

Article

Does Digital Finance Foster Financial Stability? Empirical Evidence from Cross-Country Analysis

Md. Nur Alam Siddik ^{1,2,*}, Muzafar Shah Habibullah ², Sajal Kabiraj ³ and Shakib Hassan Rakib ¹

¹ Department of Finance and Banking, Begum Rokeya University, Rangpur 5404, Bangladesh; shakibhassan.brur@gmail.com

² Putra Business School, University Putra Malaysia (UPM), Serdang 43400, Selangor, Malaysia; muzafar@putrabs.edu.my

³ Strategy & International Business, Faculty of Business and Hospitality Management, LAB University of Applied Sciences, Mukkulankatu 19, 15101 Lahti, Finland; sajal.kabiraj@lab.fi

* Correspondence: mnas@brur.ac.bd; Tel.: +880-1712684458

Abstract

The World Bank asserts that reducing extreme poverty and achieving shared prosperity are both made possible through financial inclusion. Digital finance may enhance financial stability, thereby supporting more inclusive and sustainable economic growth. Despite its potential benefits, the link between digital finance and financial stability remains under-explored in the literature. The present study addresses this research gap in the literature by exploring the relationship between digital finance and financial stability. Panel data of 160 countries over the period of 2004–2024 have been collected and analyzed by using Moment Quantile Regression (MMQREG). The robust outcomes show that digital finance significantly improves financial stability. This study aims to contribute to the existing literature. The findings of this study will help policymakers in designing effective or supportive policies for digital financial services. Findings may inform policies aligned with SDG 8: promote sustained, inclusive, and sustainable economic growth.

Keywords: digital finance; financial stability; economic policy; panel data; quantile regression

1. Introduction

The World Bank has initiated financial inclusion programs intending to alleviate poverty, achieve financial stability, and promote inclusive growth. Governments and international organizations have prioritized financial inclusion as a means to eradicate poverty and encourage equal prosperity since its inception in the early 2000s. Governments have implemented policies to promote financial inclusion across the globe. Digital finance (DF), often considered as digital financial inclusion, is regarded as a response to technological advancements in the financial sector. This encompasses all financial dealings, as well as payments, insurance, investments, and financing that is delivered digitally.

Recently, policymakers have become interested in digital finance as an avenue for achieving the financial inclusion goal, combating poverty, and achieving long-term economic security. This is because, first of all, it fosters financial stability by increasing access to the financial system. Secondly, users of financial services, providers of digital financial services, governments, legislators, and the economy all stand to gain substantially from the widespread adoption of digital financial services. For instance, it increases government spending while expanding access to credit for the impoverished. Thirdly, banks and Fintechs can save money by transitioning to branchless, technology-based systems.



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Manyika et al. (2016) state that by transitioning to digital services, financial institutions can reduce their direct expenses by \$400 billion. Finally, DF provides new avenues for providing previously excluded populations with easier access to an eclectic variety of financial services. However, DF has potential concerns, including privacy and cybersecurity issues, as well as possible legal problems from a bank's agreements with other organizations.

Notwithstanding the advantages of digital finance and financial stability, there is a discrepancy in the availability, accessibility, and utilization of finance, as significant segments of the population have not been adequately impacted. The DF gap is becoming more evident and is garnering more attention, particularly from Fintech companies. The literature has paid startlingly little attention to the connection between these and the obstacles they present to financial stability. It is also uncertain whether DF contributes to the stabilization of the financial system. A positive and unidirectional correlation between financial stability and digital finance is demonstrated by data from numerous sources (Al-Smadi, 2023; Anton & Afloarei Nucu, 2024; Lakhoul & Segdali, 2024). The authors contended that digital finance initiatives would enhance financial stability by increasing the ease of access to banking services to a broader population, particularly the impoverished, and ensuring resource efficiency through financial intermediation.

According to certain academicians, digital finance significantly undermines the stability of the financial system (For instance, Hordofa, 2024). These contradictory findings present an opportunity for additional investigation into the correlation between financial stability and digital finance. This study contributes in the following ways: First, the digital finance-financial stability relation will be examined in order to expand and deepen sustainable economic development. Regrettably, the existing literature does not appear to have addressed such a critical role of DF. Secondly, this study has the potential to provide supplementary insights into the digital finance-financial stability relationship by providing a concrete link with recent data. By contributing to the expanding corpus of knowledge, this research may help scholars and investigators comprehend how digital finance services affect stability. Finally, the findings will be used by policymakers to gain a better understanding of the challenges posed by the rapid expansion of digital financial services, effective methods for bringing these services to the impoverished, and the risks associated with digital finance.

The succeeding sections of the research article are structured as follows: Section 2 describes the concepts of digital finance and financial stability, along with the existing empirical literature. Section 3 presents the research methods. Section 4 shows empirical findings based on regressions and their discussion. Section 5 completes with recommendations, limitations, and future research.

2. Literature Review

2.1. Conceptualizing Digital Finance

There is no universally recognized definition of digital finance, but it generally refers to the goods, services, technology, and infrastructure that allow individuals to access credit, savings, and payment alternatives without physically visiting a bank branch. Manyika et al. (2016) opined that digital finance is the provision of financial services utilizing digital arrangements, such as cell phones and internet networks, which ultimately promotes a decline in the utilization of currency and the old-fashioned 'brick-and-mortar' branch banking method. Digital finance incorporates a vast array of cutting-edge client interaction and communication techniques, as well as new and enhanced financial services and management tools. Thus, digital finance enables individuals to access funds at any time and from any location, decreasing the likelihood of destitution.

There are two primary schools of thought: fintech-led digital finance companies (e.g., mobile wallets and platform-based financial intermediaries) and bank-led digital finance (e.g., ATMs and online banking). The regulatory monitoring, risk transmission routes, and balance-sheet exposure of these two types are significantly distinct. Fintech-led digital finance, which frequently operates outside of the balance sheets of traditional banks, may employ alternative risk transmission mechanisms, including shadow banking, platform intermediation, and regulatory breaches. This study examines ATM penetration as a proxy for bank-led digital finance. The balance sheets of the banks that own and administer the ATMs are closely linked to those of the banks. Consequently, they influence financial stability through conventional banking channels, such as deposit mobilisation, operational efficiency enhancement, and liquidity management.

