.01) suggests that rural population growth may hinder financial inclusion, likely due to the difficulties of providing financial services in rural areas. This challenges the expectation that rural population growth would drive greater financial inclusion. The robustness check, using the fixed-effects model, reaffirmed the following findings from the regression analysis: Digital Finance (DF) and Automatic Teller Machines (ATM) remain positively correlated with financial inclusion, with statistical significance at the 1% level for DF and 5% for ATM. Internet Usage Index (IUI) continues to show a negative relationship with financial inclusion, suggesting that inefficiencies in digital network coverage or usage could detract from financial inclusion efforts. Income (INC) and Rural Population Growth (RPG) retain negative coefficients, consistent with the regression analysis. Finally, the robustness check supports the main results, confirming the stability of the findings and the generalizability of the conclusions across different model specifications.

Therefore, the regression analysis confirms the significant positive impact of digital finance, ATMs, internet usage, and domestic credit on financial inclusion, while rural population growth and inflation have a negative effect. These results align with earlier findings from other studies, confirming the importance of technological advancements and financial infrastructure in improving financial inclusion in East Africa. The analysis clearly shows that connectivity through mobile cellular subscriptions (MCS) and fixed telephone subscriptions (FTS) has a strong and positive impact on financial inclusion in East Africa, which aligns with the growing importance of digital finance infrastructure. The findings indicate that investments in mobile and fixed-line telecommunication infrastructure should be prioritized to enhance financial inclusion. The coefficient for Digital Finance (0.139,  $p < 0.05$ ) is both positive and statistically significant, indicating that greater levels of digital finance are linked to enhanced financial inclusion. This finding aligns with prior studies (Ozili, 2018; Ugwuanyi & Efanga, 2020; Yue et al., 2022), confirming the positive role of digital finance in improving access to financial services.

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