

The Nexus between Digital Finance, Information and Communication Technology (ICT), and Financial Development in Developing Countries

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Abstract

In recent years, digital finance, particularly mobile banking, has become a key driver for financial sector development in developing nations by making financial services more accessible, affordable, efficient, and convenient, especially for underserved and unbanked population in remote areas. Therefore, this study aims to investigate the relationship between digital finance, ICT and financial development across 60 developing countries from the period 2004 to 2022. The study used system Generalized Methods of Moments (sysGMM) estimation approach. In addition, AR(2) and Hansen tests were applied to check the absence of second-order serial correlation and validity of instrument variables respectively. The regression results reveal that key factors, including number of mobile banking transactions, information communication technology, and their interaction, have a positive and significant impact on financial development in developing countries. Additionally, control variables such as foreign direct investment, trade openness, GDP per capita, government expenditure, and political stability also contribute positively to financial development. In contrast, inflation negatively affects the development of financial sector in developing nations. Based on the findings, governments and financial institutions are suggested to collaboratively work and invest more on digital finance platforms and ICT infrastructure to enhance the accessibility, quality, security, and efficiency of virtual financial services like mobile banking. This approach would support the effective integration of underserved and remote populations into the formal financial system, thereby fostering financial development in emerging economies.

Keywords

Digital Finance, ICT, Financial Development, System GMM, Developing Countries

1. Introduction

The history of digital finance can be traced back to the 1970s, marked by the advent of early electronic payment systems, including Automated Teller Machines (ATMs) and electronic funds transfer (EFT) systems, which laid the groundwork for modern financial technologies (Allen et al., 2002). However, the real shift began in the 1990s with the rise of the internet, which enabled online banking and e-commerce (Gomber et al., 2018). The early 21st century saw the emergence of mobile banking, driven by the rapid penetration of smartphones and mobile networks, particularly in developing countries (van der Boor et al., 2014). Mobile money services, such as M-Pesa in Kenya, were revolutionary in providing financial services to millions of unbanked individuals, thus boosting financial inclusion. The rapid evolution of information and communication technology (ICT) has also a profound role on the development of financial sector, by supporting how financial services are delivered, accessed, and utilized. This transformation is driven by the increasing adoption of mobile technology, internet penetration, and the expansion of fintech solutions (Gomber et al., 2018). Moreover, ICT has revolutionized the financial services industry by enabling faster transactions, reducing costs, and enhancing security. Mobile technology and cloud computing, in particular, have driven the growth of digital financial platforms.

ICT forms the backbone of digital finance by providing the necessary infrastructure for financial services to be delivered digitally. Mobile phones, internet connectivity, and digital platforms such as mobile banking apps, fintech services, and e-wallets are all products of ICT innovation. In developing countries, where traditional financial infrastructure (like brick-and-mortar banks) is limited, ICT enables people to access financial services remotely, often through mobile phones or the internet (Diniz et al., 2011). This allows previously unbanked populations to engage with formal financial systems, promoting greater financial inclusion. Therefore, digital finance, supported by ICT, plays a crucial role in promoting financial development by improving the accessibility, efficiency, and transparency of financial services. In developing countries, digital finance platforms reduce the transaction costs associated with traditional banking, expand access to credit, savings, and insurance products, and improve the speed of financial transactions (Ketterer, 2017). As a result, financial development occurs through the expansion of financial institutions and markets, deeper financial intermediation, and better risk management. This fosters a more inclusive and efficient financial system capable of supporting economic activity.

ICT infrastructure is a key driver of financial inclusion, especially in rural and

underserved areas (Mugisha, 2024). Secure digital platforms provide users with the ability to perform real-time transactions; increasing both the efficiency and accessibility of financial services the availability of internet connectivity, mobile networks, and digital devices is crucial to the expansion of digital financial services (Zandena, 2022). In developed economies, digital finance has transformed traditional banking through the rise of fintech, which includes services like peer-to-peer lending, robo-advisors, and blockchain-based transactions (Liang, 2023). In developing economies, it has primarily focused on improving financial inclusion by providing basic services such as payments, savings, and credit through mobile money platforms.

In developing countries, the intersection between digital finance, information and communication technology (ICT), and financial development is pivotal, as it underscores the transformative role of technology in broadening financial access and enhancing the efficiency of financial systems. ICT acts as a foundational enabler, providing the infrastructure and platforms necessary for digital financial services to operate effectively. By leveraging mobile networks, internet connectivity, and digital payment systems, ICT enables seamless transactions, promotes transparency, and reduces operational costs for financial institutions. This, in turn, empowers digital finance to significantly contribute to financial development by making financial services more accessible to underserved populations, including the unbanked and those in remote areas, thus fostering greater financial inclusion. Digital finance drives the modernization of financial markets and institutions by streamlining processes, facilitating real-time transactions, and improving risk management practices. Moreover, it enhances the scalability and reach of financial services, enabling institutions to offer more tailored, customer-centric solutions. The synergetic relationship between digital finance and ICT accelerates the growth of financial ecosystems, encouraging innovation and competition within the financial sector.

In today's world, digital finance plays a critical role in expanding access to financial services for all segments of the population. However, to the best of the researcher's knowledge, studies on how digital finance, ICT, and their interaction contribute to the development of the financial sector remain limited in the context of developing nations.

