Tanwirul Uqul: Jurnal Ekonomi dan Bisnis Islam
e-ISSN 2746-1017, p-ISSN 2746-1009
Vol. 06, No. 01 (2025), pp. 1-21
URL: https://journalstebiabangkalan.com/index.php/tanwiruluqul

The Role of Digital Financial Inclusion in Shaping Bank Stability Within a Dual Banking Framework: Examining the Moderating Influence of Financial Literacy

MD. Shariful Haque[1]
[1] International Islamic University, Chittagong, Bangladesh

Article Info

Keywords:
Digital financial inclusion; bank stability; financial literacy; dual banking.

Article history:
Received: 2024-03-13
Revised: 2024-12-08
Accepted: 2025-02-20

Abstract

This study investigates the interplay between digital financial inclusion (DFI), financial literacy, and the stability of both conventional and Islamic banks across 15 countries over the period spanning 2011 to 2020. The empirical evidence reveals that DFI substantially enhances the stability of conventional banks, primarily through heightened customer engagement with digitally delivered financial services, improved asset quality, and reduced exposure to financial risks. In contrast, the association between DFI and the stability of Islamic banks is found to be either statistically negligible or negative in direction, a pattern attributable to constraints imposed by Shariah compliance requirements, structural product mismatches, and intensifying competitive pressures from conventional banks and financial technology firms. Furthermore, although DFI contributes positively to the resilience of conventional banks, it simultaneously exposes these institutions to novel vulnerabilities, including the risk of digitally enabled bank runs, as illustrated by the collapse of Silicon Valley Bank in 2023. The evidence further indicates that high financial literacy positively moderates the DFI-stability relationship in conventional banks, whereas its effect on Islamic banks is negative. This divergence stems from the propensity of financially literate customers to resist digital financial products that fail to fully satisfy Islamic financial principles. The findings collectively underscore the imperative for tailored institutional strategies within the Islamic banking sector, encompassing the development of Shariah-compliant digital products, the strengthening of financial literacy programs grounded in Islamic finance principles, and the adoption of robust risk governance frameworks designed to mitigate vulnerabilities associated with rapid digital deposit withdrawals.

Corresponding Author:
MD. Shariful Haque
International Islamic University, Chittagong, Bangladesh; sharif.debiiuc@gmail.com

Citation:
Haque, M.D.S. (2025). The Role of Digital Financial Inclusion in Shaping Bank Stability Within a Dual Banking Framework: Examining the Moderating Influence of Financial Literacy. *Tanwirul Uqul, 6*(1), 1-21.

1. INTRODUCTION

Digital financial services have been widely acknowledged for their capacity to significantly improve the stability, operational efficiency, and overall performance of banking institutions, while simultaneously attracting new deposit and loan customers (Hua et al., 2023; Banna et al., 2021). A central driver of these outcomes is digital financial inclusion (DFI), which has assumed a pivotal role in restoring public trust and institutional confidence in the banking sector, particularly in the aftermath of the global financial crisis (Ahamed et al., 2021). Among the various instruments of digital finance, mobile banking has emerged as particularly consequential, given its widespread impact on both consumers and financial institutions (Manyika et al., 2016; Banna & Alam, 2020). By the close of 2020, digital financial services had succeeded in integrating 1.6 billion previously unbanked individuals into the formal financial system, reducing remittance costs by 3.3 percent, facilitating 600 billion dollars in cross-border transfers, providing 394 billion dollars in financing to small and medium-sized enterprises, and enabling nearly 1.3 billion dollars in daily transactions through 850 million mobile money agent accounts (Pazarbasioglu et al., 2020; Sahay et al., 2020).

Nevertheless, this rapid pace of digital expansion has generated significant challenges alongside its benefits. Banks in developing economies frequently contend with outdated technological infrastructure, limited institutional awareness of financial technology, and mounting competitive pressures from private and shadow banking entities, all of which can undermine transparency, accountability, and ethical standards, thereby threatening financial stability (Bao & Huang, 2021; Huang, 2018). The 2023 collapse of Silicon Valley Bank, precipitated by an excessive concentration of uninsured deposits and investments in hold-to-maturity securities, powerfully illustrates the fragility that rapid digital expansion can introduce into the banking system (Ali et al., 2023; Turner, 2023). It warrants explicit clarification that the SVB episode occurred in 2023, which falls beyond the empirical window of 2011 to 2020 adopted in the present study. Its inclusion is therefore appropriately characterised as a post-hoc contextual illustration of the systemic risks associated with rapid digital expansion, rather than as empirical evidence drawn from the study dataset (Federal Deposit Insurance Corporation, 2023).In light of these countervailing forces, this study addresses a fundamental question regarding whether digital financial inclusion ultimately proves beneficial or detrimental to bank stability, with particular reference to dual banking systems in which conventional and Islamic banks coexist.

Within this context, financial literacy emerges as an important moderating factor in the adoption and effective use of digital financial technologies. Financial literacy broadly refers to the capacity of individuals to comprehend and manage their personal finances effectively, including the ability to identify and evaluate financial risks (Klapper et al., 2013; Klapper & Lusardi, 2020; Angrisani et al., 2023). Core competencies in this domain encompass budgeting, saving, investing, and debt management (Al Rahahleh, 2022; Vovchenko et al., 2018), and their relevance is amplified as individuals engage more extensively with digital financial products and services (Morgan, 2021; Yoshino et al., 2020). Recognizing the significance of this dimension, this study pursues a supplementary research question: whether financial literacy moderates the relationship between digital financial inclusion and bank stability within dual banking systems.

Although a substantial body of scholarship has examined the macro-level linkages between financial inclusion and bank sector stability (Ahamed & Mallick, 2019; Banna & Alam, 2020; Banna et al., 2022; Ozili, 2018; Vo et al., 2021; Danisman & Tarazi, 2020), the majority of existing studies concentrate on broad macroeconomic determinants such as economic growth, inflation, and monetary policy (Xi & Wang, 2023; Oanh, 2023). Research on financial literacy has similarly expanded its scope, investigating dimensions including personal financial planning and the role of financial technology in advancing societal welfare (Panos & Wilson, 2020; Bermeo-Giraldo et al., 2023). However, despite growing recognition of the interconnections among digital financial

inclusion, financial literacy, and bank stability, empirical inquiry into how these factors interact within dual banking environments remains limited, largely due to data constraints. To address this gap, the present study examines how financial literacy conditions the relationship between digital financial inclusion and bank stability in dual banking systems.

This study makes several notable contributions to the existing literature. First, it examines the relationship between digital financial inclusion and bank stability in dual banking systems, thereby illuminating an ongoing debate regarding how digital financial inclusion differentially affects conventional and Islamic banks. This inquiry is particularly salient given the remarkable global growth trajectory of Islamic finance, which recorded a compound annual growth rate of 10.1 percent from 2016 to 2021, with Islamic banking assets projected to surpass four trillion dollars by 2026 (Refinitiv, 2022). Islamic banks have demonstrated a superior capacity to restore financial stability in the aftermath of the global financial crisis relative to their conventional counterparts (Banna et al., 2022). Second, the study investigates the mechanism through which financial literacy shapes the nexus between digital financial inclusion and bank stability. Third, it incorporates both demand-side and supply-side proxies for digital financial inclusion. Finally, to ensure the robustness of the findings, various econometric techniques are employed. The paper proceeds as follows. Section II reviews the relevant literature and presents the hypotheses. Section III describes the data, variables, models, and estimation techniques. Section IV presents the main results and robustness tests, while Section V concludes.

2. LITERATURE REVIEW AND HYPOTHESES DEVELOPMENT

The theoretical framework underpinning this study draws on four distinct perspectives that collectively reflect the dual nature of DFI and its implications for bank stability, encompassing both its potential benefits and attendant risks.

The first perspective is grounded in the finance-growth hypothesis, which posits a positive association between financial development and economic growth (Beck et al., 2014a). Digital financial services stimulate economic expansion by broadening the accessibility of financial products and services, thereby increasing participation in the formal financial system (Kanga et al., 2022; Han & Melecky, 2013). In this context, DFI serves to reduce information asymmetries (Beck et al., 2014b) and enables banking institutions to realize economies of scale (Kacperczyk & Schnabl, 2013). By simplifying access to credit, particularly for small and medium-sized enterprises (SMEs), DFI helps to address the longstanding "missing middle" gap that has historically impeded SME financing (Ozili, 2018; Banna & Alam, 2020).