2.2. Linking Digital Finance and Financial Stability

Financial inclusion is a movement that aims to ensure that all individuals, including those living in destitution and without bank accounts, have the opportunity to access financial services. Its declared objective is to reinstate formal finance services for the unbanked and underbanked. The primary goal is to guarantee that all individuals have unrestricted access to financial services, thereby enabling them to benefit from and participate in economic growth. By expanding access to affordable and dependable financial services, financial inclusion initiatives aim to enhance economic prospects for all members of society (Hannig & Jansen, 2010).

According to Sarma (2015), financial inclusion is a program that aims to increase the ease of access and utilization of financial resources and services. A financially stable system is capable of withstanding financial disruptions that are sufficiently significant to disrupt the allocation of capital to profitable investment opportunities. Financial markets, financial intermediaries, and market infrastructures are all included in this system. Authorities worldwide regard banking as the most productive sector in terms of its overall contribution to economic development. Consequently, this investigation would consider bank stability from the perspective of financial stability and banking-based financial inclusion.

Due to the technological revolution, digital finance has emerged as a widely accepted priority policy of the government. To make the financial system stable and sustainable, policymakers have undertaken and continue to take various policy measures. A number of proxies can be used to measure digital finance. For example, the number of automated teller machines (ATMs) per 100,000 adults, Outstanding loans with commercial banks (% of GDP), the number of persons consuming the Internet (percentage of people), and mobile money transactions (percentage of GDP). Now, the question remains: Does it eventually contribute to the country's financial stability goal?

The availability of physical infrastructure influences financial stability through modification of banks' competitive behavior, cost control, and funding accessibility. This cost management extends participation in formal banking networks and changes banks' balance sheet elements. These changes have a significant impact on the fundamental components of banks' stability and solvency. Furthermore, an expansion in access to digital finance also increases deposit mobilization through increasing availability and reducing transaction costs. Consequently, a boarder deposit is prevalent in financial industries, which lowers banks' risk of bankruptcy and generates revenue streams, strengthening the Z-score.

It is evident that the world has achieved notable growth in digital finance indicators. At the same time, to promote inclusive growth, governments and policymakers have implemented policies in digital finance. So, the research question arises: Does digital finance foster financial stability? Thus, it is weightier to inspect the affiliation concerning financial stability and digital finance. In retrospect, we observe that few studies posited

hypotheses regarding how digital finance might affect people's access to banking and financial services, even though most of those studies focused on a regional perspective, such as the MENA region, sub-Saharan Africa, and so on. Consequently, there are currently no global empirical studies on digital finance and financial stability. The present research will address this research gap.

2.3. Previous Empirical Studies

Arguing that a nation's access to formal financing is essential to its economic development, [Manyika et al. \(2016\)](#) estimate that a potential 6% annual growth in global GDP by 2025 could be realized through the extensive adoption of digital finance. Based on the quantile regression analysis conducted by [Anton and Afloarei Nucu \(2024\)](#) across 81 countries, considering both traditional and digital financial inclusiveness with three different indices, digital finance exerts a positive influence on financial stability. [Lakhoul and Segdali \(2024\)](#) investigated the effects of digital finance on financial inclusion in Morocco. Applying the Structural Equation Model, the authors found affirmative impacts of digital finance on financial inclusion. [Al-Smadi \(2023\)](#) examined data from 2004 to 2020, from twelve MENA countries. The author concludes that digital finance facilitates the acceleration of financial inclusion and stability through the application of the system-generalized moments technique.

Using data from 27 sub-Saharan African countries between 2007 and 2017, [Bede Uzoma et al. \(2020\)](#) applied the Granger Error Correction Model (ECM) employing the Generalized Method of Moments (GMM). The findings indicated that digital banking promotes greater financial inclusion and stability. [Antwi and Kong \(2023\)](#) investigated the correlation between financial stability and digital finance technologies by analyzing data from 55 developing economies between 2000 and 2020. The authors found that financial stability was adversely affected by digital banking technology, which serves as a substitute for mobile phone subscriptions, through quantile regression. The economic security of emerging nations is positively impacted by the use of the internet in place of traditional digital banking technology.

Using data from 41 African countries over the period 2004–2023, [Okoli \(2025\)](#) found and concluded that digital finance promotes financial stability. Utilizing an imbalanced panel dataset comprising 213 banks from four ASEAN countries, [Banna and Alam \(2021\)](#) determined that a full transition to digital finance accelerates the advancement of financial stability within ASEAN. [Hordofa \(2024\)](#) examined critical indicators of the financial industry's stability in connection with the adoption of digital finance. Using data from 1991 to 2022 and an autoregressive distributed lag (ARDL), the author identifies a statistically significant inverse association between the integrity of the banking system and the utilization of digital finance.

Based on the existing literature, the evidence is mixed. Some authors found positive impacts, while others found negative impacts of digital finance on financial stability. These conflicting findings give the researchers a way to explore and prove the association of digital finance with financial stability. [Anton and Afloarei Nucu \(2024\)](#) demonstrated identical outcomes, this study is notable for its concise focus on physical infrastructure that exclusively indicates access to financial services. We prioritize how individuals achieve prospective access instead of the usage and availability of digital financial products to support banks' financial stability. We have at least two contributions to make, even though it is debatable whether digital finance encourages financial stability. First, the research has put forward a framework where digital finance and financial stability pose both conceptual and measurement issues. Second, this research is an analysis of the most recent experimental substantiation on the topic of digital finance and financial stability.