Therefore, this study was generally designed to examine the interplay of digital finance, ICT, and financial development on developing economies between the period 2004 and 2022. The study aims to assess how advancements in digital finance, enabled by the growth of ICT infrastructure, have influenced financial development, particularly in expanding access to financial services, enhancing financial market efficiency, and deepening financial institutions.

2. Literature Review

The relationship between digital finance, Information and Communication Technology (ICT), and financial development has been extensively explored in

academic literature, underscoring the transformative potential of technological innovations in reshaping the financial landscape. As the financial sector becomes more digitized, there is growing consensus that digital finance, supported by advancements in ICT, plays a pivotal role in promoting financial development, particularly by enhancing financial inclusion, market efficiency, and financial development (Khan et al., 2020). Individuals need to understand how digital finance works and be familiar with the ways it can be used. This includes knowing how to navigate digital financial platforms, ensuring the security of their transactions, and understanding the benefits and potential risks associated with these technologies. Such knowledge empowers individuals to make informed decisions and fully leverage the opportunities provided by digital finance. In this regard, The Technology Acceptance Model (TAM), developed by (Davis, 1989), is one of the most widely used theories to explain how individuals adopt and use new technology, including digital finance systems. TAM posits that two primary factors influence user acceptance of technology: perceived usefulness (PU) and perceived ease of use (PEOU). In the context of digital finance, this theory helps to explain how users come to accept and use financial technologies like mobile banking, digital wallets, or block chain systems. Users are more likely to adopt digital finance if they believe it will enhance their financial management and if the technology is easy to understand and use.

In developing countries, the ease of access to mobile financial services has driven higher adoption rates, especially in regions where traditional banking infrastructure is limited. Digital finance technologies, such as mobile payment systems like M-Pesa in Kenya, provide unbanked individuals access to financial services without the need for traditional banking institutions. According to TAM, this is largely because users perceive these technologies as useful for transferring and storing money safely and because they are simple to use on mobile devices. However, TAM also suggests that user education and familiarity with digital platforms are crucial for broader adoption, as individuals who perceive the technology as complex may be hesitant to embrace it fully.

Once digital platforms are developed, they should be diffused as widely as possible to ensure they are accessible to all members of society. In line with this, The Diffusion of Innovation Theory, proposed by Everett Rogers in 1962, explains how new ideas, technologies, and practices spread through societies over time. This theory is highly relevant to ICT and financial development, as it sheds light on how digital financial technologies are adopted by individuals and institutions across different stages of development. Rogers categorized adopters into five groups: innovators, early adopters, early majority, late majority, and laggards. In the context of digital finance, the diffusion of innovations can be seen in how mobile banking, crypto currencies, and block chain technologies have been progressively adopted across various regions and income groups.

For instance, diffusion of mobile payment systems like M-Pesa in Kenya started with innovators and early adopters who recognized the value of these technologies for streamlining payments and improving financial inclusion (Kingiri & Fu,

2019). Over time, as the benefits of these systems became more evident, more users adopted the technologies, leading to widespread use. In developing countries, the role of early adopters is crucial, as they often act as opinion leaders who influence the decisions of the early majority. ICT infrastructure, such as mobile networks and internet access, plays a significant role in the speed of diffusion. The theory also highlights barriers to adoption, such as low financial literacy, lack of trust in digital platforms, and regulatory hurdles. For financial development to be successful, governments and institutions must address these barriers to encourage broader adoption of digital finance technologies, particularly in underserved populations.

One of the most frequently cited advantages of digital finance is its ability to promote financial inclusion, a key component of financial development. ICT has enabled the creation of mobile banking, digital payments, and online financial services, thereby extending financial access to traditionally underserved populations (Donner & Tellez, 2008). ICT infrastructures, particularly mobile and internet networks significantly expand the reach of financial services in developing countries. In countries like Kenya, mobile money services such as M-Pesa have revolutionized the financial landscape, providing millions with access to financial services for the first time. The widespread adoption of digital finance products in these regions demonstrates the power of ICT to overcome geographical and infrastructural barriers, creating a more inclusive financial system (Jack & Suri, 2011).

ICT has also been credited with improving the efficiency of financial markets by enhancing data accessibility, reducing transaction costs, and promoting transparency. ICT-driven innovations like block chain, automated trading systems, and real-time data processing reduce information asymmetries and transaction frictions, making markets more efficient (Staszkiwicz et al., 2021). Efficient financial markets are a critical component of financial development, as they enable better resource allocation, reduce costs for market participants, and promote deeper market integration (Estrada et al., 2010). The role of ICT in fostering such efficiency cannot be overstated. Block chain, for instance, has emerged as a disruptive technology that offers enhanced security and transparency in financial transactions, thus improving market trust and integrity (Estrada et al., 2010).

Together, these theories provide a comprehensive understanding of how digital finance, ICT, and financial development intersect. The Technology Acceptance Model (TAM) highlights the factors influencing user adoption of digital finance technologies, emphasizing the importance of perceived usefulness and ease of use. The Diffusion of Innovation Theory explains how digital financial technologies spread through societies, emphasizing the role of early adopters and the importance of overcoming barriers to adoption. These theories are crucial for understanding the ongoing transformation of the financial sector, particularly in developing countries, where digital finance has the potential to enhance financial inclusion and spur economic growth.

