International Journal of
Financial Studies

MDPI

Article

Fintech Adoption, Financial Inclusion, and Bank Performance: Evidence from the Asian Banking Industry

Helal Uddin [1,*] and Munim Kumar Barai [2]

[1] College of International Management, Ritsumeikan Asia Pacific University, Beppu 874-8577, Japan
[2] School of Management, Ritsumeikan Asia Pacific University, Beppu 874-8577, Japan; baraimk@apu.ac.jp
* Correspondence: h-uddin@apu.ac.jp

Abstract

Financial technology (fintech) provides access to financial services without relying on physical branch infrastructure, thereby overcoming geographical barriers and reducing transaction costs for users, including those previously excluded. Evidence from global financial databases suggests that fintech has played a significant role in bringing unbanked adults into the formal financial system, although its impact on bank-level financial inclusion and performance remains empirically contested, particularly across economies at different stages of development. This study advances understanding of the impact of fintech adoption on financial inclusion and bank performance across 14 Asian countries, divided into four subgroups. Using bank-level panel data from Bloomberg for 173 banks over the period 2016–2024 and employing Driscoll–Kraay fixed-effects estimation, the study finds that, regardless of a nation's level of development, fintech adoption significantly and generally consistently advances financial inclusion across Asian banking systems. They also show that the impacts of fintech on profitability are not ubiquitous nor instantaneous, and that in more technologically sophisticated economies, these effects may initially be detrimental before any longer-term performance advantages are materialize.

Keywords: fintech adoption; financial inclusion; bank performance; Asian banks; cross-sectional dependence

1. Introduction

Financial technology (fintech) refers to technology-enabled financial services that provide access to financial services without reliance on physical branch infrastructure (Nagorny, 2020). Beyond improving efficiency, fintech has emerged as a critical instrument for expanding access to affordable financial services for individuals and firms alike. Over the past decade, it has gained substantial scholarly attention for its potential to bridge the persistent gap between unbanked populations and formal financial systems. In particular, mobile money platforms such as M-Pesa in Kenya, bKash in Bangladesh, and Paytm in India have significantly lowered barriers to entry, enabling previously excluded individuals to participate in the formal financial sector. Consequently, the rapid diffusion of fintech has begun to restructure the traditional banking landscape by extending institutional access to historically underserved segments (Kamara & Yu, 2024).

In this transformation of the banking industry, financial inclusion constitutes a central channel through which fintech can influence broader economic outcomes. It supports economic expansion by enabling underserved populations to engage in productive financial

Academic Editors: Alina Georgiana Manta, Roxana Maria Bădîrcea and Nicoleta Mihaela Doran

Received: 29 April 2026
Revised: 10 July 2026
Accepted: 16 July 2026
Published: 4 August 2026

activities, fostering savings behavior, alleviating financial constraints, and creating opportunities for investment and entrepreneurship (N. Khan et al., 2022). Access to formal financial services—including savings accounts, credit, and payment systems—enhances participation in economic activities and strengthens financial resilience. Empirical evidence from Ahamed and Gutiérrez-Romero (2020) identifies financial inclusion as a significant driver of poverty reduction and inequality mitigation, particularly in low-income economies. It is directly involved in income generation and increases shock-absorption capacity. Moreover, Surwanti et al. (2026) position financial inclusion as a foundational component in achieving the Sustainable Development Goals (SDGs), especially those related to poverty alleviation and food security.

Indeed, a growing body of literature attributes the decline in the number of unbanked adults, at least in part, to the expansion of fintech adoption on both the demand and supply sides. On the supply side, financial institutions, including banks, have increasingly embedded fintech into their operational frameworks by integrating digital platforms, mobile banking, and innovative payment systems to broaden outreach while reducing transaction costs. This structural shift has enabled banks to scale their operations more efficiently by covering and serving previously excluded populations.

Empirical evidence largely supports this viewpoint. For instance, Aloulou et al. (2024) examine the role of banks' fintech adoption in China and find a significant positive effect on digital financial inclusion. Consistent with this, T. Yang and Zhang (2022) show that bank-level fintech adoption substantially enhances financial inclusion in the Chinese context. Noreen et al. (2022) draw similar conclusions. Using the Global Findex data for Pakistan, their study documented a positive association between fintech adoption and financial inclusion. Focusing on sub-Saharan Africa, Mothobi and Kebotsamang (2024) further demonstrate that fintech is a key driver of financial inclusion, particularly in environments with limited traditional banking infrastructure. However, Kamara and Yu (2024) identified that fintech adoption has a negative impact on the geographic dimension.

In addition to financial inclusion, fintech adoption also has implications for banks' financial performance. A number of studies have examined the relationship between fintech adoption and financial institutions' performance, finding that adopting fintech improves efficiency and creates new revenue opportunities. For instance, Y. Yang et al. (2025) analyze the impact of fintech development on the financial sustainability of 104 Chinese commercial banks and find that fintech development negatively affects bank sustainability by reducing loan efficiency and profitability. In contrast, F. Yang and Masron (2023) find that fintech adoption negatively affects banks' performance.

A survey of the current literature, which has been developed with fintech analysis, importantly highlights the fact that it suffers from some limitations. First, fintech research is dominated by single-country studies in Asia, and cross-regional research remains limited. Second, the relationship between fintech adoption and financial inclusion, as well as bank performance, is mixed.

To address this limitation, this study examines the relationship among fintech adoption, financial inclusion, and bank performance across Asia by taking a sample of 14 Asian countries. Based on the World Economic Outlook (IMF, 2026, p. 40), Japan, South Korea, Singapore, and Hong Kong are classified as advanced Asian economies. Accordingly, we grouped them as developed economies in this study.

The IMF (2026) classifies China, India, Indonesia, Malaysia, the Philippines, Thailand, and Vietnam as Emerging and Developing Asia. However, treating all seven countries as a single group may mask important differences in economic size relevant to banking inclusion. China and India are the world's second- and fifth-largest economies, respectively, while Indonesia and Malaysia are among the largest economies in Asia. Therefore, for the purpose

of this analysis, China, India, Indonesia, and Malaysia are grouped as large economies, whereas the Philippines, Thailand, and Vietnam are grouped as emerging economies.

The IMF (2026) further classifies Bangladesh, Pakistan, and Sri Lanka as part of Other Emerging and Developing Asia, whereas the MSCI Index 2026 (MSCI, 2026) classifies these countries as frontier economies. Accordingly, Bangladesh, Pakistan, and Sri Lanka are grouped as frontier economies in this study. These four blocks will perfectly represent the whole of Asia. Therefore, this study extends the literature by offering evidence from Asia, thereby broadening the empirical base. In addition, given the mixed findings in prior research, this study seeks to provide further evidence on the impact of fintech adoption on banks' financial inclusion and performance.

The paper has been divided into five sections, including the introduction, to achieve our intended objectives. Section 2 provides a brief review of the literature to develop the paper's theoretical framework and hypotheses. Section 3 explains the methodology adopted for the study. Section 4 discusses and analyzes the results. Section 5 concludes the paper with some policy recommendations.

2. Theoretical Framework and Research Hypotheses

This section provides a review of the related literature that informs the paper's theoretical framework and hypotheses. It also notes the study's justification and how this work will add value to the literature on fintech, financial inclusion, and banks' financial performance.

2.1. Theoretical Framework

Fintech development has significantly transformed the global financial system by improving access to financial services. This new model not only changes the financial landscape but also extends opportunities to unbanked populations to join the formal financial system. These technological innovations enable financial institutions to expand service coverage, reduce operational costs, and enhance the efficiency of financial intermediation (Gomber et al., 2018). According to the World Bank Global Findex Database, the global unbanked population fell sharply from 2.5 billion in 2011 to 1.4 billion in 2021, driven by fintech adoption (Demirgüç-Kunt et al., 2022). The relationships among fintech adoption, financial inclusion, and bank performance can be explained through several theoretical perspectives.

First, Schumpeter's (1942) theory of innovation posits that innovation is a key driver of economic development through the introduction of new products or processes or the reform of the organizational framework. Innovations replace existing market structures and accelerate market efficiency by replacing prior products, processes, or frameworks with advanced alternatives. In the banking industry, fintech innovations transform traditional services through digital platforms that improve delivery and reduce information asymmetry (Maradana et al., 2017). This transformation enables financial institutions to reach previously unreachable geographic locations and underserved populations.