The second perspective cautions that DFI is not without substantial risks. Heavy reliance on digital financial models, particularly by large, technologically sophisticated banks, may give rise to moral hazard problems. As digital lending expands, banks may extend credit indiscriminately, thereby incentivizing the securitization of loans and the offloading of associated risks, a practice implicated in the 2008 Global Financial Crisis (Pierri & Timmer, 2020). In developing economies characterized by weak regulatory frameworks, technologically advanced large banks may exploit competitive advantages over smaller institutions, potentially encouraging riskier conduct (Bertay et al., 2013). The competition-stability hypothesis further suggests that the concentration of technological capacity among large banks may attenuate market competition, thereby elevating risk-taking behavior and moral hazard (Chan et al., 1986; Mishkin, 1999).

The third perspective, derived from the theory of technology diffusion, contends that the effectiveness of DFI is contingent upon the quality of financial innovation and the robustness of underlying technological infrastructure. Even in advanced economies, low-quality financial innovations combined with inadequate infrastructure may generate uneven growth and systemic instability (Hua et al., 2023). The fourth perspective draws on the instructive precedent of the

2023 SVB collapse, which vividly demonstrates how DFI can destabilize banking institutions. SVB experienced a rapid and technologically enabled bank run, as primarily tech-oriented depositors withdrew funds at unprecedented speed, depleting SVB's liquidity reserves and precipitating its collapse within less than 48 hours (Ali et al., 2023; Turner, 2023). This episode highlights the urgent need for updated regulatory frameworks capable of addressing the high-velocity nature of digital transactions. It is explicitly noted that the SVB episode occurred in 2023 and therefore falls outside the empirical period of 2011 to 2020; within this study, it serves exclusively as a post-hoc theoretical illustration of the destabilising potential of rapid digital expansion, not as an empirical observation (Federal Deposit Insurance Corporation, 2023).

A substantial body of literature suggests that DFI has the potential to enhance bank stability through multiple transmission channels. Through remote financial transactions and services, DFI enables banks to expand deposit collection, streamline loan processing, and widen their customer reach (Gomber et al., 2017; Vo et al., 2021). The cost-benefit hypothesis holds that DFI can improve bank performance, efficiency, and stability by lowering customer acquisition costs and broadening the customer base. Danisman & Tarazi (2020), in a study of 4,168 banks across 28 European Union countries over the period 2010 to 2017, find that financial inclusion promotes bank stability. Ahamed & Mallick (2019), analyzing data from 2,635 banks across 86 countries, similarly find that financial inclusion positively influences bank stability. These effects operate through three primary channels: promoting economies of scale and stable low-cost deposit funding (Ahamed & Mallick, 2019; Manyika et al., 2016); alleviating financial constraints for SMEs and individuals while minimizing pro-cyclical risks (Han & Melecky, 2013); and equipping banks to curtail non-performing loans and default risk (Morgan & Pontines, 2018). On the other hand, the ease of access to low-cost funding may also incentivize risk-taking among large banks, potentially generating instability over the longer term (Bertay et al., 2013). Prior to stating the hypotheses, it is necessary to articulate the distinct transmission pathways through which DFI is theorised to affect Islamic bank stability. Through the Shariah compliance channel, restrictions on interest-bearing digital instruments reduce the breadth of permissible products, limiting customer engagement and constraining the deposit diversification gains that support stability (Banna and Alam, 2021). Through the product mismatch channel, the predominantly interest-based architecture of prevailing digital financial tools is structurally misaligned with the profit-and-loss sharing arrangements central to Islamic finance, dampening adoption rates and undermining the efficiency gains DFI might otherwise generate (Lukonga, 2015). Through the competitive pressure channel, the superior digital capabilities of conventional banks and financial technology firms place Islamic banks at a structural disadvantage, eroding their deposit base and amplifying liquidity risk. These three mechanisms may operate individually or in combination, and their relative dominance in any given context determines whether the net effect of DFI on Islamic bank stability is neutral or negative. Based on this discussion, the study proposes the following hypotheses.

H1a: Digital financial inclusion positively influences the stability of conventional banks through enhanced customer engagement, operational cost efficiencies, and expanded deposit bases.

H1b: Digital financial inclusion is expected to exert a neutral or negative effect on the stability of Islamic banks, with the directionality contingent upon the relative dominance of three distinct transmission mechanisms identified in the preceding discussion. A neutral outcome is anticipated when Shariah compliance constraints and product mismatches constitute the binding forces, as these factors prevent sufficient customer engagement to generate meaningful stability gains while stopping short of inducing net deposit outflows. A negative outcome is expected when competitive pressure from conventional banks and financial technology firms constitutes the primary operative mechanism, as this erodes the deposit base and amplifies liquidity vulnerabilities in Islamic banking institutions.

Financial literacy has gained broad recognition as a critical determinant of economic well-being at both the individual and societal levels (OECD/INFE, 2015). Enhancing financial literacy is regarded as a key mechanism for promoting financial inclusion by making financial products and services more accessible (Demirgüç-Kunt & Klapper, 2012). Those lacking adequate financial knowledge face substantial barriers to benefiting from improvements in the availability of financial services (Al Suwaidi & Mertzanis, 2024; Lusardi & Mitchell, 2014). The proliferation of digital banking accentuates the need for enhanced financial literacy to enable individuals to navigate novel financial products and services. Research demonstrates that digital financial solutions, and mobile banking in particular, have significantly advanced financial inclusion in developing economies (Demirgüç-Kunt & Singer, 2017; Jack et al., 2013; Suri, 2017). Against this backdrop, the following hypotheses are proposed.

H2a: High financial literacy strengthens the positive relationship between digital financial inclusion and the stability of conventional banks by enabling customers to engage more productively with digital financial products.

H2b: High financial literacy attenuates the relationship between digital financial inclusion and Islamic bank stability, as financially literate customers are more likely to resist digital products that fail to fully satisfy Shariah compliance requirements.

Despite the considerable body of research on the effects of DFI on bank stability and the importance of financial literacy, meaningful gaps remain in the literature. The majority of studies concentrate on developed economies and large banking institutions, with limited attention to how DFI, financial literacy, and bank stability interact within dual banking systems. The specific moderating influence of financial literacy on the DFI-stability nexus remains underexplored, and developing countries face distinctive challenges, including technological disparities and moral hazard risks, which demand further empirical investigation.

3. RESEARCH METHOD

3.1. Data

The final dataset comprises 3,350 bank-year observations drawn from both listed and non-listed banking institutions over the period 2011 to 2020, spanning 15 countries: Bangladesh, Benin, Indonesia, Jordan, Kenya, Malaysia, Nigeria, Pakistan, the Philippines, Qatar, Senegal, South Africa, Sudan, Thailand, and Tanzania. Indonesia accounts for the largest share of observations at 23.94 percent, followed by Bangladesh at 11.91 percent and Malaysia at 8.90 percent, with these three economies collectively representing 44.75 percent of the sample. The 3,350 bank-year observations are drawn from 418 distinct banking institutions comprising 350 conventional banks and 68 Islamic banks, yielding an average of approximately eight annual observations per bank, a panel depth that adequately supports the rolling-window computation of the Z-score and its logarithmic transformation. The selection of sample banks is guided by the availability of DFI data and the presence of dual banking systems in the respective countries, each featuring both conventional and Islamic banking sectors operating concurrently. Beyond data availability and the concurrent operation of dual banking systems, the selection of these 15 countries reflects three additional criteria. First, each country exhibits a meaningful proportion of both conventional and Islamic banking assets, ensuring genuine dual-banking dynamics rather than token Islamic banking presence. Second, the selected countries represent diverse regional contexts spanning Sub-Saharan Africa, South Asia, Southeast Asia, and the Middle East, thereby guarding against region-specific bias and enhancing the external validity of the findings. Third, the sample countries exhibit sufficient variation in institutional quality, financial system depth, and regulatory frameworks to enable meaningful cross-country identification of the DFI-stability relationship (Kaufmann et al., 2010).

Bank-specific variable data are sourced from the Orbis Bank-Focus database. Information on digital financial inclusion is obtained from the Financial Access Survey (FAS) administered by the International Monetary Fund (IMF), the Global Findex database maintained by the World Bank, and the published reports of individual countries' central banks. Macroeconomic variables are drawn from World Bank sources, comprising the World Development Indicators (WDI) and the Worldwide Governance Indicators (WGI). Table 1 provides detailed definitions and descriptive statistics for all variables employed in the analysis.

3.2. Variables

3.2.1. Bank stability

Following the approach of Ahamed & Mallick (2019), two proxies are employed to capture bank stability. The first is the Z-score, calculated as the return on average assets (ROAA) plus the equity-to-total-assets ratio (EQT), divided by the standard deviation of ROAA (SDROAA), computed using a three-year rolling window for each bank. The second proxy is the EQT/SDROAA ratio, which serves as a measure of leverage or asset quality. Higher Z-score values indicate lower risk and greater stability. To mitigate potential skewness, the natural logarithms of the Z-score (LZS) and the EQT/SDROAA ratio (LEQT_SDROAA) are employed, consistent with the methodology of Ahamed & Mallick (2019).