3. Empirical Review

Several scholars have studied the interplay between digital finance, information

communication technology (ICT) and financial development. Among others, [Jack and Suri \(2011\)](#) conducted a comprehensive study on M-Pesa, showing that mobile money significantly increased financial inclusion by providing access to basic financial services for millions of previously unbanked individuals. Their study also revealed that M-Pesa contributed to financial development by increasing savings rates and facilitating more efficient money transfers within the country. These findings underscore how digital finance, supported by ICT infrastructure like mobile networks, can drive financial development by broadening access to financial services. Similarly, [Donovan \(2011\)](#) found that mobile networks and internet access play a crucial role in determining the reach and effectiveness of digital financial services in developing countries. The research highlighted those countries with better ICT infrastructure experienced faster financial development, as digital finance platforms (mobile banking, online banking, and fintech applications) rely on this infrastructure to operate efficiently. Donovan's findings suggest that ICT investments, such as expanding mobile networks and increasing internet penetration, are critical for fostering financial development, particularly in rural and underserved regions.

[Gomber et al. \(2017\)](#) examined fintech applications, such as peer-to-peer lending and digital payment platforms, and their impact on financial market efficiency in developing countries. They found that fintech innovations, enabled by ICT advancements, reduce transaction costs, increase access to credit, and enhance the speed of financial transactions, all of which contribute to more efficient financial markets. Their empirical findings also indicate that fintech helps to overcome the limitations of traditional banking systems in developing countries, thus promoting financial development by providing alternative channels for financial services. [Weil and Mbiti \(2016\)](#) also empirically examined the role of mobile money in reducing the urban-rural divide in access to financial services in Kenya. Their research showed that the widespread availability of mobile money services, facilitated by ICT, allowed rural populations to engage with formal financial systems, promoting more equitable financial development. Their empirical data indicated that rural users of mobile money were more likely to save and invest, which contributed to greater financial sector participation in previously underserved areas. This study highlights the crucial role of ICT in enabling digital financial services to reach remote and rural areas, thereby supporting broader financial development across geographic divides. Moreover, [Pradhan et al. \(2021\)](#) used empirical data from India to explore the relationship between ICT penetration, digital finance, and financial development. They found that the rollout of ICT infrastructure, especially mobile networks and internet access, facilitated the rapid growth of digital financial platforms, including mobile banking and digital payments. Their findings showed that digital finance significantly increased financial inclusion in India, contributing to overall financial development. Furthermore, the study concluded that ICT plays a key role in creating the necessary conditions for digital finance to thrive, emphasizing the interdependence between ICT and

financial development. While many empirical studies highlight the positive effects of digital finance and ICT on financial development, some research points to the challenges and gaps in regulation. Arner et al. (2017) examined the regulatory responses to the growth of digital finance in emerging markets and found that although digital financial services accelerate financial development, they also introduce new risks. Their research pointed out that countries with weak regulatory frameworks struggle to manage risks related to digital finance, such as cyber security threats, fraud, and systemic vulnerabilities. This study suggests that while digital finance and ICT can drive financial development, these benefits must be carefully balanced with regulatory measures to ensure financial stability.

Mugabe et al. (2024) examined the relationship between ICT development, innovation diffusion, economic growth, and human capital development across East African nations from 2000 to 2020. Using Dynamic Ordinary Least Squares (DOLS) and the Panel Vector Error Correction Model (VECM), the study finds that ICT significantly enhances sustainable economic growth and human capital, though the impact of innovation diffusion remains comparatively smaller. The findings emphasize the need for policy support in ICT and innovation to promote economic resilience and human capital development in the region. Yao (2023) investigated the impact of digital finance on the resilience of open urban economies, highlighting its role in fostering economic innovation, optimizing economic structure, and promoting social inclusivity. The study concludes that digital finance bolsters urban economies by enhancing adaptability to risks, reducing poverty, and improving the quality of life through greater financial inclusiveness. Recommendations are made for leveraging digital finance strategies to support stable urban economic growth amid uncertainties. Wu (2022) further explored the digital finance innovation by platform enterprises in China and the U.S., focusing on electronic and digital currencies. In China, electronic money linked with fiat currency serves as a circulation and payment tool, while in the U.S., digital currency is evolving as a wealth storage and payment asset. These innovations support platform enterprises in building financial reservoirs, enabling capital accumulation and market dominance through nested investments and acquisitions. This shift presents risks to traditional monetary governance systems and the dominance of fiat currency. The study highlights the need for regulatory intervention to prevent excessive monopolistic expansion and mitigate economic risks associated with platform-financial complexes.

In conclusion, empirical studies demonstrate that digital finance, powered by advancements in ICT infrastructure, significantly enhances financial inclusion and promotes financial sector development, particularly in developing regions. Mobile money services, like M-Pesa in Kenya, have broadened access to financial services, increased savings, and facilitated efficient money transfers, especially among previously unbanked populations. Fintech innovations, such as peer-to-peer lending and digital payment platforms, further improve financial market efficiency by reducing transaction costs and expanding access to credit. Moreover,

ICT advancements enable digital financial services to reach rural and underserved areas, bridging urban-rural divides and fostering more equitable financial development.