Second, the Technology Acceptance Model (TAM), developed by Davis's (1989), explains that technology adoption behavior is determined by two core components: perceived usefulness and perceived ease of use. Perceived usefulness refers to the extent to which a particular technology enhances individual performance, while perceived ease of use captures how effortless it is to operate a new system or how easily a new technology can be used. According to TAM, individuals are more likely to adopt a technological system when they perceive it to be both useful and user-friendly.

In the context of fintech, customer acceptance of digital services such as mobile banking, internet banking, and payment platforms is mainly due to their perceived usefulness, which enhances their banking efficiency, and, from an operational perspective, ease of use,

thereby improving access to financial institutions, increasing customer participation, and enhancing financial inclusion.

Third, the Resource-Based View (RBV) developed by Barney (1991) suggests that firms achieve sustainable competitive advantage through valuable, rare, inimitable, and non-substitutable resources. In banking, fintech technologies represent strategic resources that enhance operational efficiency, reduce transaction costs, and improve service delivery (Adeleke et al., 2022). Accordingly, banks successfully integrating digital technologies are expected to strengthen their competitive position and financial performance in the industry.

Finally, financial intermediation theory explains banks' role in efficiently allocating resources between savers and borrowers by reducing transaction costs, managing risks, and overcoming information asymmetry (Diamond, 1984). Fintech strengthens this process by improving information processing, lowering costs, and expanding access through digital platforms, mobile banking, and online lending (Philippon, 2019). Boot and Thakor (2010) demonstrate that technological innovation enhances the effectiveness of financial intermediation and bank performance. Figure 1 presents the conceptual framework based on this discussion.

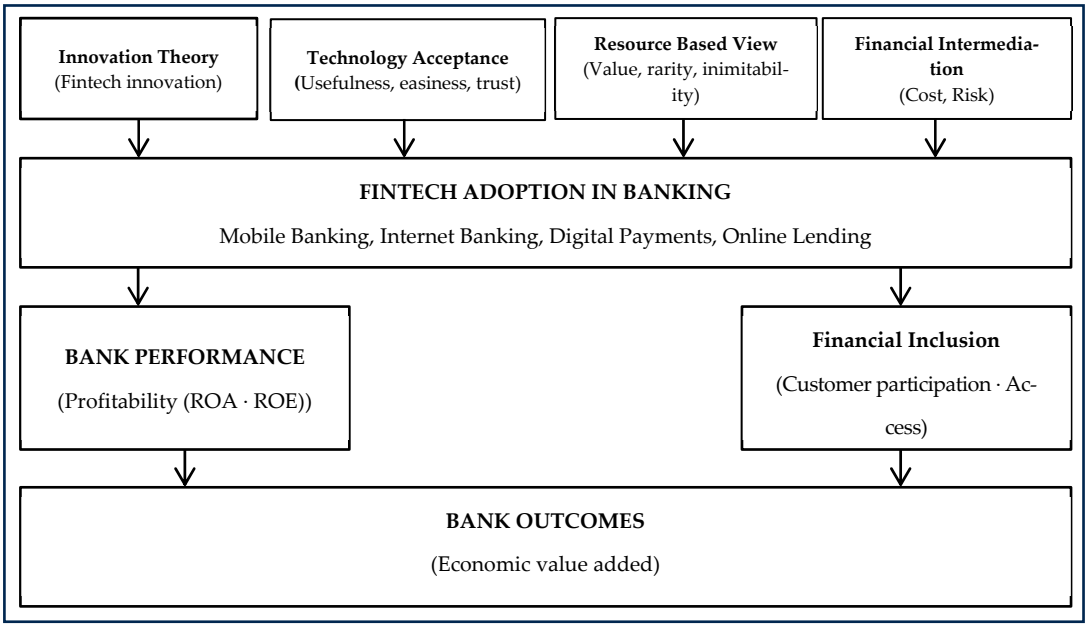

Figure 1. Conceptual framework.

In summary, these theoretical perspectives provide us with a logical explanation of how fintech influences banking outcomes through multiple interconnected channels. Schumpeterian theory explains the innovation-driven transformation of financial systems; TAM captures the behavioral mechanisms of technology adoption; RBV explains how fintech enhances firm-level competitive advantage; and Financial Intermediation Theory describes how digital technologies improve the efficiency of financial systems. Integrating these perspectives, fintech is expected to improve both financial inclusion and banking performance within financial systems.

2.2. Empirical Evidence

The literature on Fintech is divided into three main categories. On them, the first group found a positive relationship between fintech and financial inclusion, as reported by Kufo et al. (2026), Oyedotun and Makoni (2026), Chinoda and Mingiri Kapingura (2024), and Faseesin et al. (2026). The second group found a negative relationship, such as Cevik (2024). The last group reported mixed results, as evidenced by Kamara and Yu (2024).

Kufo et al. (2026) examined the role of fintech in advancing financial inclusion globally. Their sample consisted of 89 developing economies using panel data from the Global Findex reports covering the period 2011–2021. They reported that fintech is the most significant driver of financial inclusion, particularly in expanding account ownership. Similarly, Oyedotun and Makoni (2026) analyzed whether financial technology enhances financial inclusion in Africa using a dynamic panel approach. Their findings showed that fintech helps to increase financial inclusion in selected Sub-Saharan African countries. Likewise, Chinoda and Mingiri Kapingura (2024) examined the relationship between fintech adoption and financial inclusion among commercial banks in Sub-Saharan Africa. Using a sample of 10 countries over the period 2014–2021, the results revealed that the relationship between fintech adoption and financial inclusion follows an inverted U-shaped pattern. Furthermore, Faseesin et al. (2026) investigated the long-run and short-run relationship between fintech adoption and financial inclusion. Their sample comprised 45 Sub-Saharan African countries over the period 1999–2023. Using descriptive statistics and correlation analysis, they identified that fintech has a positive long-run association with financial inclusion outcomes.

In contrast, Cevik (2024) examined whether fintech transaction volume affects formal financial inclusion across countries. The study covered 84 countries using World Bank Global Findex data and Cambridge Center for Alternative Finance fintech data from 2012 to 2020, employing an unbalanced panel regression method. The author found that digital lending has a significant negative effect on the share of adults with a formal financial account, whereas digital capital raising is not statistically significant, yielding an overall negative and insignificant effect of fintech on financial inclusion.

Finally, Kamara and Yu (2024) examined whether fintech adoption crowds out or complements traditional financial inclusion. The study covered 22 countries in Sub-Saharan Africa using data from the World Bank's World Development Indicators and the IMF Financial Access Survey for the period 2004–2022. Employing Principal Component Analysis (PCA) and the Generalized Method of Moments (GMM), they found that fintech has a negative effect on the geographic dimension of financial inclusion but a positive and significant effect on its demographic dimension.

Similarly, the current literature divides fintech adoption and performance into three groups. For instance, Iatzaz Ul Hassan et al. (2025) examined the causal relationship between fintech adoption and bank performance. They collected data from 33 developing Asian countries covering the period from 2010 to 2022. By applying regression analysis, they found that fintech has a consistently positive and statistically significant impact on bank performance, particularly among lower-performing banks. On the other hand, F. Yang and Masron (2023) analyzed the impact of financial inclusion on the profitability of Chinese banks. Their sample comprised 118 Chinese banks over the period from 2014 to 2021. Applying the two-step System GMM estimator, they found that digital transformation has a negative effect on bank profitability. Similarly, Phan et al. (2020) examined the impact of FinTech firms on bank performance in Indonesia and found that increased FinTech competition significantly reduced banks' return on assets (ROA), return on equity (ROE), and net interest margins (NIM). In contrast, Liu et al. (2024) also examined the impact of fintech on the performance of Chinese banks. They examined all Chinese banks that participated in open banking during 2011–2020 and found that inclusive fintech can improve bank performance by lowering lending rates. Likewise, Lamey et al. (2024) examined fintech adoption and banks' non-financial performance. Using a structured questionnaire, they collected primary data from bank staff in Iraq, Egypt, Oman, and Jordan through convenience sampling, with a sample size of 397. The data were analyzed using Structural Equation Modeling (SEM), and the results revealed that fintech adoption

has a positive and significant impact on banks' non-financial performance. Wang et al. (2024) examined whether fintech adoption improves bank performance using a sample of 355 American banks from 2010 to 2020. Employing System GMM, fixed-effects, and OLS estimators, they found that fintech adoption positively affects bank performance. However, the effect varies across bank size and geographical regions.

