“Impact of internal fintech on bank profitability”

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ARTICLE INFO	Vlora Berisha and Blake Rayfield (2025). Impact of internal fintech on bank profitability. *Investment Management and Financial Innovations*, *22*(1), 384-404. doi:10.21511/imfi.22(1).2025.29
DOI	http://dx.doi.org/10.21511/imfi.22(1).2025.29
RELEASED ON	Friday, 14 March 2025
RECEIVED ON	Monday, 30 September 2024
ACCEPTED ON	Wednesday, 05 March 2025

JOURNAL	"Investment Management and Financial Innovations"
ISSN PRINT	1810-4967
ISSN ONLINE	1812-9358
PUBLISHER	LLC “Consulting Publishing Company “Business Perspectives”
FOUNDER	LLC “Consulting Publishing Company “Business Perspectives”

NUMBER OF REFERENCES	NUMBER OF FIGURES	NUMBER OF TABLES
65	0	15

BUSINESS PERSPECTIVES

LLC "CPC "Business Perspectives"
Hryhorii Skovoroda lane, 10,
Sumy, 40022, Ukraine

www.businessperspectives.org

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IMPACT OF INTERNAL FINTECH ON BANK PROFITABILITY

Abstract

This research investigates the relationship between the adoption of internal fintech solutions and the profitability of banks in Kosovo, leveraging the Technology Acceptance Model and Innovation Theory. The study analyzes the impact of mobile banking, e-banking, electronic payment systems, and data analytics on profitability using net interest margin (NIM) and return on assets (ROA) as key metrics. A mixed-method approach was adopted, combining audited financial report data from Kosovo's commercial banks with survey data to ensure comprehensive analysis. To explore this relationship, a structured questionnaire was administered to 169 bank employees across 10 commercial banks in Kosovo. The sample included professionals from finance, technology, credit analysis, and customer service departments, chosen for their direct involvement in fintech adoption and its implementation. This selection ensured insights from individuals who actively engage with fintech tools and their impact on bank operations. Findings reveal that fintech adoption impacts profitability based on focus. Investments in operational efficiency negatively affect ROA ($\beta = -0.079$, $p < 0.001$), while fintech adoption targeting business opportunities, credit cost reduction, and customer understanding improves ROA and NIM. Business opportunities enhance ROA ($\beta = 0.053$, $p < 0.01$) and NIM ($\beta = 0.098$, $p < 0.001$), while customer understanding increases ROA ($\beta = 0.143$, $p < 0.001$). Mobile banking, digital lending, and bank age also show positive effects.

Keywords profitability, innovation, bank, digital payments, fintech, investments

JEL Classification G21, G32, O31, O32, O33

Received on: 30th of September, 2024
Accepted on: 5th of March, 2025
Published on: 14th of March, 2025

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Conflict of interest statement:
Author(s) reported no conflict of interest

INTRODUCTION

The banking sector is undergoing a massive transformation due to technological advancements, evolving from traditional banking to automated online and mobile banking services. Historically, the sector was dominated by conventional banks. However, the influence of Fintech has revolutionized banking. The digitization of finance, driven by Fintech, has made banking exciting and full of opportunities.

In Kosovo, adopting internal Fintech products like e-banking, mobile payments, and data analytics rose considerably after the increased digital transformation trend due to the COVID-19 pandemic. This change has generated concerns about how digital banking approaches affect business results. Regardless of the rise in usage of Fintech solutions, the relationship between internal Fintech adoption and bank profitability is still an undeveloped hypothesis that requires further empirical research.

Fintech is making a difference in bridging the gaps in access to financial services that banks offer. Improving access to basic financial services translates into better productivity and profitability for banks and, in turn, better firm performance for micro and small businesses, as well as higher incomes and sustainability to improve the lives of people with less income. FinTech can reduce transaction costs by overcoming geographical barriers to access, increasing the speed, security and transparency of transactions, and enabling more tailored finan-

http://dx.doi.org/10.21511/imfi.22(1).2025.29

cial services that better serve consumers. However, many people and firms still lack access to essential financial services that can help them thrive. It is time for regulators to embrace fintech opportunities and implement policies encouraging innovation and safe financial adoption.

This research explores whether adopting internal Fintech will boost bank profitability in Kosovo, presenting valuable information about its potential impact on the banking industry.