3. Methodology

3.1. Sample, Data Sources, and Their Explanation

A relative dearth of data was the foremost issue we encountered in investigating the research issue about the promotion of financial stability by digital finance. To answer the research questions and thereby to attain research aims, based on availability, panel data of 160 countries for the period of 2004–2024 have been accumulated from different sources, such as the International Monetary Fund (IMF) and the World Bank (WB). Out of 160 countries, 55 countries are classified as high-income countries, and the remaining 105 countries are low-income to upper-middle-income countries. The list of sample countries is provided in Appendix A.

The Financial Access Survey (FAS) database of the International Monetary Fund is the most comprehensive international resource on this subject. FAS has cross-national time-series statistics on a variety of digital banking topics. Conversely, the most critical variables in this database have limited time series data, and there is a lack of data for a number of economies. We have collected data on digital finance from this source in accordance with the information that is currently available.

The largest cross-national database on financial stability and development is Global Financial Development (GFDD), which was also established by the World Bank. Similar to FAS, the primary issues with this database are the absence of data for numerous economies and the shortened time series data on the most critical variables. The Z-score was employed to quantify availability-based financial stability data that was collected from this source between 2004 and 2024. Data on all control variables, including the GDP growth rate, the ratio of national credit to GDP delivered to the private sector, and the relative quantity of private credit to GDP, were collected during the same time frame. We consult the World Bank's WDI database for this purpose. We obtained information regarding real interest rates and broad money from this database. In order to guarantee uniformity among all databases, we selected 160 countries that possess data on the pertinent criteria.

3.2. Variable Selections

3.2.1. Dependent Variable

The objective of this investigation was to ascertain whether digital finance contributes to financial stability. The economy's current status is therefore regarded as a dependent variable. The stock market volatility, bank Z-score, and non-performing loan provision are all potential indicators of financial stability; however, there is a dearth of information on these metrics. Therefore, the bank's Z-score serves as a gauge of its financial stability based on the available data. The Z-score, which is computed by dividing the bank's return on assets (ROA) plus capital ratio by the standard deviation of ROA, represents a thorough assessment of bank solvency risk. A higher Z-score denotes strengthened financial stability and a lower likelihood of insolvency. A banking system is made up of profitable, well-financed, low-volatility institutions that are less vulnerable to systemic crises. Based on numerous studies (for example, Čihák & Hesse, 2010; Diaconu & Oanea, 2014; Morgan & Pontines, 2014; Rajhi & Hassairi, 2013), where the Z-score is a widely employed indicator for assessing financial stability, this study addresses it as an indicator of aggregated financial stability. A country's banking sector is more stable when the Z-score is higher, while financial institutions are more likely to default when the Z-score is lower.

3.2.2. Independent Variable

Given that the prime objective of this investigation is to determine whether digital finance contributes to financial stability, it is classified as both an independent and primary variable of interest. Digital finance refers to the access to payments, savings, and other

banking services through electronic and technology-based channels. Although there are numerous indicators that can be employed to evaluate digital finance, such as the number of ATMs, mobile money accounts, and transactions per 1000 individuals, the absence of data remains a significant concern. The available data is employed to define digital finance as the number of ATMs per 100,000 adults. This constitutes an integral component of the digital banking system by providing electronic access to money deposit, cash withdrawal, and payment facilities without the need for physical financial institution services. A more diverse financial industry is more likely to have greater risk diversification capabilities as a whole, which is why ATMs are used as a proxy.

3.2.3. Control Variables

To clarify the influence of digital finance on financial stability, we considered numerous control variables. We commenced by accounting for the private sector's portion of domestic credit as a fraction of GDP. Financial instability may result from a disproportionate distribution of resources, as domestic credit will primarily be apportioned to the private segment. As a result, we anticipate that this variable will have a negative value. In addition, we regarded the size of the financial sector as a control variable. This metric has been employed by numerous scholars to investigate the relationship between GDP growth and financial development. Researchers discovered a positive correlation between economic growth and financial depth as an indicator of the scale of the financial sector (Gelb, 1989; King & Levine, 1993). We expect this variable to have an optimistic (+) influence on financial stability.

We considered the real interest rate. Akbas (2015) discovered a tenuous connection between real interest rates and GDP growth, in contrast to the favorable outcomes of Sanogo and Moussa (2017). A negative sign is anticipated in light of the argument that a decrease in interest rates would facilitate access to credit for all market participants, thereby promoting greater financial stability. Another control variable, the private credit to GDP ratio, has been included in the model. (Drehmann & Juselius, 2014; Gourinchas & Obstfeld, 2012) concur that the probability of financial instability rises as the private sector extends a greater share of GDP through lending.

Finally, we concur with Morgan and Pontines (2014) that an increase in GDP will be beneficial for financial stability. An increase in GDP would enhance financial stability, thereby facilitating the development of more effective digital finance. As a result, we anticipate that this variable will be positive.

3.3. The Model

To fulfill the research objectives, we develop the following econometric models:

$$Q_{\tau}(FS_{i,t}) = \beta_{0\tau} + \gamma_{\tau}DF_{i,t} + \lambda_{\tau}X_{i,t} + \varepsilon_{i,t}. \quad (1)$$

Q_{τ} represents the parameters of the τ th distributional point's methods of moments quantile regressions (MMQREG) in the aforementioned model (1). The distributional point of the independent variables, as demonstrated by τ , suggests the presence of fixed effects. The dependent variable is economic security. The primary metric for digital finance is $DF_{i,t}$, and the coefficient that is associated with it quantifies the influence of digital finance. X , the vector of control variables, denotes a collection of factors regarded as nuisance variables; $\varepsilon_{i,t}$ is the random perturbation term; $i = 1, \dots, N$ is the country; and $t = 1, \dots, t$ is the period.

We employed the quantile regression model to estimate and construct the conditional quantile functions of the dependent variable. Quantile regression is capable of addressing extreme values and offers a comprehensive representation of the conditional distribution of the explained variable (Buchinsky, 1998). This study utilizes quantile regression with robust standard errors to assess whether the assessed coefficients differ across various conditional

quantiles. We examine the 0.10, 0.20, 0.30, 0.40, 0.50, 0.60, 0.70, 0.80, and 0.90 quantiles of the distribution of the dependent variable. For a concise overview of all the variables in the study, including their definitions, measurement methods, and data sources, please see Table 1.