Despite extensive studies on fintech, financial inclusion, and bank performance, several important gaps remain in the literature. Most existing studies concentrate only on one side, whether financial inclusion or performance; however, combining both is very limited. On the other hand, most financial inclusion studies focus on Sub-Saharan Africa or other developing economies, and bank performance studies are often country-specific. Cross-country comparative studies are limited in the literature. Third, the direction in the current literature remains unclear. Therefore, this research addresses the first two gaps and provides new empirical evidence, adding another conclusion to the existing literature. A summary of selected literature is presented in Table 1.

Table 1. Summary of selected literature.

Author (Year)	Main Focus	Sample Size and Years	Main Findings
Iatzaz Ul Hassan et al. (2025)	Fintech adoption and bank performance	33 developing Asian countries (2010–2022)	Fintech has a positive and significant effect on bank performance, especially among lower-performing banks.
Liu et al. (2024)	Inclusive Fintech, open banking, and bank performance	Chinese banks involved in open banking (2011–2020)	Inclusive Fintech improves bank performance by enhancing lending rates.
Kamara and Yu (2024)	Fintech adoption and traditional financial inclusion	22 Sub-Saharan African countries (2004–2022)	Fintech negatively affects the geographic dimension but positively affects the demographic dimension of financial inclusion.
Oyedotun and Makoni (2026)	Fintech and financial inclusion	Selected Sub-Saharan African countries	Fintech significantly enhances financial inclusion.
Chinoda and Mingiri Kapingura (2024)	Fintech adoption and financial inclusion	10 Sub-Saharan African countries (2014–2021)	Fintech adoption and financial inclusion have an inverted U-shaped relationship.
Faseesin et al. (2026)	Fintech and financial inclusion	45 Sub-Saharan African countries (1999–2023)	Fintech has a positive long-run relationship with financial inclusion.
Kufo et al. (2026)	Fintech and global financial inclusion	89 developing economies (2011–2021)	Fintech is the strongest driver of financial inclusion, particularly account ownership.
F. Yang and Masron (2023)	Financial inclusion, digital transformation, and bank profitability	118 Chinese banks (2014–2021)	Digital transformation negatively affects bank profitability, while financial inclusion moderates the relationship.
Lamey et al. (2024)	Fintech adoption and banks' non-financial performance	397 bank employees from Iraq, Egypt, Oman, and Jordan	Fintech adoption improves banks' non-financial performance significantly and positively.
Lavrinenko et al. (2023)	Fintech as a financial development factor	European Union countries	Fintech contributes positively to financial development in EU countries.
Phan et al. (2020)	Fintech firms and bank performance	Indonesian commercial banks	Fintech competition reduces ROA, ROE, and NIM, indicating a negative effect on bank performance.
L. Xu et al. (2022)	Fintech business and firms' access to bank loans	Chinese firms	Fintech improves firms' access to bank loans by reducing information asymmetry.

2.3. The Relationship Between Fintech Adoption and Financial Inclusion

A number of studies find that Fintech serves as a pivotal driver of financial inclusion, particularly in emerging and developing economies where traditional banking infrastructure remains limited (Ozili, 2025; Leong & Sung, 2025). Moreover, Fintech innovations—such as mobile banking, digital wallets, and online banking—reduce transaction costs, overcome geographic barriers, and enable unbanked individuals to access formal financial services (Khera et al., 2022). Evidence also shows that fintech adoption increases financial inclusion through higher account ownership, greater frequency of digital payments, and more diversified use of savings, credit, and insurance products (Sharma et al., 2025). From this literature, we hypothesize the following:

H1. *Higher levels of fintech adoption positively and significantly predict financial inclusion.*

2.4. The Relationship Between Fintech Adoption and Performance

Fintech adoption has become a strategic lever for enhancing organizational performance, particularly in banking, where digital innovation is reshaping traditional business models (Albuainain & Ashby, 2025). A systematic review of recent studies indicate that greater adoption of fintech solutions such as mobile banking, digital payments, robo-advisory services, and data-driven credit scoring improves operational efficiency, reduces transaction costs, and enhances the customer experience, ultimately supporting higher profitability (Ghosh & Uttam, 2026). Similarly, empirical studies show that banks integrating fintech into core processes achieve better financial indicators (e.g., return on assets, return on equity, revenue growth) and non-financial outcomes (e.g., customer loyalty, service quality) compared to slower adopters, although results vary due to implementation costs, cybersecurity risks, and competitive pressures (Ghosh & Uttam, 2026). The emerging consensus suggests that, when effectively implemented and strategically aligned, fintech adoption positively affects both financial and operational performance across diverse markets and institutions (Albuainain & Ashby, 2025; R. Xu, 2026). From this literature, we hypothesize:

H2. *Higher levels of fintech adoption are positively and significantly associated with bank performance.*

We would like to emphasize that this study is expected to contribute to the literature in several ways. First, it provides a cross-country comparison of Asian economies, including developed, emerging, and large economies. Second, it improves understanding of how fintech adoption affects financial inclusion and bank performance across different economic environments. Finally, it applies a bank-level fintech adoption index, offering a more refined approach to measurement for empirical analysis.

3. Methodology

3.1. Research Methods

This study employs a regression model as follows:

$$Y_{it} = \beta_0 + \beta_1 Fintech\_Index_{it} + \int_{i=0}^{n} Control\_Variable + \varepsilon_{it} \quad (1)$$

where Y_{it} represents the dependent variable for bank i at time t. The term β_0 denotes the intercept, capturing the baseline level of the dependent variable when all explanatory variables are held constant. The coefficient β_1 measures the effect of fintech development, proxied by the Fintech Index, on the dependent variable. In addition, a set of control variables is included to account for other factors that may influence the dependent variable. The

error term ε_{it} captures unobserved influences not explicitly included in the model. Based on this general specification, the following equations are developed to test our hypotheses:

$$Financial\_Inclusion_{it} = \beta_0 + \beta_1 Fintech\_Index_{it} + \int_{i=0}^{n} Control\_Variable + \varepsilon_{it} \quad (2)$$

$$Financial\_Performance_{it} = \beta_0 + \beta_1 Fintech\_Index_{it} + \int_{i=0}^{n} Control\_Variable + \varepsilon_{it} \quad (3)$$

3.2. Variable Definitions

3.2.1. Dependent Variable

This study employs two dependent variables: financial inclusion and financial performance. Financial inclusion refers to individuals' and businesses' access to useful, affordable financial products and services—such as transactions, payments, savings, credit, and insurance—delivered responsibly and sustainably (Demirgüç-Kunt et al., 2015). Financial performance reflects a bank's ability to generate earnings, utilize assets efficiently, maintain liquidity, and create shareholder value, as shown in its financial statements (Brigham & Houston, 2021).

While the percentage of adults with formal financial accounts is the most common proxy for financial inclusion (Demirgüç-Kunt et al., 2022), recent studies argue that it captures access rather than usage (Thomas et al., 2024). True financial inclusion requires active engagement through deposits and loans, making these usage-based indicators more appropriate proxies (Ramadhan et al., 2025). Ifediora et al. (2022) used outstanding loans and deposits as a proxy for financial inclusion. However, the outstanding loan and deposit are not suitable for cross-country comparison. Hence, this study uses the natural logarithms of total deposits (LDEP) and total loans (LLOAN) as measures of financial inclusion.

Financial performance is measured using return on assets (ROA) and return on equity (ROE), which capture operational efficiency and shareholder value creation, respectively. The use of both indicators provides a comprehensive assessment, as no single measure fully captures firm performance (Nguyen et al., 2023).

3.2.2. Independent Variable

The primary independent variable is the bank-level fintech adoption index (FNT). Recent studies measure fintech using text mining (Arnone et al., 2024), text disclosure analysis (Petrović et al., 2025), and component-based scoring (Snobar & Al Hanini, 2025), but these approaches have limitations. Text mining suffers from media bias, text disclosure from inconsistent reporting practices, and component methods from incomplete data disclosure. To address these issues, this study adopts the Weighted Scoring-Based Fintech Adoption Index developed by Uddin and Barai (2026), which provides a reliable, comprehensive measure of institutional fintech adoption.

The fintech adoption index is as follows.

$$FNT_{it} = \sum_{i=0}^{n} Score_{it} \times Weight_{it} \quad (4)$$

where *FNT* represents the fintech adoption index of bank *i* at time *t*, *Score* refers to the score assigned to each indicator, and *Weight* represents the weight assigned to each indicator. Since all indicators are equally weighted, the relative contribution of each indicator remains constant across banks and over time. The index comprises eight observable, publicly verifiable indicators (see Table A1 in the Appendix A), with each indicator assigned a score of 0.00 (no adoption), 0.50 (partial adoption), or 1.00 (full adoption). The rationale for adopting a non-binary scoring approach is that banks often provide fintech-enabled services while maintaining certain procedural requirements, such as requiring customers

to visit physical branches for service activation or verification. Therefore, partial adoption captures intermediate stages of digital transformation that cannot be accurately represented using a simple binary classification.