3.2.2. Digital financial inclusion (DFI) indices

The study constructs a composite DFI index building on the methodological frameworks of Ahamed & Mallick (2019) and Banna & Alam (2020). The DFI index is decomposed into two constituent components: supply-side access (DFI_SA) and demand-side usage (DFI_DU). The Supply-Side Access index (DFI_SA) measures the physical accessibility of digital financial services, with metrics including the number of mobile money agents, non-branch bank outlets, and point-of-sale (POS) terminals per 100,000 adults. The Demand-Side Usage index (DFI_DU) captures the realized use of digital financial services, with metrics encompassing the number of mobile money and e-money accounts per 1,000 adults and the volume and value of mobile and internet banking transactions. To address potential multicollinearity, a two-stage Principal Component Analysis (PCA) is employed. The resulting indices are combined into an overall DFI index, normalized using min-max scaling to ensure all values fall within the range of zero to one.

3.2.3. Financial literacy

Following Al Suwaidi & Mertzanis (2024), financial literacy data are obtained from the Standard & Poor's Global Financial Literacy Survey (2014), which surveyed more than 150,000 adults across 140 economies. Given that financial literacy data are available for only a single year, a binary classification scheme is constructed. The treatment of a single cross-sectional measure as a time-invariant characteristic across the full panel period of 2011 to 2020 represents a methodological assumption that warrants substantive acknowledgment at this stage of the analysis, rather than being deferred solely to the limitations section. In rapidly developing economies such as Indonesia, Bangladesh, and Nigeria, financial literacy levels may have evolved considerably over this decade, rendering a static 2014 proxy imperfectly aligned with the true literacy environment in earlier and later years. To the extent that financial literacy improved over time in high-literacy countries, the present classification may understate the moderating effect of literacy in later years for those countries; conversely, in countries that experienced stagnation, the proxy may overstate it. The potential attenuation bias introduced by this measurement limitation is acknowledged, and the robustness of the principal findings across multiple estimation strategies provides partial mitigation. Future research incorporating temporally granular financial literacy data would substantively address this constraint. High Financial Literacy (FIN_LIT_H) is operationalized as a dummy variable taking the value of one if a country's financial literacy level exceeds the cross-country average, and zero otherwise. Low Financial Literacy (FIN_LIT_L) is constructed as one

minus the high financial literacy indicator. A Chi-square test is conducted to assess the statistical significance of differences between the two groups.

3.2.4. Bank-specific and macroeconomic control variables

The study incorporates a comprehensive set of control variables. The ratio of total loans to total assets (Loan Ratio, LR) measures liquidity risk at the individual bank level (Fang et al., 2014). The logarithm of total assets (Bank Size, SIZE) and the loan loss provision-to-total-loans ratio (Loan Loss Provision Ratio, LLPR) control for size effects and loan portfolio risk, respectively. The ratio of non-interest income to total operating income (Revenue Diversification, IND) accounts for off-balance-sheet activities. The ratio of total earning assets to total assets (Management Quality, MQ) serves as a proxy for managerial effectiveness. Capital risk is measured by the equity-to-total-assets ratio (Capitalization, CAP). The Herfindahl-Hirschman Index (HHI) and the Lerner Index (LINDEX) control for market concentration and market power. Macroeconomic control variables include the annual GDP growth rate (GDPG), inflation (INF), the unemployment rate (UM), and a composite Institutional Quality index (IQ) standardized from the World Bank Worldwide Governance Indicators (Kaufmann et al., 2010).

3.3. Models and Estimation

Two regression models are specified to examine the relationship between DFI and bank stability and the moderating role of financial literacy.

$$\text{Model 1: } Y_{ijt} = a + bDFI_{jt} + \gamma B_{ijt} + \varphi M_{jt} + \varepsilon_{ijt}$$

$$\text{Model 2: } Y_{ijt} = a + b_1(DFI \times FIN\_LIT\_H)_{jt} + b_2(DFI \times FIN\_LIT\_L)_{jt} + \gamma B_{ijt} + \varphi M_{jt} + \varepsilon_{ijt}$$

In these specifications, Yijt denotes a measure of bank stability (LZS or LEQT_SDROAA) for bank i in country j in year t; DFIjt represents the Digital Financial Inclusion index; (DFI x FIN_LIT_H)jt and (DFI x FIN_LIT_L)jt are the respective interaction terms with high and low financial literacy; Bijt is a vector of bank-specific factors; and Mjt is a vector of macroeconomic factors. To formally validate the preference for fixed-effects over random-effects estimation, a Hausman specification test is conducted. The test yields a chi-squared statistic of 52.37 (degrees of freedom = 15, $p < 0.001$), decisively rejecting the null hypothesis of random effects and confirming the consistency and appropriateness of the fixed-effects estimator under the assumption that country-level and bank-level unobservable characteristics are correlated with the regressors. To ensure robustness of inference, the study employs the Cameron, Gelbach, and Miller (2011) two-way clustering (CGM) estimation technique incorporating heteroscedasticity-corrected clustered standard errors. To address concerns related to endogeneity and sample selection bias, the two-stage least squares instrumental variable (2SLS-IV) method and Propensity Score Matching (PSM) are additionally employed. With regard to the specification of Model 2, a potential multicollinearity concern arising from the construction of FIN_LIT_L as the arithmetic complement of FIN_LIT_H warrants clarification. Since these two indicators partition the full sample into mutually exclusive and jointly exhaustive groups, their sum equals unity for every observation. However, the two interaction terms, namely DFI x FIN_LIT_H and DFI x FIN_LIT_L, are not perfectly collinear because they are products of binary group indicators and the continuous DFI variable, which varies within each group. The model is identified through within-group variation in DFI across the high-literacy and low-literacy country sets, and the specification does not include a standalone DFI main effect, thereby circumventing the exact linear dependence that would arise if both a main effect and the group-interacted effects were included simultaneously. The estimated coefficients on the two interaction terms therefore represent distinct conditional effects of DFI for each literacy group and are fully identified under the two-way fixed-effects structure employed (Cameron et al., 2011). A final methodological note concerns the inclusion of control variables across subsample specifications. The Herfindahl-Hirschman Index (HHI) and Lerner Index (LINDEX) are excluded from the conventional bank subsample regressions in Tables 4.3

and 4.5 because variance inflation factor (VIF) diagnostics confirmed values exceeding 10 for these variables within the conventional bank subset, attributable to high collinearity with GDP growth in the bank-concentration nexus of the sample countries. Similarly, LINDEX and the Institutional Quality index (IQ) are excluded from the Islamic bank subsample regressions in Tables 4 and 5 due to near-zero within-group variation, as Islamic banks in several sample countries operate under highly homogeneous regulatory environments, precluding stable simultaneous estimation. These exclusion decisions follow established practice in subsample panel regressions and do not affect the primary DFI coefficients of interest, whose consistency across full-sample and subsample specifications is confirmed by the auxiliary regressions available from the authors upon request.

4. RESULTS AND ANALYSIS

4.1. Descriptive Statistics

Table 4.1. Descriptive Statistics

Variables	Definition	Obs	Mean	SD	Min	Max
	Dependent variables: Bank stability					
LZS	Log of ROAA plus Equity over total assets (EQT) divided by SD of ROAA (SDROAA) using a 3-year rolling window	3350	3.825	1.108	1.283	5.558
LEQT_SDROAA	Log of (EQT/SDROAA)	3350	3.766	1.223	-2.723	9.123
	Main independent variables					
DFI	Digital financial inclusion composite index	3350	0.36	0.267	0	0.878
DFI_SA	DFI supply side or access index	3350	0.363	0.256	0	1
DFI_DU	DFI demand side or usage index	3350	0.357	0.333	0	0.999
FIN_LIT	S&P Global Financial Literacy Survey 2014	3350	0.305	0.069	0.192	0.417
	Bank-specific variables					
SIZE	Bank size – Log of total assets	3350	7.485	1.746	2.133	10.2
IND	Revenue diversification – non-interest income / total operating income	3350	35.009	20.742	3.337	82.637
LR	Loan ratio – total loans / total assets	3350	0.588	0.152	0.169	0.806
LLPR	Loan loss provision ratio – Loan loss provision / total assets	3350	0.006	0.008	-0.002	0.033
MQ	Management quality – Total earnings / total assets	3350	0.834	0.096	0.505	0.958
CAP	Capitalization – total equity / total assets	3350	0.142	0.083	0.05	0.479
HHI	Herfindahl-Hirschman Index based on total loans	3350	0.114	0.068	0.071	0.507
LINDEX	Lerner Index	3350	0.291	0.105	0.094	0.435
	Macroeconomic variables					
GDPG	Annual growth rate of GDP	3350	4.884	1.877	-0.055	9.174
INF	Inflation	3350	4.763	3.379	0.583	15.438
UM	Unemployment rate	3350	4.909	4.148	0.72	17
IQ	Institutional quality – standardized composite of Control of Corruption, Government Effectiveness, Political Stability, Regulatory Quality, Rule of Law, and Voice and Accountability	3350	0.252	0.646	-1.299	1.314

Source: Authors' own calculations.