Table 1. A synopsis of the data sources, variables, and parameters for each.

Variable	Measurement	Legend	Sources
Dependent Variable: Financial Stability	Bank Z-score	Z-Score	GFDD
Independent Variable: Digital Finance	Number of ATMs per 100,000 adults	ATM	FAS
	Amount of domestic credit to private sector (% of GDP)	DCPS	GFDD
	Broad money (% of GDP)	BM	WDI
Control variables:	Real interest rate	RI	WDI
	Percentage of private credit to GDP	PCDT	GFDD
	GDP growth rate	GDP	GFDD

Note: GFDD stands for Global Financial Development; FAS stands for Financial Access Survey; WDI stands for World Development Indicators.

4. Results

4.1. Descriptive Summary

Descriptive statistics are presented in Table 2, which provides information regarding the variables of the study. The dependent variable, FS, was discovered to have a mean of 1.146 and a range of 0.007 to 1.824. We observed that the level of variability was also minimal. We experienced a mean of 0.465 with a minimum of -1.910 and a maximum of 0.760 for the independent variable, DF, with a moderate level of standard deviation. The control variable DCPS reveals a mean value of 1.566, a minimum value of -0.303 , and a maximum value of 2.484, with a standard deviation of 0.411. BM, RI, PCDT, and GDPG demonstrate average values of 1.697, 0.747, 1.579, and 0.441 with standard deviations of 0.314, 0.487, 0.413, and 0.434, respectively. In conclusion, the descriptive statistics suggest that the variables in question are promising candidates for further research.

Table 2. Descriptive statistics.

Variable	Obs	Mean	Std. Dev.	Min	Max
FS	2530	1.146	0.271	0.007	1.824
DF	2752	0.465	0.264	-1.910	0.760
DCPS	2954	1.566	0.411	-0.303	2.484
BM	2680	1.697	0.314	0.744	4.124
RI	1880	0.747	0.487	-2.825	2.149
PCDT	2668	1.579	0.413	-0.367	2.484
GDPG	2545	0.441	0.434	-3.865	1.963

4.2. Multicollinearity Test

The present study employs panel data of 160 counties over the period of 2004 to 2024. To address the multicollinearity issue, first, we execute a correlation analysis to detect multicollinearity. As suggested by Wooldridge (2016), it is preferable to tolerate a lower degree of multicollinearity rather than one that is higher than 0.7. Second, we resort to the variance inflation factors, VIF, test to evaluate the results of the correlation between the variables. According to Ott and Longnecker (2010), if the value of the VIF result is greater than 10, there exists high multicollinearity. The right side of the correlation matrix in Table 3 shows the VIF result, where the VIF for each explanatory variable is less than 10. From Table 3, the coefficients found in the correlation matrix additionally indicate that

there exists even less multicollinearity among the variables that were examined; this low multicollinearity would not pose a major problem for further analysis.

Table 3. Correlation Matrix.

	FS	DF	DCPS	BM	RI	PCDT	GDPG	VIF
FS	1.000							
DF	0.101	1.000						1.020
DCPS	0.201	0.097	1.000					1.080
BM	0.011	0.062	0.452	1.000				1.350
RI	−0.011	0.064	−0.206	−0.152	1.000			1.070
PCDT	0.183	0.100	0.086	0.483	−0.218	1.000		2.660
GDPG	−0.085	−0.027	−0.005	0.061	−0.069	0.005	1.000	1.010
								Mean VIF
								3.130

4.3. Cross-Sectional Dependence (CD), Slope Homogeneity (SH), and Unit Root

This research appropriately employs econometric techniques suited to the specific attributes of the data. Results will be inconsistent and difficult to predict if the method is not sufficiently robust. To mitigate these influences, this scholarship utilizes the Cross-sectional dependence, Slope homogeneity, and unit root tests introduced by Pesaran (2007), Pesaran and Yamagata (2008), Friedman (1937), and Pesaran (2004, 2015). An increasing number of individuals are listening to CDs as a consequence of the cascading influence of macroeconomic and microeconomic factors. The CD and SH requirements are incomplete without the inclusion of data integration capabilities.

Starting with the outcomes of cross-sectional dependence tests as demonstrated in Table 4, the empirical analysis confirms the presence of no cross-sectional dependence, as the CD test results accept the null hypothesis of “no cross-sectional dependence” for all factors. Regarding slope homogeneity, the findings adopt an alternative perspective and reject the flawed assumption of invariant variables.

Table 4. Pre-investigative tests.

Test	p-Value	
Pesaran’s Cross-sectional Dependence	50.801	0.213
Friedman’s Cross-sectional Dependence	216.00	0.150
Analysis for Slope Homogeneity	27.006	0.000 ***
Analysis for Slope Homogeneity (ADJ)	34.330	0.000 ***

Note: *** indicates 1% level of significance.

Fisher’s (1934) unit root test is allowed to check for data stationarity for unbalanced panel data, and thus, we have used the same. Based on the findings presented in Table 5, it can be inferred that all variables are stationary at the level and 1st difference.

Table 5. Results of panel unit root tests.

	Level		First Difference	
	Intercept	Intercept + Trend	Intercept	Intercept + Trend
FS	145.532	107.365 ***	1215.599 ***	1122.169 ***
DF	629.736 ***	597.102 ***	1403.509 ***	1179.652 ***
DCPS	565.6612 ***	485.164 ***	1087.183 ***	1023.091 ***
BM	345.611	343.060 **	1102.665 ***	909.469 ***
RI	797.653 ***	651.615 ***	2267.441 ***	1754.023 ***
PCDT	83.4259	54.6978 ***	1044.576 ***	1156.577 ***
GDPG	1030.473 ***	835.143 ***	2985.989 ***	2226.309 ***

Note: ***, and ** indicate variables significant at 1, and 5% significance level, respectively.