3.2.3. Control Variable

This study incorporates bank- and country-level control variables to account for factors that influence financial inclusion and bank performance. At the bank level, total assets were initially considered as a control variable. However, because total assets are highly correlated with the performance measures (ROA and ROE), they were excluded from the final analysis to avoid potential multicollinearity issues. Instead of total assets, this research considered bank capitalization, measured by the equity-to-assets ratio (ETA), as a control variable to capture bank strength. Which is used by Duong et al. (2025). In addition, the liquidity ratio, calculated as liquid assets to total assets (LAT), is employed to measure a bank's liquidity position and financial stability. Higher ETA ratios generally reflect stronger capital positions, while LAT captures banks' ability to meet short-term obligations and withstand liquidity shocks.

At the country level, gross domestic product growth (GDP) and the inflation rate (INF) are included to capture macroeconomic conditions that may affect financial inclusion and banking performance. These control variables help ensure a more robust identification of the effects of fintech adoption across diverse institutional and economic environments. Table 2 provides a detailed description of all variables used in the study.

Table 2. Variable definitions.

Variable Type	Variable Name	Symbol	Definition	Source
Dependent variable	Financial Inclusion	LDEP	Natural Logarithm of total deposit.	Ifediora et al. (2022)
		LLOAN	Natural Logarithm of total loan	Ifediora et al. (2022)
	Performance	ROA	Return on assets	Return on assets
		ROE	Return on Equity	Return on Equity
Independent variable	Fintech Index	FNT	Weighted Scoring-Based Fintech Adoption Index	Uddin and Barai (2026)
Control Variable	Bank capitalization	ETA	Total Equity to Total Assets	Duong et al. (2025)
	Current liquidity ratio to total assets	LTA	Cash and equivalents to total assets	Mohammad and Khan (2024)
	GDP growth	GDP	GDP growth rate of the economy	Yuan et al. (2022)
	Inflation rate	INF	Inflation rate of the economy	Iatzaz Ul Hassan et al. (2025)

3.3. Data Sources and Model Specification

This study examines 173 banks from 14 Asian economies that represent diverse economic and technological development levels: developed economies (Japan, South Korea, Singapore, and Hong Kong), large economies (China, India, Indonesia and Malaysia), emerging economies (Philippine, Thailand, and Vietnam), and Frontier economies (Bangladesh, Pakistan and Sri Lanka) are perfect representatives of Asia. The sample includes local banks listed on each country's primary stock exchange, with firm-level data sourced from the Bloomberg Terminal—a widely recognized authority for financial data on publicly listed companies. This study collects data from those 173 banks over 9 years (2016–2024), resulting in perfectly balanced data.

Model selection followed standard panel data diagnostics. The Hausman test ($\chi^2 = 511.75$, $p < 0.001$) initially favored the random-effects model, but a strong negative correlation between the fixed-effects estimator and the regressors supported the fixed-effects model (Wooldridge, 2010). Pesaran's (2004) cross-sectional dependence test confirmed the presence of global shocks (CD statistics were all significant at the $p < 0.01$ level), while fixed-effects estimation revealed substantial heteroskedasticity (Greene, 2012).

Given cross-sectional dependence, heteroskedasticity, and serial correlation, this study employs fixed-effects with Driscoll–Kraay standard errors, which are robust to all three issues and are standard in cross-country banking studies (Ozili, 2022; Le et al., 2021).

4. Empirical Results

4.1. Descriptive Statistics and Correlation Analysis

Table 3 reports the descriptive statistics of all variables used in the analysis across 1557 bank observations. The fintech adoption index has a mean of 0.6571 and a relatively high standard deviation of 0.2890, with a range from 0.0833 to 1.00, indicating high variation in fintech adoption across banks and countries. The financial inclusion variables display moderate dispersion, with LDEP averaging 4.8561 (range: 2.3599–7.5878) and an SD of 1.0275. In the same way, LLOAN averaged 4.76 (SD = 0.989), with a range from 2.559 to 7.44, reflecting broadly dissimilar distributions across banks in Asian economies.

Table 3. Descriptive statistics of the variables.

Variable	Obs	Mean	Std. Dev.	Min	Max
FNT	1557	0.6571	0.2890	0.0833	1.0000
LDEP	1557	4.8561	1.0272	2.3599	7.5878
LLOAN	1557	4.7597	0.9887	2.5593	7.4402
ROA	1557	0.3941	0.6678	−6.8385	3.7351
ROE	1557	4.6121	6.8483	−67.6483	27.7127
ETA	1557	0.0851	0.0362	0.0064	0.4974
LAT	1557	0.0664	0.0601	0.0011	0.4282
GDP	1557	3.6770	3.7741	−9.5000	9.8000
INF	1557	4.2297	5.1536	−1.1000	45.2000

Bank performance indicators exhibit noticeable variation consistent with heterogeneous banking sectors. Return on assets has a mean of 0.394% (SD = 0.668%), with values ranging from −6.83% to 3.735%, indicating both highly profitable and loss-making banks in the sample. In comparison, ROE has a higher mean of 4.612% and a larger standard deviation of 6.848%, with values spanning from −67.648% to 27.713%, highlighting substantial heterogeneity in equity returns across institutions and economic contexts.

Capital adequacy, measured by equity-to-total-assets (ETA), averages 0.085, indicating moderate capitalization, though values range widely from 0.006 to 0.497, reflecting differences in regulatory strength and leverage. Liquidity, measured by LAT, has a low average of 0.066 with considerable dispersion, implying that some banks maintain limited liquid buffers while others hold substantially higher reserves.

At the macroeconomic level, GDP growth averages 3.677% (SD = 3.37%), with values ranging from −9.5% to 9.80%, effectively capturing the diverse macroeconomic conditions across countries and time periods in the dataset. Inflation (INF) averages 4.23% but ranges from −1.1% to 45.2%, highlighting significant macroeconomic instability in parts of the sample.

Table 4 presents the pairwise correlation matrix for all key variables. The results indicate that FNT is negatively associated with financial inclusion variables, specifically LDEP (r = −0.390) and LLOAN (r = −0.385), although these relationships are relatively modest in magnitude. In terms of bank performance, fintech adoption shows a positive correlation with ROA (r = 0.444) or ROE (r = 514), suggesting a clear linear relationship with profitability at this preliminary stage of analysis.

Table 4. Correlation matrix of key variables.

Variables	FNT	LDEP	LLOAN	ROA	ROE	ETA	LAT	GDP	INF
(1) FNT	1.000								
(2) LDEP	−0.390	1.000							
(3) LLOAN	−0.385	0.994	1.000						
(4) ROA	0.444	−0.483	−0.472	1.000					
(5) ROE	0.514	−0.475	−0.466	0.913	1.000				
(6) ETA	0.028	−0.257	−0.237	0.335	0.109	1.000			
(7) LAT	0.142	−0.080	−0.112	−0.034	0.047	−0.188	1.000		
(8) GDP	−0.095	−0.057	−0.037	0.145	0.161	0.033	−0.115	1.000	
(9) INF	−0.283	0.265	0.258	−0.187	−0.232	−0.012	−0.126	−0.056	1.000

Among the control variables, ETA exhibits a moderately positive correlation with fintech adoption (r = 0.028), suggesting that capital adequacy plays little or no role in facilitating fintech diffusion across banks and countries.

The LAT demonstrates a positive correlation with fintech adoption (r = 0142). This pattern suggests that higher fintech adoption may be associated with lower credit risk exposure.

The correlation between the financial inclusion measures LDEP and LLOAN is extremely high (r = 0.994), as expected since both variables capture active use of financial services and serve as alternative dependent variables in separate model specifications. Therefore, this high correlation does not raise multicollinearity concerns in the primary analysis. Similarly, the bank performance indicators ROA and ROE exhibit a strong correlation (r = 0.913), reflecting their complementary measurement of profitability from asset and equity perspectives. Critically, all remaining correlations fall below the commonly accepted multicollinearity threshold of $|r| \geq 0.80$, confirming that multicollinearity does not pose a serious threat to the regression analysis (Hair et al., 2010).

4.2. Impact of Fintech Adoption on Financial Inclusion

Table 5 reports Driscoll–Kraay fixed-effects regression results examining the effects of fintech adoption on financial inclusion across all countries, grouped into four subgroups: large economies, developed economies, emerging economies, and frontier economies.