Table 4.1 indicates that the sample banks exhibit a mean Z-score of 3.8, with a standard deviation (SD) of 1.11. The 418 distinct banking institutions in the sample comprise 350 conventional banks and 68 Islamic banks operating across 15 dual banking economies, with the three most heavily represented countries, Indonesia, Bangladesh, and Malaysia, together accounting for 44.75

percent of total observations. The mean and SD for bank size (7.45 and 1.75, respectively) reflect considerable heterogeneity in asset scale across the sampled institutions. On average, the DFI index records a score of 0.36, suggesting that a substantial proportion of the population in the sample countries remains excluded from formal digital financial services, consistent with estimates indicating that approximately 1.4 billion individuals worldwide remain unbanked (World Bank, 2022). The financial literacy measure averages 0.305 across sample countries. The sample economies exhibit an average GDP growth rate of 4.88 percent and a mean unemployment rate of 4.91 percent. To guard against potential multicollinearity, a Pearson pairwise correlation analysis is performed (Appendix A1); the highest bivariate correlation among the regressors is 0.767 between DFI and DFI_SA, which are not entered simultaneously in any single model, and no pair of control variables exhibits a correlation that would constitute a practical multicollinearity concern in the regression specifications employed.

4.2. Main Results

4.2.1. Digital Financial Inclusion and Bank Stability (Full Sample)

The baseline analysis employs two proxies for bank stability (LZS and LEQT_SDROAA) and three proxies for DFI (DFI, DFI_SA, and DFI_DU) in six model specifications presented in Table 4.2.

Table 4.2. Digital Financial Inclusion and Bank Stability

	LZS (1)	**LZS (2)**	**LZS (3)**	**LEQT_SDROAA (4)**	**LEQT_SDROAA (5)**	**LEQT_SDROAA (6)**
DFI	0.626***			0.741***		
	(0.167)			(0.181)		
DFI_SA		0.292			0.325	
		(0.184)			(0.198)	
DFI_DU			0.531***			0.635***
			(0.130)			(0.142)
LISTED	0.099	0.091	0.102	0.120	0.111	0.124*
SIZE	0.190***	0.189***	0.188***	0.183***	0.182***	0.181***
IND	-0.008***	-0.008***	-0.008***	-0.008***	-0.008***	-0.008***
LR	0.706***	0.714***	0.718***	0.749***	0.758***	0.763***
LLPR	-43.085***	-43.434***	-42.777***	-41.233***	-41.630***	-40.865***
MQ	1.093***	0.992***	1.139***	1.121***	1.003***	1.176***
CAP	3.058***	3.108***	3.038***	3.615***	3.675***	3.590***
HHI	0.249	-0.455	0.340	0.422	-0.429	0.541
LINDEX	-0.695	-0.465	-0.835	-0.965*	-0.697	-1.133**
GDPG	-0.079***	-0.086***	-0.075***	-0.086***	-0.093***	-0.081***
INF	0.000	0.008	-0.004	0.002	0.011	-0.004
UM	0.030***	0.018**	0.034***	0.030***	0.016*	0.035***
IQ	0.085	0.217**	0.063	0.106	0.264**	0.077
Constant	1.155***	1.209***	1.143***	1.087**	1.150***	1.072**
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Country FE	Yes	Yes	Yes	Yes	Yes	Yes
Bank Clustered SE	Yes	Yes	Yes	Yes	Yes	Yes
F Statistics	26.196***	24.646***	26.464***	22.775***	21.485***	23.028***
Adj. R-square	0.298	0.293	0.300	0.270	0.264	0.272
Observations	3350	3350	3350	3350	3350	3350

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

Table 4.2 reveals that DFI maintains a statistically significant positive relationship with both the Z-score and asset quality. A one-standard-deviation increase in the overall DFI index (SD of 0.267) is associated with an approximate 16.71 percent improvement in the Z-score (0.267 x 0.626) and a roughly 19.79 percent improvement in asset quality (0.267 x 0.741). These magnitudes are substantively important and carry meaningful implications for policymakers. The results further indicate that DFI_DU (demand-side) exerts a positive and significant effect on both stability proxies, whereas DFI_SA (supply-side) displays an insignificant association. This pattern suggests that DFI_DU, which reflects active customer engagement and generates reliable revenue streams, plays a more substantive role in enhancing bank stability. Conversely, the insignificant result for DFI_SA implies that over-expansion of digital service points without commensurate growth in actual usage may generate operational costs without directly strengthening banks' financial positions (Unnikrishnan et al., 2019). These results collectively support Hypothesis H1a. It warrants additional note that the DFI_SA index incorporates metrics such as mobile money agents, non-branch bank outlets, and POS terminals per 100,000 adults, which may partly reflect traditional as well as genuinely digital access channels. To the extent that these proxies imperfectly capture digital outreach, the insignificant coefficient on DFI_SA may reflect construct misalignment rather than the complete absence of a stability effect. Future research employing more refined supply-side measures, such as active digital banking endpoints or broadband connectivity-adjusted outlet counts, would more cleanly identify the supply-side access channel. The asymmetry between DFI_SA and DFI_DU also suggests that access investments translate into stability benefits only after a threshold level of actual usage is achieved, implying a sequenced approach to digital financial development policy.

4.2.2. Digital Financial Inclusion and Bank Stability: Conventional versus Islamic Banks

Tables 4.3 and 4.4 partition the sample into conventional and Islamic banks to explore the differential impact of DFI on bank stability across banking types.

Table 4.3. Digital Financial Inclusion and Bank Stability (Conventional Banks)

	LZS (1)	**LZS (2)**	**LZS (3)**	**LEQT_SDROAA (4)**	**LEQT_SDROAA (5)**	**LEQT_SDROAA (6)**
DFI	0.686***			0.830***		
	(0.186)			(0.202)		
DFI_SA		0.290			0.331	
		(0.203)			(0.218)	
DFI_DU			0.604***			0.738***
			(0.144)			(0.157)
LISTED	0.171**	0.170**	0.171**	0.211***	0.210***	0.212***
SIZE	0.192***	0.190***	0.190***	0.189***	0.186***	0.186***
IND	-0.009***	-0.010***	-0.009***	-0.010***	-0.011***	-0.010***
LR	0.684***	0.670**	0.710***	0.693**	0.677**	0.725**
LLPR	-44.343***	-44.233***	-44.232***	-42.350***	-42.206***	-42.218***
MQ	0.957**	0.864**	1.015**	1.057**	0.946**	1.130**
CAP	3.625***	3.682***	3.601***	4.255***	4.324***	4.225***
GDPG	-0.095**	-0.104**	-0.090*	-0.115**	-0.125**	-0.109**
UM	0.034***	0.016	0.040***	0.036***	0.016	0.045***
IQ	0.056	0.239**	0.012	0.071	0.296**	0.015
Constant	1.166***	1.259***	1.127**	1.061**	1.174**	1.013**
Year FE	Yes	Yes	Yes	Yes	Yes	Yes

Country FE	Yes	Yes	Yes	Yes	Yes	Yes
Bank Clustered SE	Yes	Yes	Yes	Yes	Yes	Yes
F Statistics	25.585***	23.325***	26.233***	21.434***	19.935***	21.794***
Adj. R-square	0.303	0.297	0.305	0.280	0.272	0.283
Observations	2903	2903	2903	2903	2903	2903

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

Table 4.4. Digital Financial Inclusion and Bank Stability (Islamic Banks)

	LZS (1)	**LZS (2)**	**LZS (3)**	**LEQT_SDROAA (4)**	**LEQT_SDROAA (5)**	**LEQT_SDROAA (6)**
DFI	-0.997**			-0.916*		
	(0.471)			(0.478)		
DFI_SA		-0.187			0.059	
		(0.553)			(0.664)	
DFI_DU			-0.895**			-0.904**
			(0.366)			(0.387)
LISTED	-0.173	-0.165	-0.182	-0.221	-0.215	-0.230
SIZE	0.206***	0.185***	0.215***	0.193**	0.174**	0.203**
IND	-0.005*	-0.005	-0.005	-0.006*	-0.005	-0.005*
LR	0.697	0.697	0.657	0.829	0.823	0.787
LLPR	-33.123***	-32.716***	-34.039***	-33.456***	-33.461***	-34.381***
MQ	1.421*	1.373*	1.518**	1.015	0.976	1.121
CAP	1.355	1.258	1.402	1.789	1.702	1.846
HHI	-2.691*	-1.219	-2.933*	-2.088	-0.493	-2.487
GDPG	-0.117***	-0.122***	-0.123***	-0.131***	-0.142***	-0.136***
UM	0.024	0.032*	0.022	0.012	0.020	0.009
Constant	1.328	1.137	1.191	1.847**	1.599*	1.727**
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Country FE	Yes	Yes	Yes	Yes	Yes	Yes
Bank Clustered SE	Yes	Yes	Yes	Yes	Yes	Yes
F Statistics	13.574***	12.383***	14.130***	10.835***	10.073***	10.825***
Adj. R-square	0.350	0.342	0.353	0.297	0.292	0.301
Observations	447	447	447	447	447	447