4.4. Cointegration Test

If two related variables share the identical integration order $I(1)$, it is essential to define whether they exhibit long-term concordance. To determine whether these variables can be cointegrated, we apply the Westerlund test. The objective of this test is to assess whether the alternative hypothesis or the null hypothesis of no cointegration is more substantiated. In this experiment, the autoregressive (AR) parameter remains unchanged through all panels. Table 6 exhibits the findings of the cointegration test performed by Westerlund (2005), Pedroni (2004), and Kao (1999). Cointegration is observed across all panels based on the statistics, which support the rejection of the null hypothesis that no such relationship exists. Statistical tests consistently reject the null hypothesis of no cointegration at the 5% significance level. A persistent long-term association is evident across all sampled nations, as these variables demonstrate synchronized movement over the extended period. Based on the findings of the Pedroni cointegration test along with the Kao test, as presented in Table 6, the variables are cointegrated, indicating a long-term relationship among them.

Table 6. Results of Cointegration Tests.

	Westerlund	Pedroni	Kao
Variance ratio	42.249 ***		
Modified Phillips–Perron t		15.257 ***	
Phillips–Perron t		−14.341 ***	
Augmented Dickey–Fuller t		−11.130 ***	
Modified Dickey–Fuller t			−7.823 ***
Dickey–Fuller t			−7.689 ***
Augmented Dickey–Fuller t			−3.716 ***

Note: *** indicates significant at 1% level of significance. t stands for test.

4.5. Estimated Results and Their Discussion

Table 7 depicts quantile regression results. The outcome demonstrates that digital finance and financial stability are significantly correlated at specific points in their conditional distribution, particularly at the 40th and 50th percentiles. Quantile regression results reveal that digital finance positively impacts financial stability. The findings of the quantile regression estimate examining the heterogeneous impact of digital finance on bank financial stability. At the lower quantile (Q10–Q30), digital finance reveals a strong and favorable effect on the distribution of financial stability, as shown by the bank Z-score. This suggests that financially struggling nations become more robust in the financial banking system as physical access (ATMs) expands. At the middle quantile (Q30–Q60), digital finance remains positive and significant, but it has a minor effect on financial stability, demonstrating that ATM expansions decrease marginal benefit. At higher quantiles (Q70–Q90), DF shows a positive but mostly statistically insignificant result. This implies that access expansion plays a limited role in a highly stable banking system. Though not the same, the positive coefficient across quantiles shows that digital finance has a significant effect on financial stability. Nonetheless, the lowest quantile (Q10) has the largest magnitude, which means that digital finance has its strongest influence in a financially fragile system. This finding is similar to the findings of Quoc et al. (2025). Digital finance improves lending, liquidity, risk diversification, and transaction costs, especially in financially weak economies. On the contrary, the quantile regression results suggest that digital finance may exacerbate systemic risk or introduce new issues in advanced countries (larger quantiles), rather than promoting inclusivity. Once a financial system reaches a certain level of maturity and stability, such as the after 50th quantile towards 90th quantile, the incremental improvement from additional digital adoption is smaller compared to the transformative impact in less developed financial systems (Khattak et al., 2023). Consequently, digital finance remains

beneficial; however, the positive impact on financial stability does not increase uniformly across quantiles.

Table 7. Quantile regression results for financial stability.

Variable	Quantiles								
	10	20	30	40	50	60	70	80	90
DF	0.352 ** (0.179)	0.077 (0.101)	0.114 * (0.063)	0.086 * (0.048)	0.080 ** (0.039)	0.047 (0.046)	0.082 ** (0.038)	0.059 (0.063)	0.105 (0.075)
DCPS	0.355 (0.444)	0.227 (0.469)	0.437 (0.432)	0.363 (0.332)	0.290 (0.233)	0.272 * (0.154)	0.407 ** (0.187)	0.374 ** (0.182)	0.454 ** (0.196)
BM	−0.017 (0.051)	−0.062 (0.046)	−0.071 ** (0.036)	−0.070 ** (0.029)	−0.089 *** (0.026)	−0.092 ** (0.154)	−0.099 *** (0.038)	−0.106 *** (0.016)	−0.065 ** (0.037)
RI	−0.034 (0.043)	0.054 *** (0.019)	0.023 (0.026)	0.013 (0.020)	−0.003 (0.018)	0.006 (0.020)	−0.013 (0.020)	−0.014 (0.021)	−0.003 (0.026)
PCDT	0.270 * (0.455)	0.110 (0.478)	0.321 (0.451)	0.254 (0.347)	0.174 * (0.241)	0.126 (0.152)	0.255 (0.196)	0.178 (0.194)	0.268 * (0.197)
GDPG	0.076 ** (0.040)	0.060 * (0.034)	0.043 (0.028)	0.024 (0.023)	0.023 * (0.021)	0.013 (0.016)	0.023 (0.023)	0.050 (0.031)	0.021 * (0.022)
Constant	0.621 *** (0.158)	0.872 *** (0.119)	0.980 *** (0.064)	1.075 *** (0.062)	1.151 *** (0.042)	1.151 *** (0.041)	1.200 *** (0.052)	1.224 *** (0.055)	1.193 *** (0.064)
Observations	814	814	814	814	814	814	814	814	814

Note: Bootstrap standard errors are in the parentheses. ***, **, * specifies variables significant at 1, 5, and 10% significance levels, respectively.

Quantile regression analysis further indicates that stable interest rates and a substantial financial sector both promote financial stability, whereas government debt exerts an opposing influence. According to researchers who employed the Z-score, a financial stability metric, the likelihood of financial institution failure decreased substantially as the use and accessibility of digital finance increased. We discovered the same result, which is consistent with the outcomes of [Han and Melecky \(2013\)](#), [Hannig and Jansen \(2010\)](#), and [Morgan and Pontines \(2014\)](#). As a result, we believe that the stability and resilience of the financial system are significantly enhanced by the increased accessibility and usage of digital money.