The results indicate that fintech adoption is consistently dominant across all Asian economies. Fintech is positively and significantly associated with deposits across all country groups. The largest effect is observed in Emerging economies (β = 1.00, $p < 0.01$), followed by Large (β = 0.842, $p < 0.01$), Advanced (β = 0.745, $p < 0.01$), and Frontier (β = 0.565, $p < 0.01$), and all coefficients are significant at the 1% level. This specifies that a one-unit increase in fintech adoption by banks will increase deposits by one unit in emerging economies, 0.842 units in large economies, 0.745 units in Advanced economies, and 0.565 units in Frontier economies. The relationship is almost one-to-one in Emerging economies. The current study is also consistent with Kufo et al. (2026) and Chinoda and Mingiri Kapingura (2024).

Similarly, fintech adoption has a positive and significant impact on loans, with the largest coefficient in Advanced economies (β = 1.054, $p < 0.01$), followed by Emerging (β = 0.949, $p < 0.01$), Large (β = 0.810, $p < 0.01$), and Frontier (β = 0.526, $p < 0.01$), implying that fintech also plays a key role in promoting bank lending. This finding also aligns with L. Xu et al. (2022), who found that fintech helps enhance loan screening efficiency.

The impact of bank-level control variables such as ETA varies considerably across countries. For deposits, ETA has a negative and significant effect in Large ($\beta = -0.916$, $p < 0.10$) and Frontier ($\beta = -2.328$, $p < 0.01$) economies, but a positive and significant effect in Advanced (β = 2.409, $p < 0.01$) and Emerging (β = 1.29, $p < 0.05$) economies.

This emphasizes that a higher ETA helps banks attract more deposits in these countries. However, it has a negative effect on Large and Frontier economies, suggesting that higher ETA is associated with lower deposits. This implies that the benefits of ETA depend on a country's level of economic and financial development. A similar pattern is observed for loans, where ETA is insignificant in large economies but positively associated with loans in Advanced (β = 5.161, $p < 0.01$) and Emerging (β = 2.323, $p < 0.01$) economies, while negatively associated with loans in Frontier economies ($\beta = -2.082$, $p < 0.01$).

Table 5. Fintech adoption and financial inclusion (Driscoll–Kraay standard errors).

	Deposit				Loan			
	Large	**Advance**	**Emerging**	**Frontier**	**Large**	**Advance**	**Emerging**	**Frontier**
FNT	0.842 ***	0.745 ***	1.000 ***	0.565 ***	0.810 ***	1.054 ***	0.949 ***	0.526 ***
	(0.170)	(0.153)	(0.172)	(0.132)	(0.184)	(0.210)	(0.186)	(0.138)
ETA	−0.916 *	2.409 **	1.290 *	−2.328 ***	−0.650	5.161 ***	2.323 ***	−2.082 ***
	(0.450)	(0.878)	(0.615)	(0.145)	(0.392)	(0.804)	(0.683)	(0.0997)
LAT	−1.634 **	−0.254	−0.0310	−0.643 **	−2.316 ***	−0.658 **	−0.105	−1.120 ***
	(0.639)	(0.212)	(0.144)	(0.217)	(0.600)	(0.285)	(0.247)	(0.286)
GDP	0.0110 **	0.00166	0.000241	−0.00848	0.0101 **	0.00202	0.00114	−0.00581
	(0.00357)	(0.00325)	(0.00182)	(0.00462)	(0.00359)	(0.00409)	(0.00206)	(0.00331)
INF	−0.00492	0.0145 **	0.00324	0.00372 **	−0.00416	0.00701	0.00291	0.00269 **
	(0.0163)	(0.00505)	(0.00560)	(0.00157)	(0.0168)	(0.00658)	(0.00480)	(0.00106)
Constant	3.555 ***	4.260 ***	3.705 ***	5.531 ***	3.543 ***	3.758 ***	3.552 ***	5.452 ***
	(0.109)	(0.120)	(0.156)	(0.0456)	(0.112)	(0.139)	(0.164)	(0.0500)
Obs.	405	450	234	468	405	450	234	468
R-squared	0.428	0.392	0.516	0.591	0.441	0.445	0.462	0.550
F-statistic	169.4	33.11	127.9	7986.7	245.5	35.28	222.2	7847.6

Note: Standard errors in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Among the macroeconomic variables, GDP has a positive and significant effect only in large economies for both deposits ($\beta = 0.011$, $p < 0.05$) and loans ($\beta = 0.010$, $p < 0.05$), whereas its impact is insignificant in the remaining country groups. Inflation has a limited influence on banking activities. It positively affects deposits in Advanced (0.0145 ** $\beta = 0.0145$, $p < 0.05$) and Frontier ($\beta = 0.0037$, $p < 0.05$) economies, while for loans, a significant positive effect is found only in Frontier economies ($\beta = 0.002$, $p < 0.05$).

The results confirm Hypothesis 1: higher levels of fintech adoption positively and significantly predict financial inclusion across Asia. Driscoll–Kraay estimates demonstrate robust effects on both deposit mobilization and loan provision, with the strongest impacts in all economic groups. These findings validate H1.

4.3. Fintech Adoption and Bank Performance

Table 6 presents the regression results for bank performance across Asian banks, grouped by four country subgroups. The results show that the effect of fintech adoption (FNT) on bank profitability is mixed across the four groups of economies. For ROA, fintech has a negative and statistically significant effect only in Advanced economies ($\beta = -0.178$, $p < 0.05$). A similar finding is also presented by Liu et al. (2024). They explain that, initially, fintech incurred high costs, which have negatively impacted ROA, while its effect is positive but statistically insignificant in Large, Emerging, and Frontier economies, similar to Phan et al. (2020). This indicates that any profitability gains from fintech adoption have not yet materialized in this economy.

Table 6. Fintech adoption and bank performance.

	ROA				ROE			
	Large	**Advance**	**Emerging**	**Frontier**	**Large**	**Advance**	**Emerging**	**Frontier**
FNT	0.458	−0.178 **	0.329	−0.00363	6.319	−1.814 **	6.575	−0.0215
	(0.393)	(0.0572)	(0.221)	(0.00237)	(3.984)	(0.725)	(3.595)	(0.0302)
ETA	11.46 **	1.779 *	9.033 ***	0.0751 ***	98.99 **	−15.75 **	17.80	0.928
	(3.867)	(0.856)	(1.041)	(0.0166)	(31.00)	(6.013)	(13.38)	(0.528)
LAT	2.617 *	−0.152	0.504	0.0291	47.86 ***	−4.633 *	5.360	0.0542
	(1.153)	(0.0890)	(0.310)	(0.0160)	(9.416)	(2.478)	(3.526)	(0.152)
GDP	0.0558 ***	0.000317	0.0101 **	0.000582 **	0.555 ***	−0.00978	0.105 **	0.00665
	(0.00992)	(0.000489)	(0.00355)	(0.000228)	(0.0884)	(0.00920)	(0.0434)	(0.00379)
INF	−0.00982	0.0121 ***	−0.0134	0.000239 **	−0.0725	0.205 ***	−0.218	0.00361 *
	(0.0206)	(0.00299)	(0.0147)	(0.0000860)	(0.205)	(0.0163)	(0.196)	(0.00170)
Constant	−1.017	0.216 **	−0.633 **	−0.00189	−10.90 *	5.793 ***	0.282	−0.0135
	(0.632)	(0.0756)	(0.223)	(0.00246)	(5.615)	(0.475)	(1.822)	(0.0539)
Obs.	405	450	234	468	405	450	234	468
R-squared	0.131	0.0554	0.242	0.154	0.129	0.0506	0.0628	0.0943
F-statistic	48.11	53.46	250.4	241.9	16.61	78.39	7.670	4.808

Standard errors in parentheses, * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

A similar pattern is observed for ROE, where fintech has a significant negative effect only in Advanced economies ($\beta = -1.814$, $p < 0.05$). These findings suggest that fintech adoption does not immediately improve bank profitability and may initially increase operating or technology investment costs, particularly in Advanced economies. However, it shows a positive but not significant effect on Large, Emerging, and Frontier economies, consistent with the findings of H. U. Khan et al. (2025).