4. Methodology

This study used a balanced panel dataset across 60 countries over the period from 2004 to 2022 to examine the dynamic relationship between financial development and its key determinants. The sample countries include Algeria, Angola, Argentina, Armenia, Bangladesh, Bhutan, Bolivia, Botswana, Brazil, Cabo Verde, Cameroon, Chad, China, Colombia, Comoros, Costa Rica, Ecuador, Egypt, El Salvador, Equatorial Guinea, Eswatini, Fiji, Gambia, Georgia, Ghana, Guatemala, Guinea, Honduras, India, Indonesia, Iraq, Kenya, Kosovo, Lesotho, Madagascar, Malawi, Malaysia, Mauritania, Mauritius, Mexico, Mozambique, Namibia, Nepal, Nicaragua, Nigeria, Pakistan, Paraguay, Peru, Philippines, Rwanda, Sao Tome and Principe, South Africa, Tajikistan, Tanzania, Thailand, Tunisia, Uganda, Viet Nam, Zambia, and Zimbabwe.

The study chosen the System Generalized Method of Moments (sysGMM) to effectively address the potential endogeneity issues and to provide consistent and robust outcomes. The system GMM is suited for dynamic panel data models as it can address both potential reverse causality and unobserved country-specific effects by using internal instruments derived from lagged values of the endogenous variables. System GMM enhances the efficiency of the estimates by combining equations in both levels and first differences, minimizing biases that might have arisen from omitted variable problems and endogeneity. Moreover, diagnostic tests, such as the Arellano-Bond test for serial correlation and the Hansen test for instrument validity, were conducted to ensure the reliability of the model specification and the appropriateness of the instruments used. Hence, the empirical model of the system GMM model is specified as follows:

$$Y_{it} = \alpha + \sum_{i=1}^n \beta_j x_{it} + \varepsilon_{it}$$

where:

Y_{it} represents the dependent variable; Y_{it-1} is the lagged dependent variable; X_{it} represents the vector of independent variables, and ε_{it} is the error term.

All variables assumed in this study have been transformed to logarithm. This transformation helps normalize the distribution of variables, reducing the influence of outliers and making data more symmetric. Logarithmic transformation also facilitates interpreting results, especially when variables span multiple orders of magnitude; for instance, the percentage changes become linear relationships in log terms, making coefficients more intuitive to interpret. Generally speaking, the log transformation enhances the robustness and interpretability of results, meeting assumptions of homoscedasticity and linearity more closely, thereby improving model reliability and the validity of statistical inferences. Therefore, based on the GMM empirical model framework stated above, the empirical model of this

study is stated here under.

$$FD_{it} = \alpha + \beta_1 \ln FD_{it-1} + \beta_2 \ln ICT_{it} + \beta_3 \ln nmobtxn_{it} + \beta_4 \ln FDI_{it} + \beta_5 \ln TO_{it} + \beta_6 \ln INF_{it} + \beta_7 \ln GDPPC_{it} + \beta_8 \ln GOVEXP_{it} + \beta_9 \ln POLSTBTY_{it} + \varepsilon_{it}$$

FD_{it} financial development; FD_{it-1} lagged value of the dependent variable; $nmobtxn_{it}$ number of mobile banking transactions; FDI_{it} foreign direct investment; TO_{it} trade openness; INF_{it} inflation; $GDPPC_{it}$ GDP per capita; $GOVEXP_{it}$ government expenditure; $POLSTBTY_{it}$ political stability, α represents a constant term, from β_1 to β_9 denote coefficients of independent variables, ε_{it} stands for composite error term.

Table 1 below presents measurement of variables, their expected signs and the sources where data gathered from. This provides information on how each variable is measured and the theoretical expectations behind its effect on financial development in the context of developing countries.

Table 1. Variable measurement, expected sign, and data sources.

Variable	Measurement	Exp. Sign	Source
Financial Development (FD)	Indexed using PCA based on two indicators: domestic credit to private sector (% of GDP); Broad Money (M3) (% of GDP)	+	World Bank
Number of Mobile banking transactions (nmobtxn)	Number of mobile banking transactions	+	IMF
Information Communication Technology (ICT)	Indexed using PCA based on three indicators: Number of internet users; Number of Mobile cellular subscriptions; Fixed broadband subscriptions	+	World Bank
Foreign Direct Investment (FDI)	Net inflows as % of GDP	+	World Bank
Inflation (INF)	Consumer Price Index (CPI) growth rate	-	World Bank
Trade openness (TO)	Sum of exports and imports as % of GDP	+	World Bank
GDP per capita (GDPPC)	Annual GDP per capita growth	+	World Bank
Government Expenditure (GOVEXP)	General government final consumption expenditure as % of GDP	+	World Bank
Political Stability (POLSTBLTY)	Index of political stability and absence of violence/terrorism	+	World Bank

5. Results and Discussions

In this particular section, the researcher started by presenting and discussing key findings from the various statistical tests and models applied in the analysis. First, Levin-Lin-Chu (LLC) and Im, Pesaran, and Shin (IPS) unit root tests are conducted to examine the stationarity of the data, ensuring that the variables used in the regression models are stable over time and suitable for econometric analysis. Following this, a pair-wise correlation analysis is performed to explore the relationships between the independent variables and assess their potential influence

on the dependent variable. To ensure the robustness of the model, the researchers also checked for multicollinearity, as highly correlated variables can distort the regression estimates. Lastly, the results of the Generalized Method of Moments (GMM) estimation results have been and discussed.

Table 2. Levin-Lin-Chu (LLC) and Im, Pesaran, and Shin (IPS) stationarity test results.