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

Table 4.3 demonstrates that DFI maintains a significant positive relationship with bank stability for conventional banks, consistent with Hypothesis H1a. Table 4.4, by contrast, shows that the relationship between DFI and the stability of Islamic banks is either statistically insignificant or negative in direction, supporting Hypothesis H1b. A statistical caveat regarding the Islamic bank subsample is warranted at this stage. The 447 bank-year observations in Table 4.4 are drawn from 68 distinct Islamic banking institutions, a subsample that, while sufficient for fixed-effects panel estimation, entails reduced statistical power relative to the conventional bank subsample of 2,903 observations from 350 distinct institutions. The negative and statistically significant coefficients in Table 4.4 should therefore be interpreted as indicative rather than definitive, and findings specific to Islamic banks are best regarded as preliminary empirical evidence warranting replication in larger Islamic banking datasets as data availability improves. The consistency of the negative directionality across multiple specifications, DFI measures, and robustness checks,

however, lends meaningful support to the conclusion that the DFI-stability relationship operates through structurally distinct pathways in Islamic banking contexts. The negative or negligible impact of DFI on Islamic bank stability may be attributed to several interrelated factors: the distinctive risk architecture of Islamic banks, structural mismatches between digital financial products and Islamic finance principles, heightened competitive pressures from conventional banks and financial technology firms, and a more risk-averse customer orientation toward the adoption of digital financial services (Banna and Alam, 2021). Drawing a parallel with the SVB collapse of 2023, the proliferation of digital transactions can amplify institutional vulnerabilities, particularly when financial institutions such as Islamic banks are insufficiently equipped to manage rapid, large-scale digital transactions (Ali et al., 2023; Turner, 2023). It is important to note that this parallel requires careful qualification. The SVB case involved conventional banking vulnerabilities driven primarily by rapid digital deposit withdrawals and concentration risk, whereas the Islamic bank instability identified in the present study stems from structurally distinct mechanisms, namely product non-compliance and customer hesitancy toward Shariah non-conforming digital services. The comparison is therefore offered in the narrow sense that both cases illustrate how insufficient preparedness for the velocity of digital financial transactions can amplify institutional vulnerabilities (Federal Deposit Insurance Corporation, 2023).

4.2.3. The Moderating Role of Financial Literacy

Table 4.5 examines whether high financial literacy conditions the relationship between DFI and bank stability.

Table 4.5. Financial Literacy, Digital Financial Inclusion and Bank Stability

	Full: LZS (1)	**Full: LEQT (2)**	**Conv: LZS (3)**	**Conv: LEQT (4)**	**Islamic: LZS (5)**	**Islamic: LEQT (6)**
DFI×FIN_LIT_H	0.625***	0.743***	0.682***	0.831***	-0.980**	-0.902*
	(0.167)	(0.182)	(0.187)	(0.203)	(0.465)	(0.472)
DFI×FIN_LIT_L	0.699	0.598	0.909*	0.797	-1.493*	-1.300
	(0.448)	(0.508)	(0.507)	(0.580)	(0.880)	(0.933)
SIZE	0.190***	0.183***	0.192***	0.189***	0.206***	0.193**
LR	0.706***	0.750***	0.683***	0.693**	0.708	0.838
LLPR	-43.097***	-41.210***	-44.368***	-42.346***	-32.895***	-33.279***
MQ	1.093***	1.121***	0.956**	1.058**	1.402*	1.000
CAP	3.057***	3.616***	3.622***	4.256***	1.354	1.789
HHI	0.247	0.425	0.594	0.753	-2.669*	-2.069
GDPG	-0.079***	-0.087***	-0.093**	-0.116**	-0.118***	-0.132***
UM	0.030***	0.030***	0.034***	0.036***	0.024	0.012
IQ	0.086	0.104	0.058	0.071	0.392	0.281
Constant	1.154***	1.090**	1.157***	1.063**	1.326	1.846**
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Country FE	Yes	Yes	Yes	Yes	Yes	Yes
Bank Clustered SE	Yes	Yes	Yes	Yes	Yes	Yes
F Statistics	25.256***	21.950***	24.669***	20.663***	13.215***	10.783***
Adj. R-square	0.298	0.270	0.303	0.280	0.348	0.296
Observations	3350	3350	2903	2903	447	447

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

The interaction between DFI and high financial literacy maintains a statistically significant positive relationship with bank stability for the full sample and for conventional banks, supporting Hypothesis H2a. The positive coefficient is explicable by the compatibility between

financial literacy and the broad range of digital financial products available in conventional banking, which collectively enhance customer engagement, operational efficiency, and institutional profitability (Klapper et al., 2013). In contrast, the corresponding interaction terms carry negative coefficients for Islamic banks, supporting Hypothesis H2b. This divergence may stem from the unique demands of Shariah-compliant financial products, where financially literate customers are more likely to exercise caution or actively resist digital financial services that do not fully satisfy Islamic financial principles (Lukonga, 2015). This resistance results in lower digital adoption rates and potentially weakens financial performance, thereby reducing stability in Islamic banking institutions.

4.3. Robustness Tests

A series of robustness checks is conducted to validate the main findings: (i) an alternative proxy for bank stability; (ii) an alternative measure of digital financial inclusion; (iii) two-stage least squares instrumental variable (2SLS-IV) regression to address potential endogeneity; and (iv) propensity score matching (PSM) to minimize sample selection bias.

4.3.1. Alternative Bank Stability Variable

Following the approaches of Ahamed & Mallick (2019) and Banna & Alam (2021), the volatility of ROAA is adopted as an alternative proxy for bank stability in Table 4.6. To maintain directional consistency with the Z-score, the natural logarithm of SDROAA is multiplied by negative one. The results remain substantively consistent with the baseline findings.

Table 4.6. Alternative Bank Stability

Dep. var: -LN(SDROAA)	Full (1)	Full (2)	Conv. (3)	Conv. (4)	Islamic (5)	Islamic (6)
DFI	0.631***		0.736***		-0.704	
	(0.218)		(0.244)		(0.661)	
DFI×FIN_LIT_H		0.632***		0.734***		-0.679
		(0.217)		(0.244)		(0.655)
DFI×FIN_LIT_L		0.543		0.876		-1.377
		(0.510)		(0.575)		(1.168)
SIZE	0.260***	0.260***	0.257***	0.257***	0.368***	0.367***
LR	0.677**	0.677**	0.857***	0.856***	-1.091	-1.075
LLPR	-48.644***	-48.622***	-51.412***	-51.437***	-21.839	-21.362
MQ	1.538***	1.538***	1.359**	1.358**	3.896**	3.868**
GDPG	-0.008	-0.008	0.095	0.096	-0.130***	-0.132***
UM	0.037***	0.037***	0.051***	0.051***	0.055**	0.055**
Constant	-2.203***	-2.201***	-2.476***	-2.481***	-3.995**	-3.996**
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Country FE	Yes	Yes	Yes	Yes	Yes	Yes
Bank Clustered SE	Yes	Yes	Yes	Yes	Yes	Yes
F Statistics	12.631***	12.218***	11.332***	10.922***	7.089***	6.785***
Adj. R-square	0.183	0.183	0.177	0.177	0.270	0.269
Observations	3035	3035	2628	2628	407	407

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

4.3.2. Alternative Digital Financial Inclusion Variable

In Table 4.7, following Banna & Alam (2021), the study employs the percentage of adults who made or received digital payments in the preceding year (DFI_A) as an alternative proxy for digital financial inclusion, sourced from the Global Findex database. This proxy captures the ratio of total digital financial transactions to each country's GDP. The results remain consistent with

the baseline findings, providing further support for the robustness of the main conclusions.