1. LITERATURE REVIEW

The banking industry has witnessed a profound transformation driven by technological advancements in recent decades, spanning from traditional brick-and-mortar establishments to automated teller machines, Internet banking, mobile banking, instant money transfers, and more. The convergence of finance and technology, often referred to as fintech, has reshaped the financial landscape (Lee et al., 2021; Lee, 2021; Nicoletti, 2017), introducing innovation that challenge the established norms (Adarkar et al., 2022; Chen et al., 2022; Crouhy et al., 2021; Puschmann, 2017; Shala & Berisha, 2021; Unsal & Rayfield, 2019). Dominated by traditional banks, the industry has been reshaped by fintech's influence, yielding improved operational efficiencies, reduced costs, enhanced customer service, and round-the-clock accessibility (Akhisar et al., 2015; Ardiany et al., 2021; Arner et al., 2015; Dong et al., 2020; Singh et al., 2021).

Internal fintech signifies using technology within financial institutions to advance specific internal processes and operations. This is attained through integrating technology, finance, and the internet to reach people, improve efficiency, cost, and competitiveness, and develop new business models for the bank. These improvements have been supported by such scholars as Asongu et al. (2021), Dong et al. (2020), Harelimana, (2017) and Kulu et al. (2022). These technologies automate repetitive tasks, lower the occurrence of operational errors, and improve the precision of risk assessment, lowering the operation cost and enhancing customer experiences.

Moreover, internal fintech allows the creation of new business models, allowing banks to offer personalized services, enhance credit scoring, and improve fraud detection accordingly. All these technologies are related to cost-cutting and setting up the banks for better competition in a fast-changing digital marketplace.

The study on the relationship between fintech adoption and bank profitability is based on the theory of innovation, as first proposed by Schumpeter (1939) and further adopted by Kulu et al. (2022), Shih and Fang (2004), Wonglimpiyarat (2017), and Zaleska and Kondraciuk (2019).

Schumpeter viewed innovation as a driving force of economic growth, characterized by creative destruction, where innovations replace older ones, leading to increased profitability. Based on innovation theory, some researchers believed that fintech posed a risk to the banking sector, especially retail banking. In Wonglimpiyarat's (2017) research, which was guided by innovation theory, banks should adopt proper strategies for market competition, analyze how they manage technological complexity and use technology to improve their competitiveness. Kemboi (2018) suggests that if banks use fintech to gain a competitive advantage over other banks, their financial performance may be impacted. Acar and Çıtak (2019) used the theory of innovation to describe the fintech integration process, and based on a case study of Turkish banks, they identified seven phases. The seven phases of fintech integration involve collecting information, finding relevant fintech solutions, incorporating them into the bank's business model, presenting to department VPs, coordinating with IT, compliance, and legal teams, initiating a proof of concept (POC), and eventually making the technology accessible to customers. In addition to innovation theory, the Technology Acceptance Model (TAM) is a fundamental concept in the study of fintech adoption. Introduced by Davis in 1989, TAM is widely cited by researchers studying technology innovation acceptance (Arjunwadkar, 2018; Taherdoost, 2018). This model elucidates how individuals embrace technological innovations. TAM centers on two key factors users consider when adopting technology: perceived usefulness and ease of use (Su & Li, 2021). Perceived ease of use pertains to the extent to which individuals be-

lieve technology will boost productivity and reduce time spent (Grupta & Tham, 2019; Toraman, 2022; Venkatesh & Davis, 2000). Perceived usefulness is how individuals believe in updated technology's benefits and performance improvements (Toraman, 2022). These factors are regarded as favorable and unfavorable conditions within the model.

Drawing from TAM the adoption of Fintech by banks can be viewed as either a threat (Förster & Schulz, 2022; Shih & Fang, 2004; Singh et al., 2020; Wonglimpiyarat, 2017), and a substitution for their existing businesses, a competitive challenge, or an opportunity to enhance financial performance (Wong & Ho, 2020). Banks rely on the TAM to assess various variables, including the cost of technology. If the benefits of innovative technology outweigh the adoption cost, banks are inclined to embrace it (Kemboi, 2018). Furthermore, banks can employ TAM to assess the impact of innovative technologies on bolstering data analytics, credit scoring, efficiency, effectiveness, and overall financial performance (Marakarkandy et al., 2017; Sila, 2015; Su & Li, 2021; Taherdoost et al., 2009).

The impact of fintech on banking profitability has been a focus of considerable research in recent years, with studies providing mixed results. Early studies by Wong and Ho (2020) highlighted a positive relationship, showing that fintech adoption in Hong Kong banks reduced the cost-to-income ratio and enhanced profitability. Similarly, Singh et al. (2021) found a significant positive effect of fintech adoption on profitability, especially in terms of return on assets (ROA) and return on equity (ROE) for Indian banks. Keliuotytė-Staniulėnienė & Smolskytė (2019) examined the Lithuanian banking sector and found that while fintech indicators influenced profitability, the effect was not highly significant. This illustrates a point of divergence in the literature, where the relationship between fintech and profitability is not always straightforward.