Variables	LLC	IPS	Stationarity Status of Both Tests
	t-Statistic	t-Statistic	
lnFD	-6.1229***	-4.1229***	I (0)
lnmobtxn	-28.4802***	-6.3972***	I (0)
lnICT	-12.6260***	-17.9360***	I (0)
lnICT*lnmobtxn	-12.5084***	-4.9118***	I (0)
lnFDI	-6.1229***	-8.4035***	I (0)
lnTRADE	-89.1436***	-3.6778***	I (0)
lnINF	-7.1516***	-10.6126***	I (0)
lnGDPPC	-11.8810***	-13.6901***	I (0)
lnGOVEXP	-91.7873***	-3.8833***	I (0)
lnPOLSTBT	-5.4762***	-4.4580***	I (0)

*** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

The results from the Levin-Lin-Chu (LLC) and Im, Pesaran, and Shin (IPS) stationarity tests indicate that all the variables in the analysis are stationary at their level form (Table 2). This suggests that the data series for each variable does not exhibit a unit root, meaning the variables are stable and do not display time-dependent patterns like trends or random drifting. In other words, the statistical properties of these variables, such as their mean and variance, remain constant over time, which is a fundamental requirement for time series and panel data analysis. When variables are non-stationary, they can produce spurious regression results, leading to inaccurate inferences about the relationships between variables. By confirming stationarity, these tests ensure that the relationships estimated between the variables will be valid and not distorted by underlying trends or non-stationary behavior. Since all the variables are stationary at level, there is no need to transform or difference them to make them stationary, which simplifies the econometric modelling process. This is particularly important in dynamic panel data models, where differencing can sometimes lead to the loss of valuable long-term information (Table 3).

Several key relationships have been revealed from the correlation analysis depicted above. For example, financial development (FD) has positive correlations with GDP per capita (0.559) and government expenditure (0.355), indicating that higher income levels and public spending are interacted with greater financial development. The correlations of FD with ICT (0.372), lnmobtxn (0.235), and

Table 3. Pair-wise correlation analysis.

Variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
(1) FD	1.000									
(2) lnmobtxn	0.235	1.000								
(3) ICT	0.372	0.319	1.000							
(4) ICT*lnmobtxn	0.246	0.466	0.327	1.000						
(5) lnFDI	0.337	0.353	0.248	0.408	1.000					
(6) lnTRADE	0.394	0.434	0.355	0.350	0.245	1.000				
(7) lnINF	-0.184	-0.256	-0.385	-0.259	-0.152	-0.263	1.000			
(8) GDPPC	0.559	0.378	0.433	0.460	0.341	0.277	-0.398	1.000		
(9) lnGOVEXP	0.355	0.329	0.545	0.395	0.304	0.255	-0.459	0.289	1.000	
(10) lnPOLSTBT	0.201	0.416	0.520	0.318	0.275	0.359	-0.343	0.316	0.228	1.000

ICT*lnmobtxn (0.246) also suggest that availability of ICT infrastructure and mobile are transactions are relevant in triggering financial development at the same time. lnFDI also shows a weak to moderate correlation with FD (0.337), implying limited influence of foreign direct investment on financial development. Inflation (lnINF) has a negative correlation with most variables, including lnFD (-0.184), suggesting that higher inflation may lead to slow down the rate of financial sector development. Overall, the correlation results imply that imply the chance of multicollinearity issue is less likely.

Table 4. Variance inflation factor.

	VIF	1/VIF
ICT*lnmobtxn	3.589	0.279
ICT	3.521	0.285
lnTRADE	1.292	0.774
lnPOLSTBTY	1.267	0.789
lnGOVEXP	1.185	0.844
lnFDI	1.158	0.863
lnGDPPC	1.114	0.898
lnINF	1.097	0.911
lnmobtxn	1.097	0.912
Mean VIF	1.701	

The results of Variable Inflation Factor (VIF) presented in **Table 4** suggest that there is no multicollinearity problem for variables which have been considered in the model. The VIF values for all variables are below 5, which is the commonly accepted threshold for multicollinearity issues. The highest VIFs are observed for the interaction term ICT lnmobtxn (3.589) and ICT (3.521), which may be

expected given the nature of interaction terms. All other variables, such as lnTRADE (1.292) and lnFDI (1.158), have VIF values close to 1, showing minimal multicollinearity. The mean VIF of 1.701 further confirms that overall multicollinearity is low. Therefore, the independent variables can be reliably interpreted without significant distortion in the regression results due to multicollinearity.

Table 5. The fixed effect, one step GMM and two step GMM regression results.

Dependent variable: Financial development (lnFD)			
Independent variables	Fixed Effect	One-step sysGMM	Two-step sysGMM
L.lnFD		1.128*** (0.0379)	1.217*** (0.0387)
lnmobtxn	0.0173** (0.00795)	0.0104*** (0.00400)	0.0364*** (0.0109)
lnICT	0.297*** (0.0291)	0.0782*** (0.0188)	0.0540*** (0.0200)
lnICT*lnmobtxn	0.0144*** (0.00244)	0.0292*** (0.00885)	0.0450*** (0.00726)
lnFDI	0.0316* (0.0183)	0.109*** (0.0421)	0.0548** (0.0218)
lnINF	-0.466*** (0.0677)	-0.0515*** (0.00743)	-0.0628*** (0.00797)
lnTRADE	0.0259** (0.0118)	0.400** (0.156)	0.109*** (0.0390)
lnGOVEXP	0.203*** (0.0549)	0.269*** (0.0504)	0.0970*** (0.0351)
lnGDPPC	0.0441*** (0.00989)	0.0950*** (0.0197)	0.0700*** (0.0123)
lnPOLSTBTY	0.0753*** (0.0279)	0.0331* (0.0177)	0.0297* (0.0180)
Constant	2.609*** (0.341)	0.396 (0.455)	1.200*** (0.185)
Observations	1140	1052	1052
Number of id	60	60	60
Number of instruments	–	28	28
AR(2)	–	0.112	0.155
Hansen test	–	0.093	0.126