Table 4.7. Alternative Digital Financial Inclusion

Dep. var: LZS	Full (1)	Full (2)	Conv. (3)	Conv. (4)	Islamic (5)	Islamic (6)
DFI_A	0.004**		0.005**		-0.014**	
	(0.002)		(0.002)		(0.007)	
DFI_A×FIN_LIT_H		0.005**		0.005**		-0.014**
		(0.002)		(0.002)		(0.007)
DFI_A×FIN_LIT_L		-0.002		-0.001		-0.017
		(0.005)		(0.005)		(0.034)
SIZE	0.184***	0.185***	0.185***	0.186***	0.234***	0.235***
LR	0.833***	0.838***	0.810***	0.815***	0.432	0.434
LLPR	-42.655***	-42.652***	-43.108***	-43.105***	-33.638***	-33.615***
MQ	1.110***	1.105***	1.013**	1.007**	2.315***	2.309**
CAP	3.382***	3.399***	3.643***	3.660***	2.181**	2.190**
IQ	0.233**	0.203*	0.298**	0.268**	0.572*	0.565*
Constant	0.816*	0.841*	1.102**	1.126**	-1.364	-1.381
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Country FE	Yes	Yes	Yes	Yes	Yes	Yes
Bank Clustered SE	Yes	Yes	Yes	Yes	Yes	Yes
F Statistics	27.707***	27.086***	26.166***	25.528***	10.791***	10.827***
Adj. R-square	0.302	0.302	0.307	0.308	0.346	0.343
Observations	3167	3167	2839	2839	328	328

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

4.3.3. Endogeneity and Sample Selection Bias

A potential reverse causality concern exists in this context, whereby bank stability may itself drive investment in digital financial infrastructure, thereby inducing higher DFI levels. While the use of macro-level data partially mitigates endogeneity concerns, the study follows established methodological precedents (Ahamed & Mallick, 2019) by additionally employing two-stage least squares instrumental variable (2SLS-IV) estimation. Following Banna et al. (2021), the country-level share of mobile cellular subscriptions per 100 persons is employed as the instrumental variable. After instrumenting the baseline bank stability specifications with the extent of digital financial inclusion, the results remain consistent with the main findings, as reported in Table 4.8. The validity of this instrument rests on two conditions. The relevance condition requires that mobile cellular subscription density exhibits a sufficiently strong correlation with DFI, which is supported by the intuition that widespread mobile connectivity is a necessary precondition for the adoption of mobile banking and digital payment platforms; countries with higher subscription density systematically exhibit greater penetration of digital financial services, consistent with prior findings in the fintech-inclusion literature (Banna et al., 2021; Kanga et al., 2022). The exclusion restriction requires that mobile cellular subscriptions affect bank stability exclusively through their influence on DFI and do not operate through independent channels. This condition is plausible on the grounds that mobile connectivity per se does not alter a bank's capital adequacy, loan quality, or management effectiveness; it affects stability only insofar as it enables the expansion of the digital customer base that constitutes the DFI mechanism. The principal threat to the exclusion restriction would arise if mobile connectivity were correlated with broader technological or economic development that independently affects bank stability; this concern is mitigated by the inclusion of GDP growth, institutional quality, and year and country fixed effects, which absorb the main technological and macroeconomic confounders at the country-year level.

Table 8. 2SLS-IV Regression

Dep. var: LZS	Full (1)	Full (2)	Full (3)	Conv. (4)	Conv. (5)	Conv. (6)	Islamic (7)	Islamic (8)	Islamic (9)
DFI	0.454***			0.484***			-0.542		
	(0.155)			(0.164)			(0.634)		
DFI×FIN_LIT_H		0.424***			0.444***			-0.368	
		(0.144)			(0.154)			(0.489)	
DFI×FIN_LIT_L			-0.070			0.003			-0.268
			(0.393)			(0.443)			(0.785)
SIZE	0.196***	0.196***	0.195***	0.192***	0.191***	0.190***	0.258***	0.257***	0.250***
LR	0.841***	0.835***	0.839***	0.865***	0.859***	0.867***	0.456	0.448	0.428
LLPR	-35.304***	-35.205***	-35.214***	-34.819***	-34.739***	-34.813***	-37.086***	-37.459***	-37.377***
MQ	1.114***	1.118***	1.094***	1.125***	1.130***	1.097***	1.591**	1.606**	1.620**
CAP	3.683***	3.702***	3.733***	3.930***	3.953***	3.991***	2.743**	2.760***	2.769**
LINDEX	-1.401**	-1.468**	-1.535**	-1.296**	-1.360**	-1.388**	-1.592	-1.353	-1.183
Constant	1.101***	1.146***	1.207***	1.035**	1.079**	1.129**	0.036	-0.123	-0.152
Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Country FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Chi-square	795.098***	793.755***	780.332***	717.473***	714.831***	698.268***	277.945***	271.632***	304.942***
Centred R-sq.	0.304	0.304	0.297	0.304	0.303	0.297	0.413	0.413	0.411
Observations	3261	3261	3261	2896	2896	2896	365	365	365

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

A propensity score matching (PSM) technique, widely applied in the contemporary banking literature (e.g., Elnahass et al., 2021), is additionally employed to address sample selection bias. Propensity scores are estimated by comparing banks with above-mean DFI levels (treatment group) against those with below-mean DFI levels (control group). Samples are matched using a one-to-one nearest-neighbor algorithm without replacement. The results presented in Table 4.9 confirm that, across all model specifications, digital financial inclusion significantly enhances bank stability, and that high financial literacy exerts a positive moderating influence on this relationship.

Table 4.9. Propensity Score Matching

Dep. var: LZS	Full (1)	Full (2)	Conv. (3)	Conv. (4)	Islamic (5)	Islamic (6)
DFI	0.362***		0.490***		-1.562***	
	(0.138)		(0.148)		(0.511)	
DFI×FIN_LIT_H		0.360***		0.487***		-1.551***
		(0.138)		(0.148)		(0.509)
DFI×FIN_LIT_L		0.509		0.808		-1.836*
		(0.444)		(0.500)		(0.936)
SIZE	0.193***	0.193***	0.194***	0.194***	0.209***	0.207***
LR	0.769***	0.768***	0.713**	0.711**	0.300	0.297
LLPR	-42.262***	-42.277***	-42.246***	-42.268***	-38.243***	-38.162***
MQ	1.244***	1.244***	1.188***	1.187***	2.321***	2.315***
CAP	3.384***	3.381***	3.711***	3.704***	1.557	1.548
IQ	0.297***	0.298***	0.236***	0.238***	0.779***	0.781***
GDPG	-0.096***	-0.095**	-0.093**	-0.090**	-0.046	-0.048
Constant	0.539	0.525	0.694	0.667	-0.507	-0.420
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Country FE	Yes	Yes	Yes	Yes	Yes	Yes
Bank Clustered SE	Yes	Yes	Yes	Yes	Yes	Yes
F Statistics	29.771***	28.633***	28.148***	27.133***	15.002***	14.447***

Adj. R-square	0.303	0.302	0.307	0.307	0.375	0.373
Observations	3028	3028	2701	2701	327	327

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

5. CONCLUSION AND POLICY IMPLICATIONS

This study examines the relationship between digital financial inclusion (DFI), financial literacy, and bank stability, focusing on both conventional and Islamic banks across 15 countries over the period 2011 to 2020. For conventional banks, DFI, particularly as operationalized through demand-side indicators, significantly enhances bank stability by improving asset quality and reducing risk exposure, consistent with the existing literature that emphasizes the stabilizing effect of customer engagement with digital financial services. For Islamic banks, by contrast, the relationship between DFI and bank stability is either statistically insignificant or negative. The distinctive architecture of Islamic finance, which requires adherence to Shariah principles, constrains the effectiveness of DFI. Structural mismatches between digital products and Islamic financial principles, competitive pressures from conventional banks and financial technology firms, and operational constraints collectively impede the positive impact of DFI on Islamic banking stability.

The interaction between high financial literacy and DFI yields a positive association with stability in conventional banks, as financially literate customers are more inclined to engage productively with digital financial products, thereby enhancing institutional efficiency and profitability. In Islamic banks, however, this interaction is negative, as financially literate customers may exercise greater caution toward digital services that do not fully conform to Shariah principles, resulting in lower adoption rates and diminished institutional stability. These findings remain robust across multiple alternative specifications and estimation strategies, including the use of alternative stability proxies, alternative DFI measures, 2SLS-IV estimation, and propensity score matching.

The study also draws cautiously on the SVB episode as a contextual reference, while maintaining awareness of the structural differences between that case and the Islamic banking dynamics identified here. The SVB collapse was driven by conventional banking vulnerabilities rooted in rapid digital deposit withdrawals and asset-liability mismatches, mechanisms that are structurally distinct from the product non-compliance and customer hesitancy channels operating in Islamic banking. Rather than asserting equivalence, the present study invokes the SVB case in the narrow sense that both episodes illustrate how insufficient institutional preparedness for the pace and volume of digital financial flows can amplify systemic risk, regardless of the bank type involved. Future research examining the specific digital run risk exposure of Islamic banks, distinct from their product-compliance vulnerabilities, would advance the understanding of this parallel further.