Our findings corroborate the results of [Morgan and Pontines \(2014\)](#), who discovered that GDP growth substantially improved the Z-score among control variables. This suggests that countries with higher incomes are less likely to experience financial instability. In addition, real-world data from banks indicates that the health of financial institutions improves in conjunction with the growth of private credit relative to GDP. We discovered that financial stability was significantly enhanced by a more robust financial sector, as [Gelb \(1989\)](#) and [King and Levine \(1993\)](#) had previously demonstrated. Our findings are consistent with those of [Sanogo and Moussa \(2017\)](#), who also found that real interest rates foster stability.

4.6. Robustness Checks

To appraise the vigor of the baseline model outcomes and account for the long-term relationships among the variables, this study applied two strategies: First, the use of an alternative proxy for the digital finance; Second, split the panel sample according to income classifications. In the first method, we used an alternative indicator, namely, active mobile money accounts for digital finance. We use mobile money accounts (MMA) as the alternative proxy because researchers (for example, [Hasan et al., 2024](#); [Shaikh et al., 2023](#)) have observed that mobile money is a significant indicator of economic growth through digital financial inclusion. Data on mobile money accounts have been collected from the financial access survey of the International Monetary Fund for the same 160 countries over the period of 2004 to 2024, and then quantile regression has been conducted. Results are

presented in Table 8. According to Table 8, the results are similar to the findings of the baseline model. Thus, we conclude that our findings are robust.

Table 8. Robustness check by alternative proxy.

Variable	Quantile								
	10	20	30	40	50	60	70	80	90
MMA	0.001 ***	0.002 ***	0.0021 ***	0.003 **	0.001	0.001	0.004 *	0.004 *	0.001 *
DCPS	0.069	0.099	−0.135	0.016	−0.031	0.164	0.054	0.233	0.742
BM	0.016	0.026	0.027	−0.001	0.062	0.008	0.052	0.033	0.235
RI	0.001	0.120 ***	0.133 ***	0.103 ***	0.095 ***	0.074 *	0.075	0.087	0.091
PCDT	−0.002	−0.048	0.170	0.056	0.055	−0.043	0.014	−0.130	−0.744
GDPG	−0.029	0.063	0.158	0.093	0.084	0.089	0.117	0.054	0.150
Constant	4.716 ***	6.242 ***	8.105 ***	10.404 ***	10.503 ***	15.236 ***	12.939 ***	16.388 ***	15.835 ***
Observations	1275	1275	1275	1275	1275	1275	1275	1275	1275

Note: ***, **, * specifies variables significant at 1, 5, and 10% significance levels, respectively.

In the second approach, we split our panel sample of 160 nations from 2004 to 2024 based on the World Bank's classification into high, middle, and low-income countries. To create middle-income countries, we blend the economies of the upper and lower middle-income countries. Results in Table 9 indicate that digital finance has a significant positive impact on the financial stability of all three types of countries, as classified by high-income, middle-income and low-income countries. This result strongly supports the findings of the baseline quantile regression model, indicating the robustness of the findings.

Table 9. Robustness check by countries' income classifications.

		Quantiles								
Countries' Income Classifications	Variable	10	20	30	40	50	60	70	80	90
High income	DF	0.0704 (0.102)	0.141 (0.0859)	0.148 * (0.0626)	0.134 *** (0.0321)	0.139 *** (0.0280)	0.149 *** (0.0231)	0.158 *** (0.0297)	0.106 ** (0.0395)	0.142 *** (0.0390)
	con	0.824 *** (0.0554)	0.952 *** (0.0431)	1.053 *** (0.0381)	1.099 *** (0.0175)	1.133 *** (0.0157)	1.159 *** (0.0130)	1.190 *** (0.0201)	1.251 *** (0.0201)	1.317 *** (0.0210)
Middle income	DF	0.248 *** (0.0548)	0.124 *** (0.0342)	0.112 ** (0.0353)	0.106 (0.0648)	0.0867 (0.0766)	−0.0212 (0.0689)	−0.0986 (0.0635)	−0.0719 (0.0605)	−0.0717 (0.0500)
	con	0.675 *** (0.0352)	0.856 *** (0.0206)	0.942 *** (0.0227)	1.015 *** (0.0401)	1.116 *** (0.0450)	1.241 *** (0.0379)	1.333 *** (0.0298)	1.401 *** (0.0273)	1.526 *** (0.0275)
Low income	DF	0.206 (0.192)	0.191 *** (0.0343)	0.232 *** (0.0484)	0.246 *** (0.0531)	0.271 *** (0.0614)	0.265 *** (0.0512)	0.284 *** (0.0517)	0.272 *** (0.0757)	0.124 (0.111)
	con	0.857 *** (0.121)	0.908 *** (0.0203)	0.952 *** (0.0203)	0.991 *** (0.0305)	1.034 *** (0.0205)	1.090 *** (0.0232)	1.106 *** (0.0262)	1.175 *** (0.0392)	1.337 *** (0.0610)

Note: ***, **, * specifies variables significant at 1, 5, and 10% significance levels, respectively.

5. Conclusions

This study aimed to examine the correlation between the financial stability of banking sectors in countries and digital finance. Using cross-country panel data from 2004 to 2024 and employing Moment Quantile Regression (MMQREG) techniques, this study addressed a lacuna in the literature by testing the hypothesis that digital finance enhances financial stability. The literature has primarily concentrated on the correlation between the two, rather than the underlying causes. Other studies discovered either ambiguous or negative consequences, while some earlier research suggested that digital finance would enhance financial stability. Robust findings indicate that digital finance, as indicated by the number of ATMs per 100,000 individuals, significantly improves financial stability. We conclude that digital finance exerts a positive impact on financial stability in the selected

countries, although the specific nature of this effect is contingent upon other variables. To put it simply, the likelihood of financial institutions defaulting decreases as digital finance expands. Additionally, we found that the growth rate of GDP, interest rates, and M2/GDP had a positive effect on financial stability. These results remain valid when additional factors that could account for the results are taken into account. In light of these findings, the research suggests that national governments should take action to promote digital finance and contribute to the objective of increased financial stability.