Standard errors in parentheses; *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

The two-step system GMM regression results reveal that the coefficient of the lagged dependent variable is positive and statistically significant (Table 5). This indicates that a strong persistence of financial development, implying that

previous level of financial development strongly influences the current levels. The other variable Mobile banking has a coefficient of 0.0364; it means that a 1% increase in the number of mobile transactions increases associated with a 0.0364% increase in financial development. The results confirm the idea that the adoption of mobile banking has been widely acknowledged as a key driver of financial development in developing countries, where the traditional banking services are scarce and inaccessible for all segments of the population. Mobile banking platforms enable individuals to access financial services without visiting bank branches in person, effectively avoiding geographical barriers. Digital finance, particularly mobile banking, is remarkably transforming the financial services ecosystem by enabling millions of unbanked and underserved populations to engage in the formal financial services. This transformation not only improves the accessibility but also avoids risks of theft and significantly reduces the transaction costs as compared to the traditional banking system. The regression results have further reaffirmed that digital finance, with a focus on mobile banking services, its efficiency in facilitating quick, secure and cost-effective financial transactions makes is a powerful tool in promoting financial development.

Previous studies have revealed that digital finance facilitates the access to and usage of financial services, specifically for unbanked and underserved population. For instance, [Jack and Suri \(2011\)](#) showed that how M-Pesa mobile banking system in Kenya significantly driving financial inclusion, thereby enhancing financial development. The authors have also highlighted that digital finance like mobile banking not only improves the accessibility of financial services but also promotes savings and investments. According to the authors, users of M-pesa mobile banking system in Kenya were found to be more likely to save and invest their money compared to individuals who didn't use mobile banking services. In general, the results underscore the transformative potential of mobile banking, particularly for emerging economies. [Ahmad et al. \(2020\)](#) further demonstrated that the role of mobile banking in integrating financially excluded individuals into the formal financial system. According to the authors, digital finance serves as a bridge to connect the unbanked population with the formal financial service. Therefore, , in developing countries, the implementation and expansion of mobile banking services have proven to essential for bringing and integrating many individuals to the formal financial system, thereby fostering financial development.

Information and communication technology has statistically significant positive impact on financial development, with a coefficient of 0.0540. This finding implies that a 1% increase in ICT infrastructure leads to a 0.0540% improvement in financial development in developing countries. Many previous research findings have confirmed that the ICT's for financial sector development. For example, [Ejemeyovwi et al. \(2021\)](#) highlighted ICT infrastructure facilitates digital payment solutions among others PayPal, M-pesa, WeChat and Alipay, which enable users to receive and transfer money, and to make online payments affordably and quickly without geographical restrictions.

The interaction between ICT and mobile banking has a positive and statistically significant impact on financial development. Their combination effect shows that when ICT infrastructures are improved, the benefits of mobile banking are more magnified. A study by [Andrianaivo and Kpodar \(2011\)](#) in Sub-Saharan Africa similarly found that the interaction between ICT and mobile banking increases the level of financial inclusion, leading to financial sector development, specifically in countries with poor banking infrastructure.

The interaction of ICT and mobile banking has also a significant positive impact on financial development, with a coefficient of 0.0540. This indicates that a 1% increase in the interaction between ICT and mobile banking contributes to 0.0540% increase in the financial development. The combined effect of these two variables implies that the effectiveness of mobile banking in enhancing financial development is largely depending on ICT infrastructure. This finding is supported by previous studies. For example, [Andrianaivo and Kpodar \(2011\)](#) noted that digital finance, supported by ICT, is essential for expanding financial access, and fostering financial development, especially in developing countries. For example, countries such as China, where internet penetration and mobile networks have exponentially been expanded rapidly, platforms such as WeChat, developed by Tencent, and Alipay, created by Alibaba have played a significant role by creating almost cashless society. What this shows that how deeply digital finance and ICT interconnected each other. The combination of Digital finance and ICT has a great role to broaden access to and usage of financial services, especially in remote and underserved areas. This interconnectedness makes the financial ecosystem to be more inclusive.

As digital information becomes increasingly critical in today's financial ecosystem, the integration of information and communication technology (ICT) and mobile banking has emerged as a pivotal driver of financial development. In an age where digital connectivity underpins most financial transactions, ICT serves as the backbone for mobile banking platforms, enabling secure, fast, and efficient financial services. Furthermore, studies by [Del Gaudio et al. \(2021\)](#) confirm that countries making significant investments in ICT and promoting mobile banking have experienced faster financial sector development, particularly in regions with previously limited banking services. The authors have further confirmed that further nations investing in ICT and promoting mobile banking have seen accelerated financial sector development, particularly in developing regions. As mobile banking platforms become more efficient with stronger ICT infrastructure, they foster trust and stability within the financial system, encouraging more users to engage with formal financial services.