ETA generally has a positive effect on profitability. For ROA, ETA is positive and significant in Large ($\beta = 11.46$, $p < 0.05$), Advanced ($\beta = 1.779$, $p < 0.10$), Emerging ($\beta = 9.033$, $p < 0.05$), and Frontier ($\beta = 0.0751$, $p < 0.01$) economies, indicating that higher ETA is associated with better bank performance. For ROE, ETA has a strong positive effect in large economies ($\beta = 0.98.99$, $p < 0.05$), while its effect is negative in Advanced economies ($\beta = -15.75$, $p < 0.05$) and insignificant in Emerging and Frontier economies. This suggests that the impact of ETA on shareholders' returns differs across country groups.

LAT also shows mixed results. It has a positive and significant effect on ROA in Large economies ($\beta = -2.617$, $p < 0.10$) but is insignificant in the remaining groups. For ROE, LAT has a positive and significant effect in large economies ($\beta = 57.86$, $p < 0.01$) but a negative effect in Advanced economies ($\beta = -4.633$, $p < 0.05$), with no significant relationship in Emerging and Frontier economies.

Among the macroeconomic variables, GDP has a positive and significant effect on ROA in Large ($\beta = 0.0558$, $p < 0.01$), Emerging ($\beta = 0.0101$, $p < 0.050$), and Frontier ($\beta = 0.000582$, $p < 0.05$) economies, whereas it is insignificant in Advanced economies. For ROE, GDP also positively affects Large ($\beta = 0.555$, $p < 0.01$) and Emerging ($\beta = 0.105$, $p < 0.05$) economies but has no significant effect in Advanced and Frontier economies. Inflation has a limited influence on profitability. It positively affects ROA in Advanced ($\beta = 0.0121$, $p < 0.01$) and Frontier ($\beta = 0.00239$, $p < 0.05$) economies, while for ROE, inflation is positive and significant in Advanced ($\beta = 0.0205$, $p < 0.01$) and Frontier ($\beta = 0.0036$, $p < 0.10$) economies but insignificant in Large and Emerging economies.

The results show an inverse relation between fintech adoption and performance in advanced economies, which does not support our Hypothesis 2. On the other hand, fintech adoption shows a positive relationship with other country segments, but the effect is not significant. Which supports Hypothesis 2? Therefore, we can say that the relation is context-dependent.

4.4. Endogeneity Test

A critical concern in estimating the impact of fintech adoption on financial inclusion and bank performance is the potential endogeneity of fintech adoption (Greene, 2012). Endogeneity may arise from reverse causality, where banks with higher financial inclusion and stronger profitability tend to adopt more fintech, or from unobserved variables. If not properly addressed, the Driscoll–Kraay fixed-effects estimates may be inconsistent and yield biased coefficients, either upward or downward from the true values (Greene, 2012).

To address this issue, this study employs an instrumental-variables two-stage least squares (IV-2SLS) estimator using the one-period-lagged value of the fintech adoption index (L.FNT) (Baum et al., 2007). The analysis employs Durbin–Wu–Hausman (DWH) endogeneity test (Baum et al., 2007). The justification for using L.FNT rests on two conditions: first, relevance, as lagged fintech adoption strongly correlates with current adoption and supports financial inclusion and performance (Lee & Shin, 2018); second, exogeneity, as current outcomes cannot influence prior-year fintech levels, satisfying the exclusion restriction (Baum et al., 2007; Wooldridge, 2010).

Table 7 presents two-stage least squares (IV-2SLS) estimator results. Panel A shows that the IV-2SLS coefficients on FNT are larger than the fixed-effects coefficients for both deposits (1.025 vs. 0.765) and loans (1.042 vs. 0.804), and both remain significant at the 1% level. This supports our original fixed-effects model, which finds that fintech adoption affects deposits and loans, not the other way around.

Table 7. Endogeneity test results—IV-2SLS with lagged FNT as instrument.

	LDEP	LLOAN	ROA	ROE
Panel A: IV-2SLS Estimates of FNT				
FNT coefficient	1.025 ***	1.042 ***	0.184	3.164 **
	(0.0432)	(0.0458)	(0.135)	(1.431)
Corresponding FE-DK coefficient	0.765 ***	0.804 ***	0.144	1.389
Observations	1384	1384	1384	1384
Panel B: Instrument Validity Tests				
Under identification test (Anderson canon. corr. LM)	760.531	760.531	760.531	760.531
p-value	[0.000]	[0.000]	[0.000]	[0.000]
Weak identification test (Cragg–Donald Wald F)	2036.101	2036.101	2036.101	2036.101
Stock–Yogo 10% critical value	16.38	16.38	16.38	16.38
Sargan overidentification test	n/a (exactly identified)	n/a (exactly identified)	n/a (exactly identified)	n/a (exactly identified)
Panel C: Endogeneity Test (Durbin–Wu–Hausman)				
C-statistic ($\chi^2(1)$)	171.960	179.167	4.484	7.305
p-value	[0.000] ***	[0.000] ***	[0.034] **	[0.007] ***
Conclusion	Endogenous	Endogenous	Endogenous	Endogenous
Instrument	L.FNT	L.FNT	L.FNT	L.FNT

Note: ** $p < 0.05$, *** $p < 0.01$.

For ROE, the FNT coefficient becomes significant under IV (3.164, $p = 0.027$), even though it was not significant in the original fixed-effects model. This suggests that endo-

geneity bias was not present in ROE. A similar conclusion also applies to ROA, as the result is consistent in both places.

In panel B, the Anderson canonical correlation LM statistic (760.531, $p = 0.000$) confirms that the instruments contain enough information to identify the model, while the Cragg–Donald Wald F-statistic of 2036.101 comfortably exceeds the Stock–Yogo 10% critical value of 16.38, showing that the instruments are strong and that weak-instrument bias is not a concern (Stock & Yogo, 2005).

Panel C confirms that the correction was needed. The Durbin–Wu–Hausman test shows that fintech adoption is endogenous in all four models. However, the endogeneity is much stronger for deposits ($\chi^2(1) = 171.960$, $p < 0.001$) and loans ($\chi^2(1) = 179.167$, $p < 0.001$) than for ROA ($\chi^2(1) = 4.484$, $p = 0.034$) and ROE ($\chi^2(1) = 7.305$, $p = 0.007$).

5. Conclusions and Policy Implications

5.1. Conclusions

This study examines the impact of fintech adoption on financial inclusion and bank performance across 14 Asian economies, namely China, India, Indonesia, Malaysia, Japan, South Korea, Singapore, Hong Kong, the Philippines, Thailand, Vietnam, Bangladesh, Pakistan, and Sri Lanka, using bank-level panel data. Employing Driscoll–Kraay fixed-effects estimation robust to cross-sectional dependence, heteroskedasticity, and serial correlation, alongside instrumental-variables methods to address endogeneity, the paper has produced the following major findings.

The results proved that fintech adoption promotes financial inclusion by increasing both bank deposits and loans across all country groups. The strongest impact on deposits is observed in emerging economies, suggesting that fintech technologies are particularly effective in expanding access to formal financial services where traditional banking infrastructure remains relatively underdeveloped. In the same way, fintech significantly enhances lending activities, with the greatest effect found in advanced economies, indicating that fintech improves the efficiency of credit delivery and loan disbursement. These findings confirm that fintech serves as an important driver of financial inclusion across Asia.

In contrast, the relationship between fintech adoption and bank profitability is considerably more mixed. Fintech adoption is associated with a significant negative effect on both ROA and ROE in Advanced economies, consistent with the view that early-stage fintech investment imposes substantial technology and operating costs that outweigh near term profitability gains. In Large, Emerging, and Frontier economies, the relationship between fintech adoption and profitability is positive but not statistically significant, suggesting that any profitability gains from fintech adoption have yet to materialize. Taken together, these results suggest that fintech adoption's benefits are uneven across performance dimensions.

The control variables further underscore the role of country-level financial development in shaping these relationships. Capitalization (ETA) supports deposit and loan growth in Advanced and Emerging economies but is associated with lower deposit and loan levels in Large and Frontier economies. Liquidity, GDP growth, and inflation exhibit more limited and group-specific effects, reinforcing the conclusion that macroeconomic and bank-level conditions interact with fintech adoption differently across countries at different stages of economic and financial development.

Overall, these findings are cumulative and suggest that the study makes two primary contributions to the existing literature. First, they confirm that fintech adoption plays a significant and largely consistent role in advancing financial inclusion across Asian banking systems, regardless of a country's level of development. Second, they reveal that fintech's profitability effects are neither universal nor immediate and may initially be negative in more digitally advanced markets before any longer-term performance gains emerge.