Our policy recommendation for countries is to reassess their regulatory frameworks concerning digital finance. Only then will they be able to effectively associate mobile phone usage with financial services and, ultimately, ensure the long-term sustainability of their banking system. Given the profound implications of digital financial technology for the financial stability of nations, the study recommends that policymakers evaluate the current landscape of digital finance platforms—particularly internet access and mobile phone subscriptions—as well as the relevant banking regulations. Subsequently, they should establish appropriate safeguards to monitor the utilization of these technologies by both financial institutions and consumers. Specifically, in order to assess how policies and initiatives concerning digital finance and banking may enhance the stability of the banking system, they should be appraised according to specific financial stability criteria. Thus, it is indispensable to examine regulatory frameworks and the methods by which unbanked individuals engage with the financial ecosystem via digital finance. Furthermore, the research suggests that the countries sustain or strengthen their existing policies concerning the beneficial influence of internet utilization on financial stability.

Limitations and Future Research

The key limitation of this research was the lack of data, particularly data on digital banking-related attributes. Despite the fact that there are numerous variables that could be used to assess financial stability, we were unable to include all of them due to the fact that several digital finance measures only have data for one or two years. When data becomes accessible, the integration of the domestic sector into the nation's financial system could be utilized for future research. When data on additional indicators of financial stability, for instance, stock market instability, changes in bank deposits, and financial crises, becomes available, they can be utilized in a similar manner to ascertain the influence of digital financial inclusion on financial stability. Finally, regional economies have undertaken initiatives to enhance digital finance and financial stability; therefore, the effect of digital financial technology on the stability of emerging countries may diverge across regions. The principal focus of the study, however, was not on the regional groups. Consequently, future research should consider conducting more comprehensive analyses that incorporate regional classifications.

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Appendix A. The List of Sample Countries

High Income	Upper Middle Income	Lower Middle Income	Low Income
Antigua and Barbuda	Albania	Angola	Afghanistan
Australia	Algeria	Bangladesh	Burkina Faso
Austria	Argentina	Benin	Burundi
The Bahamas	Armenia	Bhutan	Central African Rep.
Barbados	Azerbaijan	Bolivia	Chad
Belgium	Belize	Cambodia	Ethiopia
Bulgaria	Bosnia and Herzegovina	Cameroon	The Gambia
Canada	Botswana	Comoros	Guinea-Bissau
Chile	Brazil	Congo, Rep.	Liberia
Costa Rica	Cabo Verde	Egypt, Arab Rep.	Madagascar
Croatia	China	Eswatini	Malawi
Czechia	Colombia	Ghana	Mali
Denmark	Dominica	Guinea	Mozambique
Estonia	Dominican Republic	Haiti	Niger
Finland	Ecuador	Honduras	Rwanda
France	El Salvador	India	Sierra Leone
Germany	Fiji	Jordan	South Sudan
Greece	Gabon	Kenya	Sudan
Guyana	Georgia	Kyrgyz Republic	Togo
Hong Kong SAR, China	Grenada	Lebanon	Uganda
Hungary	Guatemala	Lesotho	Yemen Republic
Iceland	Indonesia	Mauritania	
Ireland	Iraq	Morocco	
Israel	Jamaica	Myanmar	
Italy	Kazakhstan	Namibia	
Japan	Kosovo	Nepal	
Kuwait	Libya	Nicaragua	
Latvia	Malaysia	Nigeria	
Lithuania	Maldives	Pakistan	
Luxembourg	Mauritius	Papua New Guinea	
Macao SAR, China	Mexico	Philippines	
Malta	Moldova	São Tomé and Príncipe	
Netherlands	Mongolia	Senegal	
New Zealand	Montenegro	Sri Lanka	
Norway	North Macedonia	Tunisia	
Oman	Paraguay	Uzbekistan	
Panama	Peru	Vanuatu	
Poland	Serbia	Vietnam	
Portugal	South Africa	Zambia	
Qatar	St. Lucia	Zimbabwe	
Romania	Suriname		

High Income	Upper Middle Income	Lower Middle Income	Low Income
Russian Federation	Thailand		
San Marino	Türkiye		
Saudi Arabia	Ukraine		
Seychelles			
Singapore			
Slovak Republic			
Slovenia			
Spain			
Sweden			
Switzerland			
Trinidad and Tobago			
United Arab Emirates			
United States			
Uruguay			