Among control variables Foreign Direct Investment (FDI), trade openness, government expenditure, GDP per capita and political stability have a positive and significant impact on financial development in developing counties. FDI plays a key role in promoting financial development by injecting capital into an economy. FDI fosters technology transfer, including financial technologies that improve

service delivery and access. Trade openness encourages financial development by facilitating cross-border transactions and integrating economies into global financial systems, which fosters innovation and increases the demand for robust financial services. With greater trade, the need for efficient financial systems like digital payments grows, further driving development. Government expenditure, particularly in infrastructure and digital technologies, supports financial development by building the foundation for financial services to operate efficiently. Public spending on ICT infrastructure, education, and public services helps broaden access to financial services, especially in remote and underserved areas. GDP per capita reflects economic prosperity and is positively associated with financial development. As incomes rise, individuals and businesses are more likely to use financial services, such as credit, savings, and investments, which expands the financial sector. Political stability is a foundational factor in enhancing financial development. In contrast inflation has a negative impact on financial development. A high inflation erodes the purchasing power of money and affect saving and investment which are critical for financial development.

The values of the AR(2) test indicate that there is no significant second-order serial correlation in the residuals of the model, which supports the validity of the model's dynamic relationship among variables. In addition, the Hansen test results revealed that the null hypothesis of instrument validity would not be rejected at conventional significance levels. This means that the instruments considered in the System GMM estimation are appropriate and do not suffer from any over-identification, reinforcing the robustness of the model's results. Overall, these diagnostic tests have confirmed the reliability of the estimated relationships within the model.

6. Conclusion

The integration of mobile banking and information and communication technology (ICT) has become a key driver of financial development in developing countries. The results from GMM regression analysis show that an increase in mobile banking services has a significant positive impact on financial development in developing countries where access to traditional banking services is limited. Mobile banking services are more effective than the traditional banking system in overcoming geographical barriers and providing access to banking services for underserved and unbanked populations. Additionally, ICT infrastructure has also a crucial role in amplifying the benefits of mobile banking by enabling fast, efficient, and secure access to digital financial services. Moreover, the interaction effect of mobile banking and ICT contributes to financial development by increasing savings, investment opportunities, and financial transactions. The existence of adequate ICT infrastructure is very crucial to ensure the quality and efficiency of digital financial services. Therefore, ICT and digital finance collectively enhances financial sector development in emerging economies. For example, WeChat and Alipay mobile payment platforms in China and M-pesa in Kenya are almost

creating a cashless society and accelerating the level of financial inclusion, thereby contributing to financial development.

7. Recommendations

To foster sustainable financial sector development in developing countries, it is essential for financial institutions, governments, policymakers, and other relevant stakeholders to prioritize strategic investments in digital finance platforms and ICT infrastructure. These investments are crucial for building resilient financial ecosystems, as they enhance the accessibility, quality, speed, security, and operational efficiency of digital financial transactions. Moreover, improved digital infrastructure facilitates financial inclusion by reaching unbanked and underserved populations, strengthens payment systems, and promotes innovation within the financial industry. Promoting public awareness and financial literacy on the effective use of mobile banking services should also be made a top priority. For example, educational campaigns highlighting the convenience, security, and benefits of mobile banking could significantly boost user engagement, particularly in rural areas where access to traditional banking services is limited or non-existent. These campaigns can address common concerns, such as fear of fraud or lack of trust in digital platforms, while demonstrating how mobile banking enables faster transactions, bill payments, savings management, and access to microloans. By building confidence and promoting digital literacy, such initiatives empower underserved populations to adopt mobile financial services. The public and private sectors should collaborate on expanding digital infrastructure, ensuring reliable internet access and mobile network coverage, especially in underserved areas. Lastly, it is crucial to create regulatory frameworks that safeguard the security and privacy of digital financial transactions. A strong regulatory framework ensures trust in digital financial services. In general, developing countries need to invest in expanding digital infrastructure, such as reliable internet connectivity and mobile networks, to ensure broader access to financial services, thereby fostering financial development.

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Data Availability Statement

The data supporting the results of this study can be accessed upon reasonable request by contacting the corresponding author.

Conflicts of Interest

The author declares no conflicts of interest regarding the publication of this paper.