Based on these findings, several policy recommendations can be advanced. For conventional banks, policymakers should prioritize increasing the active use of digital financial services through targeted promotional campaigns and incentive structures that translate digital access into actual engagement. For Islamic banks, financial institutions should invest in the development of Shariah-compliant digital products incorporating profit-and-loss sharing arrangements, risk-sharing mechanisms, and interest-free transaction structures. Given the positive interaction between financial literacy and DFI in conventional banks, central banks in dual banking economies should implement financial literacy programmes specifically tailored to digital financial services, with a particular focus on underserved and rural populations. Bank Indonesia, Bangladesh Bank, and Bank Negara Malaysia are specifically identified in this context on the basis of three criteria grounded in the empirical analysis. Foremost, these three central banks govern the dual banking systems of Indonesia, Bangladesh, and Malaysia, which collectively

account for the three largest country-level observation shares in the dataset at 23.94 percent, 11.91 percent, and 8.90 percent respectively, implying that the estimated DFI-stability relationship is most directly applicable to their jurisdictions. Furthermore, these countries exhibit DFI indices and financial literacy scores that place them at the margin of the high-low literacy classification, suggesting that targeted literacy interventions are most likely to shift banks from the low-literacy to the high-literacy regime and thereby unlock the stability-enhancing moderation identified in Hypothesis H2a. Finally, all three central banks possess established financial literacy infrastructure and existing regulatory mandates for financial inclusion, providing an institutional foundation upon which the recommended programmes can be practically implemented. Special emphasis should be placed on Shariah-compliant financial literacy for customers of Islamic banking institutions.

This study is subject to certain limitations that warrant acknowledgment. The reliance on existing secondary datasets may not fully capture the nuances of digital financial inclusion and financial literacy across different regional contexts. The availability of financial literacy data for only a single year (2014) represents a notable constraint, and future research would benefit from more temporally granular financial literacy data. As a sensitivity check, the continuous financial literacy score from the S&P survey was employed as an interaction term with DFI in lieu of the binary high-low classification; the results yield qualitatively consistent directionality, corroborating the moderation effect while confirming that the binary specification provides a more policy-relevant threshold-based interpretation. The geographic distribution of the sample also warrants transparent acknowledgment: three economies, Indonesia, Bangladesh, and Malaysia, collectively account for 44.75 percent of total observations, reflecting genuine data availability constraints and the dual banking maturity of these jurisdictions. Findings may therefore be most directly applicable to Southeast Asian and South Asian dual banking systems, and future research extending the country coverage to encompass additional Middle Eastern and African dual banking markets would substantially strengthen the cross-regional generalisability of the conclusions. The emphasis on quantitative proxies may also overlook qualitative factors such as customer trust, cultural attitudes toward digital finance, and the heterogeneous quality of Shariah supervisory boards across Islamic banking institutions. Future research could productively integrate qualitative methodologies, extend the temporal horizon, and conduct longitudinal analyses to yield deeper insights into the evolving interrelationship among DFI, financial literacy, and bank stability in dual banking systems.

BIBLIOGRAPHY

1. Ahamed, M. M., Ho, S. J., Mallick, S. K., & Matousek, R. (2021). Inclusive banking, financial regulation and bank performance: Cross-country evidence. *Journal of Banking & Finance, 124*, 106055. https://doi.org/10.1016/j.jbankfin.2021.106055
2. Ahamed, M. M., & Mallick, S. K. (2019). Is financial inclusion good for bank stability? International evidence. *Journal of Economic Behavior & Organization, 157*, 403–427. https://doi.org/10.1016/j.jebo.2017.07.027
3. Al Rahahleh, N. (2022). Financial literacy levels among Saudi citizens across budgeting, saving, investment, debt, and insurance dimensions. *Journal of Risk and Financial Management, 15*(12), 582. https://doi.org/10.3390/jrfm15120582
4. Al Suwaidi, R. A., & Mertzanis, C. (2024). Financial literacy and FinTech market growth around the world. *International Review of Financial Analysis, 95*, 103481. https://doi.org/10.1016/j.irfa.2024.103481
5. Ali, H., Aysan, A. F., & Yousef, T. (2023). *From tech hub to banking failure: Exploring the implications of CBDCs on the destiny of Silicon Valley Bank* (SSRN Working Paper No. 4411360). https://ssrn.com/abstract=4411360
6. Angrisani, M., Burke, J., Lusardi, A., & Mottola, G. (2023). The evolution of financial literacy

over time and its predictive power for financial outcomes. *Journal of Pension Economics & Finance, 22*(4), 640–657. https://doi.org/10.1017/s1474747222000154

7. Banna, H., & Alam, M. R. (2020). Islamic banking efficiency and inclusive sustainable growth: The role of financial inclusion. *Journal of Islamic Monetary Economics and Finance, 6*(1), 213–242. https://doi.org/10.21098/jimf.v6i1.1089
8. Banna, H., & Alam, M. R. (2021). Does digital financial inclusion matter for bank risk-taking? Evidence from the dual-banking system. *Journal of Islamic Monetary Economics and Finance, 7*(2), 401–430. https://doi.org/10.21098/jimf.v7i2.1320
9. Banna, H., Alam, M. R., Ahmad, R., & Sari, N. M. (2022). Does financial inclusion drive the Islamic banking efficiency? A post-financial crisis analysis. *The Singapore Economic Review, 67*(01), 135–160. https://doi.org/10.1142/S0217590819420050
10. Banna, H., Hassan, M. K., & Rashid, M. (2021). Fintech-based financial inclusion and bank risk-taking: Evidence from OIC countries. *Journal of International Financial Markets, Institutions and Money, 75*, 101447. https://doi.org/10.1016/j.intfin.2021.101447
11. Bao, Z., & Huang, D. (2021). Shadow banking in a crisis: Evidence from FinTech during COVID-19. *Journal of Financial and Quantitative Analysis, 56*(7), 2320–2355. https://doi.org/10.1017/s0022109021000430
12. Beck, R., Georgiadis, G., & Straub, R. (2014a). The finance and growth nexus revisited. *Economics Letters, 124*(3), 382–385. https://doi.org/10.1016/j.econlet.2014.07.002
13. Beck, T., Lin, C., & Ma, Y. (2014b). Why do firms evade taxes? The role of information sharing and financial sector outreach. *The Journal of Finance, 69*(2), 763–817. https://doi.org/10.1111/jofi.12123
14. Beck, T., Senbet, L., & Simbanegavi, W. (2014c). Financial inclusion and innovation in Africa: An overview. *Journal of African Economies, 24*(Suppl. 1), i3–i11. https://doi.org/10.1093/jae/eju031
15. Bermeo-Giraldo, M. C., Valencia-Arias, A., Palacios-Moya, L., & Valencia, J. (2023). Adoption of FinTech services in young students: Empirical approach from a developing country. *Economies, 11*(9), 226. https://doi.org/10.3390/economies11090226
16. Bertay, A. C., Demirgüç-Kunt, A., & Huizinga, H. (2013). Do we need big banks? Evidence on performance, strategy and market discipline. *Journal of Financial Intermediation, 22*(4), 532–558. https://doi.org/10.1016/j.jfi.2013.02.002
17. Cameron, A. C., Gelbach, J. B., & Miller, D. L. (2011). Robust inference with multiway clustering. *Journal of Business & Economic Statistics, 29*(2), 238–249. https://doi.org/10.1198/jbes.2010.07136
18. Chan, Y. S., Greenbaum, S. I., & Thakor, A. V. (1986). Information reusability, competition and bank asset quality. *Journal of Banking & Finance, 10*(2), 243–253. https://doi.org/10.1016/0378-4266(86)90006-5
19. Danisman, G. O., & Tarazi, A. (2020). Financial inclusion and bank stability: Evidence from Europe. *The European Journal of Finance, 26*(18), 1842–1855. https://doi.org/10.1080/1351847X.2020.1719589
20. Demirgüç-Kunt, A., & Klapper, L. F. (2012). *Measuring financial inclusion: The global Findex database* (Policy Research Working Paper No. 6025). World Bank.
21. Demirgüç-Kunt, A., & Singer, D. (2017). *Financial inclusion and inclusive growth: A review of recent empirical evidence* (Policy Research Working Paper No. 8040). World Bank.
22. Elnahass, M., Trinh, V. Q., & Li, T. (2021). Global banking stability in the shadow of Covid-19 outbreak. *Journal of International Financial Markets, Institutions and Money, 72*, 101322. https://doi.org/10.1016/j.intfin.2021.101322
23. Fang, Y., Hasan, I., & Marton, K. (2014). Institutional development and bank stability: Evidence from transition countries. *Journal of Banking & Finance, 39*, 160–176. https://doi.org/10.1016/j.jbankfin.2013.10.027
24. Gomber, P., Koch, J. A., & 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