References

- Akbas, Y. E. (2015). Financial development and economic growth in emerging market: Bootstrap panel causality analysis. *Theoretical & Applied Economics*, 22(3), 171–186.
- Al-Smadi, M. O. (2023). Examining the relationship between digital finance and financial inclusion: Evidence from MENA countries. *Borsa Istanbul Review*, 23(2), 464–472. [\[CrossRef\]](#)
- Anton, S., & Afloarei Nucu, A. E. (2024). The impact of digital finance and financial inclusion on banking stability: International evidence. *Oeconomia Copernicana*, 15(2), 563–593. [\[CrossRef\]](#)
- Antwi, F., & Kong, Y. (2023). Investigating the impacts of digital finance technology on financial stability of the banking sector: New insights from developing market economies. *Cogent Business & Management*, 10(3), 2284738. [\[CrossRef\]](#)
- Banna, H., & Alam, M. R. (2021). Impact of digital financial inclusion on ASEAN banking stability: Implications for the post-COVID-19 era. *Studies in Economics and Finance*, 38(2), 504–523. [\[CrossRef\]](#)
- Bede Uzoma, A., Omankhanlen, A. E., Obindah, G., Arewa, A., & Okoye, L. U. (2020). Digital finance as a mechanism for extending the boundaries of financial inclusion in sub-Saharan Africa: A general methods of moments approach. *Cogent Arts & Humanities*, 7(1), 1788293. [\[CrossRef\]](#)
- Buchinsky, M. (1998). Recent advances in quantile regression models: A practical guideline for empirical research. *Journal of Human Resources*, 33(1), 88–126. [\[CrossRef\]](#)
- Čihák, M., & Hesse, H. (2010). Islamic banks and financial stability: An empirical analysis. *Journal of Financial Services Research*, 38(2), 95–113. [\[CrossRef\]](#)
- Diaconu, R. I., & Oanea, D. C. (2014). The main determinants of bank's stability: Evidence from Romanian banking sector. *Procedia Economics and Finance*, 16(5), 329–335. [\[CrossRef\]](#)
- Drehmann, M., & Juselius, M. (2014). Evaluating early warning indicators of banking crises: Satisfying policy requirements. *International Journal of Forecasting*, 30(3), 759–780. [\[CrossRef\]](#)
- Fisher, R. A. (1934). *Statistical methods for research workers* (5th ed). Oliver & Boyd.
- Friedman, M. (1937). The use of ranks to avoid the assumption of normality implicit in the analysis of variance. *Journal of the American Statistical Association*, 32(200), 675–701. [\[CrossRef\]](#)
- Gelb, A. H. (1989). *Financial policies, growth, and efficiency*. World Bank.
- Gourinchas, P. O., & Obstfeld, M. (2012). Stories of the twentieth century for the twenty-first. *American Economic Journal: Macroeconomics*, 4(1), 226–265. [\[CrossRef\]](#)
- Han, R., & Melecky, M. (2013). *Financial inclusion for financial stability: Access to bank deposits and the growth of deposits in the global financial crisis*. World Bank.
- Hannig, A., & Jansen, S. (2010). *Financial inclusion and financial stability: Current policy issues*. Asian Development Bank Institute.
- Hasan, M. M., Sayem, M. A., & Hossain, B. S. (2024). Resolving the paradox: How mobile money drives economic growth through financial inclusion. *Heliyon*, 10(19), e38755. [\[CrossRef\]](#) [\[PubMed\]](#)
- Hordofa, D. F. (2024). Impact of digital transformation on financial stability in emerging markets: Evidence from Ethiopia. *Discover Sustainability*, 5(1), 309. [\[CrossRef\]](#)

- Kao, C. (1999). Spurious regression and residual-based tests for cointegration in panel data. *Journal of Econometrics*, 90(1), 1–44. [\[CrossRef\]](#)
- Khattak, M. A., Ali, M., Azmi, W., & Rizvi, S. A. R. (2023). Digital transformation, diversification and stability: What do we know about banks? *Economic Analysis and Policy*, 78, 122–132. [\[CrossRef\]](#)
- King, R. G., & Levine, R. (1993). Finance and growth: Schumpeter might be right. *The Quarterly Journal of Economics*, 108(3), 717–737. [\[CrossRef\]](#)
- Lakhoul, A., & Segdali, M. (2024). The impact of digital finance on financial inclusion in Morocco. *European Journal of Economic and Financial Research*, 8(4), 27–50. [\[CrossRef\]](#)
- Manyika, J., Lund, S., Singer, M., White, O., & Berry, C. (2016). *Digital finance for all: Powering inclusive growth in emerging economies*. McKinsey Global Institute.
- Morgan, P., & Pontines, V. (2014). *Financial stability and financial inclusion*. Asian Development Bank Institute.
- Okoli, T. T. (2025). Gauging the impact of digital finance on financial stability in the presence of multiple unknown structural breaks: Evidence from developing economies. *Economies*, 13(7), 187. [\[CrossRef\]](#)
- Ott, L. R., & Longnecker, M. T. (2010). *An introduction to statistical methods and data analysis* (6th ed). Cengage Learning.
- Pedroni, P. (2004). Panel cointegration: Asymptotic and finite sample properties of pooled time series tests with an application to the PPP hypothesis. *Econometric Theory*, 20(3), 597–625. [\[CrossRef\]](#)
- Pesaran, M. H. (2004). *General diagnostic tests for cross section dependence in panels*. Cambridge University.
- Pesaran, M. H. (2007). A simple panel unit root test in the presence of cross-section dependence. *Journal of Applied Econometrics*, 22(2), 265–312. [\[CrossRef\]](#)
- Pesaran, M. H. (2015). Testing weak cross-sectional dependence in large panels. *Econometric Reviews*, 34(6–10), 1089–1117. [\[CrossRef\]](#)
- Pesaran, M. H., & Yamagata, T. (2008). Testing slope homogeneity in large panels. *Journal of Econometrics*, 142(1), 50–93. [\[CrossRef\]](#)
- Quoc, H. N., Le Quoc, D., & Van, H. N. (2025). Assessing digital financial inclusion and financial crises: The role of financial development in shielding against shocks. *Heliyon*, 11(1), e41231. [\[CrossRef\]](#) [\[PubMed\]](#)
- Rajhi, W., & Hassairi, S. A. (2013). Islamic banks and financial stability: A comparative empirical analysis between MENA and Southeast Asian countries. *Région et Développement*, 37(3), 149–179. [\[CrossRef\]](#)
- Sanogo, V., & Moussa, R. K. (2017). Financial reforms, financial development, and economic growth in the Ivory Coast. *Economies*, 5(1), 7. [\[CrossRef\]](#)
- Sarma, M. (2015). Measuring financial inclusion. *Economics Bulletin*, 35(1), 604–611.
- Shaikh, A. A., Glavee-Geo, R., Karjaluo, H., & Hinson, R. E. (2023). Mobile money as a driver of digital financial inclusion. *Technological Forecasting and Social Change*, 186, 122158. [\[CrossRef\]](#)
- Westerlund, J. (2005). New simple tests for panel cointegration. *Econometric Reviews*, 24(3), 297–316. [\[CrossRef\]](#)
- Wooldridge, J. M. (2016). *Introductory econometrics: A modern approach* (6th ed.). Cengage Learning.

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