References

- Ahmad, A. H., Green, C., & Jiang, F. (2020). Mobile Money, Financial Inclusion and Development: A Review with Reference to African Experience. *Journal of Economic Surveys*, *34*, 753-792. <https://doi.org/10.1111/joes.12372>
- Allen, F., James, M., & Philip, E. S. (2002). E-Finance: An Introduction. *Journal of Financial Services Research*, *22*, 5-27.
- Andrianaivo, M., & Kpodar, K. (2011). *ICT, Financial Inclusion, and Growth: Evidence from African Countries*. International Monetary Fund.
- Arner, D. W., Barberis, J., & Buckley, R. P. (2017). FinTech, RegTech, and the Reconceptualization of Financial Regulation. *Northwestern Journal of International Law & Business*, *37*, 371-414.
- Davis, F. D. (1989). Perceived Usefulness, Perceived Ease of Use, and User Acceptance of Information Technology. *MIS Quarterly*, *13*, 319-340. <https://doi.org/10.2307/249008>
- Del Gaudio, B. L., Porzio, C., Sampagnaro, G., & Verdoliva, V. (2021). How Do Mobile, Internet and ICT Diffusion Affect the Banking Industry? An Empirical Analysis. *European Management Journal*, *39*, 327-332. <https://doi.org/10.1016/j.emj.2020.07.003>
- Diniz, E., Birochi, R., & Pozzebon, M. (2011). Triggers and Barriers to Financial Inclusion: The Use of ICT-Based Branchless Banking in an Amazon County. *Electronic Commerce Research and Applications*, *11*, 484-494. <https://doi.org/10.1016/j.elerap.2011.07.006>
- Donner, J., & Tellez, C. A. (2008). Mobile Banking and Economic Development: Linking Adoption, Impact, and Use. *Asian Journal of Communication*, *18*, 318-332. <https://doi.org/10.1080/01292980802344190>
- Donovan, K. (2011). Mobile Money for Financial Inclusion. *Information and Communications for Development*, *8*, 61-73. https://doi.org/10.1596/9780821389911_ch04
- Ejemeyovwi, J. O., Osabuohien, E. S., & Bowale, E. I. K. (2021). ICT Adoption, Innovation and Financial Development in a Digital World: Empirical Analysis from Africa. *Transnational Corporations Review*, *13*, 16-31. <https://doi.org/10.1080/19186444.2020.1851124>
- Estrada, G., Park, D., & Ramayandi, A. (2010). *ADB Economics Working Paper Series Financial Development and Economic Growth in Developing Asia*. Asian Development Bank Economics Working Paper.
- Gomber, P., Kauffman, R. J., Parker, C., & Weber, B. W. (2018). On the Fintech Revolution: Interpreting the Forces of Innovation, Disruption, and Transformation in Financial Services. *Journal of Management Information Systems*, *35*, 220-265. <https://doi.org/10.1080/07421222.2018.1440766>
- Gomber, P., Koch, J., & Siering, M. (2017). Digital Finance and Fintech: Current Research and Future Research Directions. *Journal of Business Economics*, *87*, 537-580. <https://doi.org/10.1007/s11573-017-0852-x>
- Jack, W., & Suri, T. (2011). *Mobile Money: The Economics of M-PESA*. NBER Working Paper Series.
- Ketterer, J. A. (2017). *Digital Finance: New Times, New Challenges, New Opportunities*. <http://dx.doi.org/10.18235/0007028>
- Khan, S., Hasan, M. M., & Yajuan, L. (2020). Promoting China's Inclusive Finance through Digital Financial Services. *Global Business Review*, *23*, 984-1006. <https://doi.org/10.1177/0972150919895348>
- Kingiri, A. N., & Fu, X. (2019). Understanding the Diffusion and Adoption of Digital Finance Innovation in Emerging Economies: M-Pesa Money Mobile Transfer Service in

- Kenya. *Innovation and Development*, 10, 67-87.
<https://doi.org/10.1080/2157930x.2019.1570695>
- Liang, S. (2023). The Future of Finance: Fintech and Digital Transformation. *Highlights in Business, Economics and Management*, 15, 20-26.
<https://doi.org/10.54097/hbem.v15i.9222>
- Mugabe, R., Liu, S., Byiringiro, E., & Bruce, G. (2024). Does ICT Development, Innovation Dissemination Promote Economic Growth and Human Capital? An Econometric Approach Based on East African Countries. *Journal of Human Resource and Sustainability Studies*, 12, 172-203. <https://doi.org/10.4236/jhrss.2024.121010>
- Mugisha, B. (2024). Role of Information and Communication Technologies in Promoting Financial Inclusion in Rural African Communities in Rwanda. *International Journal of Technology and Systems*, 9, 15-27. <https://doi.org/10.47604/ijts.2276>
- Pradhan, R. P., Arvin, M. B., Nair, M. S., Hall, J. H., & Bennett, S. E. (2021). Sustainable Economic Development in India: The Dynamics between Financial Inclusion, ICT Development, and Economic Growth. *Technological Forecasting and Social Change*, 169, Article ID: 120758. <https://doi.org/10.1016/j.techfore.2021.120758>
- Staszkiwicz, P., Łosiewicz-Dniestrzańska, E., & Grygiel-Tomaszewska, A. (2021). European Financial Institution Physical Geolocation and the High-Frequency Trading Potential. In A. Marszk, & E. Lechman (Eds.), *The Digitalization of Financial Markets* (pp. 19-37). Routledge. <https://doi.org/10.4324/9781003095354-2>
- van der Boor, P., Oliveira, P., & Veloso, F. (2014). Users as Innovators in Developing Countries: The Global Sources of Innovation and Diffusion in Mobile Banking Services. *Research Policy*, 43, 1594-1607. <https://doi.org/10.1016/j.respol.2014.05.003>
- Weil, D. N., & Mbiti, I. (2016). Mobile Banking the Impact of M-Pesa in Kenya. *African Successes, III*, 247-293.
- Wu, J. (2022). Analysis of Digital Finance Innovation of Platform Enterprises. *Open Access Library Journal*, 9, 1-12. <https://doi.org/10.4236/oalib.1109190>
- Yao, W. (2023). The Impact of Digital Finance on the Resilience of Open City Economic Development. *Journal of Service Science and Management*, 16, 592-602.
<https://doi.org/10.4236/jssm.2023.165031>
- Zandena, J. L. (2022). Examining the Relationship of Information and Communication Technology and Financial Access in Africa Jan. *Journal of Business and Economic Options*, 6, 26-36.