25. Han, R., & Melecky, M. (2013). *Financial inclusion for financial stability: Access to bank deposits and the growth of deposits in the global financial crisis* (Policy Research Working Paper No. 6577). World Bank.
26. Hannig, A., & Jansen, S. (2010). *Financial inclusion and financial stability: Current policy issues* (ADBI Working Paper No. 259). Asian Development Bank Institute.
27. Hua, X., Bi, J., & Shi, H. (2023). The appropriate level of financial inclusion: The perspective of financial stability. *China Economic Quarterly International, 3*(3), 167–178. https://doi.org/10.1016/j.ceqi.2023.06.001
28. Huang, J. (2018). Banking and shadow banking. *Journal of Economic Theory, 178*, 124–152. https://doi.org/10.1016/j.jet.2018.04.001
29. Jack, W., Ray, A., & Suri, T. (2013). Transaction networks: Evidence from mobile money in Kenya. *American Economic Review, 103*(3), 356–361. https://doi.org/10.1257/aer.103.3.356
30. Kacperczyk, M., & Schnabl, P. (2013). How safe are money market funds? *The Quarterly Journal of Economics, 128*(3), 1073–1122. https://doi.org/10.1093/qje/qjt010
31. Kanga, D., Oughton, C., Harris, L., & Murinde, V. (2022). The diffusion of fintech, financial inclusion and income per capita. *The European Journal of Finance, 28*(1), 108–136. https://doi.org/10.1080/1351847X.2021.1945731
32. Kaufmann, D., Kraay, A., & Mastruzzi, M. (2010). *The worldwide governance indicators: A summary of methodology, data and analytical issues* (Policy Research Working Paper No. 5430). World Bank.
33. Klapper, L., & Lusardi, A. (2020). Financial literacy and financial resilience: Evidence from around the world. *Financial Management, 49*(3), 589–614. https://doi.org/10.1111/fima.12283
34. Klapper, L., Lusardi, A., & Panos, G. A. (2013). Financial literacy and its consequences: Evidence from Russia during the financial crisis. *Journal of Banking & Finance, 37*(10), 3904–3923. https://doi.org/10.1016/j.jbankfin.2013.06.006
35. Lukonga, M. I. (2015). *Islamic finance, consumer protection, and financial stability*. International Monetary Fund.
36. Lusardi, A., & Mitchell, O. S. (2014). The economic importance of financial literacy: Theory and evidence. *Journal of Economic Literature, 52*(1), 5–44. https://doi.org/10.1257/jel.52.1.5
37. Manyika, J., Lund, S., Singer, M., White, O., & Berry, C. (2016). *Digital finance for all: Powering inclusive growth in emerging economies*. McKinsey Global Institute.
38. Mishkin, F. S. (1999). Financial consolidation: Dangers and opportunities. *Journal of Banking & Finance, 23*(2–4), 675–691. https://doi.org/10.1016/S0378-4266(99)00021-0
39. Morgan, P. J. (2021). FinTech, financial literacy, and financial education. In A. Lusardi & O. S. Mitchell (Eds.), *The Routledge handbook of financial literacy* (pp. 239–258). Routledge.
40. Morgan, P. J., & Pontines, V. (2018). Financial stability and financial inclusion: The case of SME lending. *The Singapore Economic Review, 63*(01), 111–124. https://doi.org/10.1142/S0217590818400027
41. Neaime, S., & Gaysset, I. (2018). Financial inclusion and stability in MENA: Evidence from poverty and inequality. *Finance Research Letters, 24*, 230–237. https://doi.org/10.1016/j.frl.2017.04.007
42. Oanh, T. T. K. (2023). Relationship between financial inclusion, monetary policy and financial stability. *Heliyon, 9*(6), e16647. https://doi.org/10.1016/j.heliyon.2023.e16647
43. OECD/INFE. (2015). *Policy handbook on national strategies for financial education*. OECD.
44. Ozili, P. K. (2018). Impact of digital finance on financial inclusion and stability. *Borsa Istanbul Review, 18*(4), 329–340. https://doi.org/10.1016/j.bir.2017.12.003
45. Panos, G. A., & Wilson, J. O. (2020). Financial literacy and responsible finance in the FinTech era: Capabilities and challenges. *The European Journal of Finance, 26*(4–5), 297–301. https://doi.org/10.1080/1351847X.2020.1717569

46. Pazarbasioglu, C., Mora, A. G., Uttamchandani, M., Natarajan, H., Feyen, E., & Saal, M. (2020). *Digital financial services*. World Bank Group.
47. Petersen, M. A., & Rajan, R. G. (1995). The effect of credit market competition on lending relationships. *The Quarterly Journal of Economics, 110*(2), 407–443. https://doi.org/10.2307/2118445
48. Pierri, M. N., & Timmer, M. Y. (2020). *Tech in fin before fintech: Blessing or curse for financial stability?* (IMF Working Paper No. 20/14). International Monetary Fund.
49. Refinitiv. (2022). *Islamic finance: Global trends and the UK market*.
50. Sahay, M. R., von Allmen, M. U. E., Lahreche, M. A., Khera, P., Ogawa, M. S., Bazarbash, M., & Beaton, M. K. (2020). *The promise of fintech: Financial inclusion in the post COVID-19 era*. International Monetary Fund.
51. Suri, T. (2017). Mobile money. *Annual Review of Economics, 9*(1), 497–520. https://doi.org/10.1146/annurev-economics-063016-103638
52. Federal Deposit Insurance Corporation. (2023). *FDIC staff study: Review of the Federal Reserve's supervision of Silicon Valley Bank*. Federal Deposit Insurance Corporation.
53. Turner, J. (2023). *Why did Silicon Valley Bank fail*. Economics Observatory.
54. Unnikrishnan, S., Larson, J., Pinpradab, B., & Brown, R. (2019). *How mobile money agents can expand financial inclusion*. Boston Consulting Group.
55. Vo, D. H., Nguyen, N. T., & Van, L. T. H. (2021). Financial inclusion and stability in the Asian region using bank-level data. *Borsa Istanbul Review, 21*(1), 36–43. https://doi.org/10.1016/j.bir.2020.07.004
56. Vovchenko, N. G., Galazova, S. S., Danchenko, E. A., Ivanova, O. B., & Kostoglodova, E. D. (2018). Improvement of financial literacy as a crucial factor of economic development. *European Research Studies Journal, 21*(Special Issue 1), 16–24. https://doi.org/10.35808/ersj.934
57. World Bank. (2022). *Covid-19 boosted the adoption of digital financial services*.
58. Xi, W., & Wang, Y. (2023). Digital financial inclusion and quality of economic growth. *Heliyon, 9*(9), e19731. https://doi.org/10.1016/j.heliyon.2023.e19731
59. Yoshino, N., Morgan, P. J., & Long, T. Q. (2020). *Financial literacy and FinTech adoption in Japan* (ADBI Working Paper No. 1095). Asian Development Bank Institute.

APPENDIX

Appendix A1. Pairwise Correlations

Variable	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)
(1) DFI	1.000														
(2) SA	0.767*	1.000													
(3) DU	0.943*	0.508*	1.000												
(4) SIZE	-0.179*	-0.196*	-0.139*	1.000											
(5) IND	-0.014	0.112*	-0.078*	0.060*	1.000										
(6) LR	0.086*	0.089*	0.069*	0.143*	-0.206*	1.000									
(7) LLPR	0.088*	0.066*	0.084*	-0.095*	-0.059*	0.133*	1.000								
(8) MQ	0.147*	0.201*	0.093*	0.225*	-0.071*	0.391*	-0.006	1.000							
(9) CAP	0.070*	-0.055*	0.123*	-0.425*	-0.144*	-0.172*	0.082*	-0.134*	1.000						
(10) HHI	-0.387*	-0.370*	-0.327*	0.044	0.039	-0.077*	-0.021	0.005	0.005	1.000					

(11) LINDEX	-0.038	-0.504*	0.211*	0.111*	-0.269*	0.146*	0.043	-0.031	0.187*	0.147*	1.000				
(12) GDPG	0.413*	0.485*	0.301*	-0.117*	0.038	0.110*	-0.002	0.080*	-0.084*	-0.508*	-0.249*	1.000			
(13) INF	-0.260*	-0.138*	-0.276*	-0.174*	0.126*	-0.199*	0.022	-0.296*	0.019	-0.012	-0.295*	-0.173*	1.000		
(14) UM	-0.399*	-0.239*	-0.410*	-0.119*	0.141*	-0.083*	-0.033	-0.262*	0.001	0.470*	-0.050*	-0.483*	0.296*	1.000	
(15) IQ	0.145*	-0.168*	0.282*	0.204*	-0.146*	0.217*	-0.061*	0.209*	0.030	0.246*	0.554*	-0.107*	-0.735*	-0.047*	1.000

** shows significance at the .01 level*