5.2. Policy Implications

The findings of this study have several practical implications for policymakers, regulators, and bank management across the Asian banking system. First, as fintech adoption helps create a financially inclusive society, regulators, especially in Frontier Economies, should encourage banks to adopt user-friendly fintech solutions so that more people use fintech to access banking services for various business and personal financial activities. Secondly, fintech adoption in Frontier Economies is significantly associated with deposit and loan growth regardless of economic status. Hence, regulators should continue to support fintech adoption, especially in Frontier Economies, where inclusion benefits remain low. Third, fintech adoption is associated with a significant negative effect on profitability in Advanced Economies. Therefore, regulators should monitor whether these short-term cost pressures create incentives for banks to take on additional risk to offset reduced margins, a development that warrants close regulatory oversight. Finally, in Large, Emerging, and Frontier economies, where fintech's effect on profitability is positive but not significant, banks should continue their fintech operations, as they help increase their loan and deposit bases.

A key limitation of this study is that greater fintech adoption is linked to lower bank profitability (measured by ROA and ROE) in advanced economies. However, the study does not clearly state why this happens. This research hypothesizes that this could be explained by banks' substantial expenditure on new and advanced technology in the early stages of fintech adoption, or by strong competition in mature economies that lowers profit margins. Future research will try to fill this gap by incorporating bank-level income and expenditure data, especially expenditure on fintech components.

Author Contributions: Conceptualization, H.U. and M.K.B.; methodology, H.U.; software, H.U.; validation, H.U. and M.K.B.; data curation, H.U.; writing—original draft preparation, H.U. and M.K.B.; review and editing, M.K.B. and H.U.; visualization, H.U.; supervision, M.K.B. All authors have read and agreed to the published version of the manuscript.

Funding: This research received no external funding.

Institutional Review Board Statement: Not applicable.

Informed Consent Statement: Not applicable.

Data Availability Statement: The data used in this study were obtained from Bloomberg L.P. under license and are not publicly available. Due to licensing restrictions, the authors cannot share the data. Researchers can access the data directly through a Bloomberg Terminal subscription.

Acknowledgments: We acknowledged the help of Lin Yitao, Senior Associate at State Street Trust Bank, who helped us to collect additional data for this research.

Conflicts of Interest: The authors declare no conflicts of interest.

Appendix A

Table A1. Fintech index questionnaire.

No.	Question	Category	Weight (%)	Score (0–1)
1	Does the bank have its own mobile banking app?	Digital Banking	12.5	0/0.5/1
2	Does the bank offer online banking via a web portal?	Digital Banking	12.5	0/0.5/1
3	Does the bank allow online account opening?	Digital Banking	12.5	0/0.5/1
4	Does the bank accept online loan or credit applications?	Digital Banking	12.5	0/0.5/1

Table A1. *Cont.*

No.	Question	Category	Weight (%)	Score (0–1)
5	Does the bank support digital wallets or contactless payments?	Digital Payments	12.5	0/0.5/1
6	Does the bank offer instant or real-time payment services?	Digital Payments	12.5	0/0.5/1
7	Does the bank use AI chatbots or digital assistants for customers?	Customer Interface	12.5	0/0.5/1
8	Does the bank provide a personalized online analytics tool (e.g., spending insights, budgeting, investment tracking)?	Customer Interface	12.5	0/0.5/1

Source: Uddin and Barai (2026).

References

Adeleke, A. G., Sanyaolu, T. O., Efunniyi, C. P., Akwawa, L. A., & Azubuko, C. F. (2022). Optimizing systems integration for enhanced transaction volumes in fintech. *Finance & Accounting Research Journal*, *4*, 345–363. [CrossRef]

Ahamed, M., & Gutiérrez-Romero, R. (2020). *COVID-19 response needs to broaden financial inclusion to curb the rise in poverty CGR Working Paper 105*. Available online: https://cgr.sbm.qmul.ac.uk/CGRWP105.PDF (accessed on 22 May 2026).

Albuainain, A., & Ashby, S. (2025). Enablers and barriers in FinTech adoption: A systematic literature review of customer adoption and its impact on bank performance. *FinTech*, *4*(3), 49. [CrossRef]

Aloulou, M., Grati, R., Al-Qudah, A. A., & Al-Okaily, M. (2024). Does fintech adoption increase the diffusion rate of digital financial inclusion? A study of the banking industry sector. *Journal of Financial Reporting and Accounting*, *22*(2), 289–307. [CrossRef]

Arnone, M., Costantiello, A., Leogrande, A., Naqvi, S. K. H., & Magazzino, C. (2024). Financial stability and innovation: The role of non-performing loans. *FinTech*, *3*(4), 496–536. [CrossRef]

Barney, J. (1991). Firm resources and sustained competitive advantage. *Journal of Management*, *17*(1), 99–120. [CrossRef]

Baum, C. F., Schaffer, M. E., & Stillman, S. (2007). Enhanced routines for instrumental variables/generalized method of moments estimation and testing. *Stata Journal*, *7*(4), 465–506. [CrossRef]

Boot, A. W. A., & Thakor, A. V. (2010). The accelerating integration of banks and markets and its implications for regulation. *Oxford Review of Economic Policy*, *26*(3), 370–384. [CrossRef]

Brigham, E. F., & Houston, J. F. (2021). *Fundamentals of financial management* (16th ed.). Cengage Learning.

Cevik, S. (2024). Promise (Un)kept? Fintech and Financial Inclusion. *IMF Working Paper*, *2024*(131), 17. [CrossRef]

Chinoda, T., & Mingiri Kapingura, F. (2024). Fintech-based financial inclusion and banks' risk-taking: The role of regulation in Sub-Saharan Africa. *Journal of Economic and Administrative Sciences*, *42*(2), 554. [CrossRef]

Davis, F. D. (1989). Perceived usefulness, perceived ease of use, and user acceptance of information technology. *MIS Quarterly*, *13*(3), 319–340. [CrossRef] [PubMed]

Demirgüç-Kunt, A., Klapper, L., Singer, D., Saniya, A., & Hess, J. (2022). *The Global Findex Database 2021: Financial inclusion, digital payments, and resilience in the age of COVID-19*. World Bank Publications.

Demirgüç-Kunt, A., Klapper, L., Singer, D., & Van Oudheusden, P. (2015). *The Global Findex Database 2014: Measuring financial inclusion around the world* (World Bank policy research working paper No. 7255). World Bank.

Diamond, D. W. (1984). Financial intermediation and delegated monitoring. *Review of Economic Studies*, *51*(3), 393–414. [CrossRef]

Duong, Q. N., Tran, N. T. K., & Dang, T. P. T. (2025). Income diversification and liquidity risk in ASEAN-5 banks: A Bayesian perspective. *PLoS ONE*, *20*(3), e0316949. [CrossRef] [PubMed]

Faseesin, O., Omolade, A., Akinbode, D., & Aina, D. (2026). Financial technology and financial inclusion in Sub-Saharan Africa (SSA) countries. *International Journal of Finance and Accounting*, *5*(1), 82–96. [CrossRef]

Ghosh, M., & Uttam, R. (2026). Emerging role of fintech in Indian economy. *International Journal of Economic Practices and Theories*, *2026*, 1384–1397.

Gomber, P., Kauffman, R. J., Parker, C., & Weber, B. W. (2018). On the fintech revolution: Interpreting the forces of innovation, disruption, and transformation in financial services. *Journal of Management Information Systems*, *35*(1), 220–265. [CrossRef]

Greene, W. H. (2012). *Econometric analysis* (7th ed.). Pearson Education.

Hair, J. F., Black, W. C., Babin, B. J., & Anderson, R. E. (2010). *Multivariate data analysis* (7th ed.). Pearson.

Iatzaz Ul Hassan, M., Wu, M., Lu, J., Sohu, J. M., Ali, S., Anjum, H. N., & Bilal, M. (2025). Financial technology and banking performance in developing countries: Evidence from an advanced quantile regression approach. *Humanities and Social Sciences Communications*, *12*(1), 1455. [CrossRef]

Ifediora, C., Offor, K. O., Eze, E. F., Takon, S. M., Ageme, A. E., Ibe, G. I., & Onwumere, J. U. (2022). Financial inclusion and its impact on economic growth: Empirical evidence from sub-Saharan Africa. *Cogent Economics & Finance*, *10*(1), 2060551. [CrossRef]

IMF. (2026). *World economic outlook*. IMF.

Kamara, A. K., & Yu, B. (2024). The impact of FinTech adoption on traditional financial inclusion in Sub-Saharan Africa. *Risks*, *12*(7), 115. [CrossRef]

Khan, H. U., Abbas, M., Nazir, S., Khan, F., & Moon, Y. K. (2025). The intersection of finTech adoption, HR competency potential, service innovation, and firm growth in the banking sectors using Entropy and TOPSIS. *PLoS ONE*, *20*(1), e0313210. [CrossRef] [PubMed]

Khan, N., Zafar, M., Okunlola, A. F., Zoltan, Z., & Robert, M. (2022). Effects of financial inclusion on economic growth, poverty, sustainability, and financial efficiency: Evidence from the G20 countries. *Sustainability*, *14*(19), 12688. [CrossRef]

Khera, P., Ng, S., Ogawa, S., & Sahay, R. (2022). Measuring digital financial inclusion in emerging market and developing economies: A new index. *Asian Economic Policy Review*, *17*(2), 213–230. [CrossRef]

Kufo, A., Gjeçi, A., Çera, G., & Cenolli, K. (2026). Breaking barriers: How fintech expands access to finance? *Journal of Risk and Financial Management*, *19*(4), 297. [CrossRef]

Lamey, Y. M., Tawfik, O. I., Durrah, O., & Elmaasrawy, H. E. (2024). Fintech adoption and banks' non-financial performance: Do circular economy practices matter? *Journal of Risk and Financial Management*, *17*(8), 319. [CrossRef]

Lavrinenko, O., Čižo, E., Ignatjeva, S., Danileviča, A., & Krukowski, K. (2023). Financial technology (FinTech) as a financial development factor in the EU countries. *Economies*, *11*(2), 45. [CrossRef]

Le, T. D. Q., Ho, T. H., Nguyen, D. T., & Ngo, T. (2021). Fintech credit and bank efficiency: International evidence. *International Journal of Financial Studies*, *11*(1), 13. [CrossRef]

Lee, I., & Shin, Y. J. (2018). Fintech: Ecosystem, business models, investment decisions, and challenges. *Business Horizons*, *61*(1), 35–46. [CrossRef]

Leong, K., & Sung, A. (2025). Introducing AIRSim: An innovative AI-driven feedback generation tool for supporting student learning. *Technology, Knowledge and Learning*, *30*(4), 2393–2415. [CrossRef]

Liu, Z., Li, X., & Li, Z. (2024). Inclusive FinTech, open banking, and bank performance: Evidence from China. *Financial Innovation*, *10*(1), 1–24. [CrossRef]

Maradana, R. P., Pradhan, R. P., Dash, S., Gaurav, K., Jayakumar, M., & Chatterjee, D. (2017). Does innovation promote economic growth? Evidence from European countries. *Journal of Innovation and Entrepreneurship*, *6*(1), 1. [CrossRef]

Mohammad, K. U., & Khan, M. R. (2024). Liquid asset holdings and banking profitability: Evidence from South Asia. *Journal of Central Banking Theory and Practice*, *13*(2), 129–152. [CrossRef]

Mothobi, O., & Kebotsamang, K. (2024). The impact of network coverage on adoption of fintech and financial inclusion in sub-Saharan Africa. *Journal of Economic Structures*, *13*(1), 5. [CrossRef]

MSCI. (2026). *MSCI 2026 annual market classification review*. MSCI Inc. MSCI Market Classification.

Nagorny, P. D. (2020). Bank without branches: Digitalization of society and fintech technologies of the present and future. *Accounting & Finance*, *89*, 55. [CrossRef]

Nguyen, T. T. C., Le, A. T. H., & Nguyen, C. V. (2023). Internal factors affecting the financial performance of an organisation's business processes. *Business Process Management Journal*, *29*(5), 1408–1435. [CrossRef]

Noreen, M., Mia, M. S., Ghazali, Z., & Ahmed, F. (2022). Role of government policies in fintech adoption and financial inclusion: A study in Pakistan. *Universal Journal of Accounting and Finance*, *10*(1), 37–46. [CrossRef]

Oyedotun, I. K., & Makoni, P. L. (2026). Nexus between financial technology and financial inclusion in sub-Saharan Africa: A dynamic panel technique. *Sage Open*, *16*(1), 21582440251407742. [CrossRef]

Ozili, P. K. (2022). Financial inclusion and sustainable development: An empirical association. *Journal of Money and Business*, *2*(2), 186–198. [CrossRef]

Ozili, P. K. (2025). Financial inclusion in banking: A literature review and future research directions. *Modern Finance*, *3*(1), 91–109. [CrossRef]

Pesaran, M. H. (2004). *General diagnostic tests for cross-section dependence in panels* (Cambridge working papers in economics no. 0435). University of Cambridge.

Petrović, D., Dasilas, A., & Karanović, G. (2025). Bank risk-adjusted efficiency using a composite risk management index. *Journal of Risk Finance*, *26*(3), 485–515. [CrossRef]

Phan, D. H. B., Narayan, P. K., Rahman, R. E., & Hutabarat, A. R. (2020). Do financial technology firms influence bank performance? *Pacific-Basin Finance Journal*, *62*, 101210. [CrossRef]

Philippon, T. (2019). *On fintech and financial inclusion* (Working paper no. w26330). National Bureau of Economic Research.

Ramadhan, A., Vidianto, M. A., Muharam, H., & Mawardi, W. (2025). Fintech and financial inclusion: Evidence from emerging markets. *Research Horizon*, *5*(3), 599–612. [CrossRef]

Schumpeter, J. (1942). Creative destruction. In *Capitalism, socialism and democracy* (Vol. 825, pp. 82–85). Nueva York.

Sharma, M., Bahl, J., Gothwal, P., Kumar, D., Atree, L., & Kumar, S. (2025). Role of fintech in financial inclusion: A quantitative review. *International Journal of Engineering Science and Information Technology*, *5*(4), 385–394. [CrossRef]

Snobar, R. A. A., & Al Hanini, E. A. (2025). The impact of capital adequacy and liquidity ratios on earnings quality in Jordanian commercial banks. *International Journal of Professional Business Review*, *10*(3), 3. Available online: https://dialnet.unirioja.es/servlet/articulo?codigo=10054431 (accessed on 28 May 2026). [CrossRef]

Stock, J. H., & Yogo, M. (2005). Testing for weak instruments in linear IV regression. In D. W. K. Andrews, & J. H. Stock (Eds.), *Identification and inference for econometric models: Essays in honor of Thomas Rothenberg* (pp. 80–108). Cambridge University Press. [CrossRef]

Surwanti, A., Mahmoud, M. I., & Sano, R. (2026). Financial inclusion and sustainable development: A bibliometric analysis of interdisciplinary research. *Discover Global Society*, *4*(1), 2. [CrossRef]

Thomas, G. N., Nur, S. M. R., & Indriaty, L. (2024). The impact of financial literacy, social capital, and financial technology on financial inclusion of Indonesian students. *arXiv*. [CrossRef]

Uddin, H., & Barai, M. K. (2026). Fintech adoption and bank risk, efficiency and stability: Evidence from panel data of selected Asian economies. *FinTech*, *5*(1), 14. [CrossRef]

Wang, W., Moreira, F. F., & Liang, Y. (2024). Does FinTech adoption improve bank performance? *International Journal of Monetary Economics and Finance*, *17*(1), 1–28. [CrossRef]

Wooldridge, J. M. (2010). *Econometric analysis of cross section and panel data* (2nd ed.). MIT Press.

Xu, L., Liu, Q., Li, B., & Ma, C. (2022). Fintech business and firm access to bank loans. *Accounting & Finance*, *62*(4), 4381–4421. [CrossRef]

Xu, R. (2026). *Fintech competition and banks' shrinking margins in Brazil (No. 2026/007)*. International Monetary Fund.

Yang, F., & Masron, T. A. (2023). Does financial inclusion moderate the effect of digital transformation on banks' performance in China? *Cogent Economics & Finance*, *11*(2), 2267270. [CrossRef]

Yang, T., & Zhang, X. (2022). Fintech adoption and financial inclusion: Evidence from household consumption in China. *Journal of Banking & Finance*, *145*, 106668. [CrossRef]

Yang, Y., Yang, F., Yi, X., & He, D. (2025). How FinTech affects financial sustainability: Evidence from Chinese commercial banks using a three-stage network DEA-Malmquist model. *arXiv*. [CrossRef]

Yuan, D., Gazi, M. A. I., Harymawan, I., Dhar, B. K., & Hossain, A. I. (2022). Profitability determining factors of banking sector: Panel data analysis of commercial banks in South Asian countries. *Frontiers in Psychology*, *13*, 1000412. [CrossRef] [PubMed]