Other studies, such as those by Lv et al. (2022) and Wu and Yuan (2021), suggest that the effect of fintech adoption on profitability is more nuanced. Lv et al.'s (2022) study results find a U-shaped relationship, where the profitability impact is negative initially but improves over time as fintech usage matures. Conversely, Wu and Yuan (2021) found that in Chinese state-owned banks, fintech development negatively affected profitability, raising concerns about its potential downside. Al-Dmour et al. (2020) and Nguyen and Dang (2022) found similarly negative results, with fintech adoption showing a weak or detrimental impact on bank performance in Jordan and emerging markets, respectively.

Further investigations into fintech's impact on profitability reveal mixed outcomes. Chhaidar et al. (2022) found a positive correlation between fintech investment and profitability in European banks, while Dong et al. (2020) reported that excessive technology investments could negatively impact business performance. Studies by Akhisar et al. (2015) and Ardiany et al. (2021) also raised concerns about the adverse effects of fintech in developing countries and specific banking sectors like Islamic banks, where increased debt for technology investments could reduce profitability. The findings of Kulu et al. (2022) and Asongu et al. (2021) show an effect of mobile money transactions, particularly in developing countries, suggesting that these innovations might hinder bank performance by decreasing deposits and increasing inefficiencies.

The literature presents a complex landscape where the impact of fintech on banking profitability varies depending on factors such as the stage of fintech adoption, market characteristics, and regional context. While many studies suggest that fintech can reduce costs and improve profitability, others highlight potential risks and negative effects, especially when excessive technological investments or fintech solutions are not adequately integrated into the banking system.

The literature review reflects the dual nature of fintech adoption's impact on bank profitability, underscoring the importance of understanding contextual factors that can influence the outcomes.

The main purpose of this study is to explore the relationship between internal fintech adoption and bank profitability in Kosovo's banking sector, considering both the positive and negative impacts highlighted in previous research. This study's hypothesis is as follows:

H: *Internal fintech adoption in Kosovo's banking sector positively impacts profitability.*

http://dx.doi.org/10.21511/imfi.22(1).2025.29

2. METHODS

This study examines the adoption of fintech within ten prominent banks operating in Kosovo's banking sector. Employees from diverse departments, including finance, technology, credit analysis, and customer service, completed a structured questionnaire to collect systematic data on internal fintech usage. To ensure the reliability of the questionnaire, an initial administration was conducted with a group of 15 individuals, including academic experts and experienced banking professionals. Feedback from the pilot group was received and used to refine the questionnaire. The development of the questionnaire was based on a comprehensive literature review, with references to reports from EY, KPMG, and Cornerstone. Before the official survey, the questionnaire underwent testing procedures. During the survey phase, data were collected using a 5-point Likert scale to ensure consistency in measurement. To enhance the study's comprehensiveness, supplementary data were obtained from annual audited reports covering the period from 2019 to 2021. A range of statistical methods, including principal component analysis, regression analysis, t-tests, and determination coefficients, were employed to assess the data.

The present study employs a questionnaire divided into three parts. It combines primary data gathered from respondents' perceptions with secondary data from financial reports available on the banks' websites for 2019, 2020, and 2021. Respondents were asked to share their perceptions regarding the utility of internal fintech adoption over the preceding three years.

The intuition behind the relationship between internal fintech adoption and a bank's profitability comes from the hypothesis that adopting technological innovations (mobile banking, e-banking, e-payments) fits well with the TAM and ITH theories. In terms of internal fintech usage and banking financial performance, the following can be modelled:

$$P = f\left(FTA, V\right), \tag{1}$$

where bank's profitability (BP) as measured by ROA and NIM. *FTA* denotes fintech adoption, while *V* stands for other determining variables.

To assess bank profitability, secondary data and a structured questionnaire were utilized, considering fintech adoption and other covariates. To examine the connection between fintech adoption –

Table 1. Questionary items and construct IFA

Construct	Questionary item	Source
Internal fintech (e.g. E-banking, M-banking, E payments) adoption has affected our bank in: Fintech adoption	Improving customer experience/service delivery	Cornerstone reports (2019), Dwivedi et al. (2021), Lien et al. (2020), pwc Global (2022)
	Improving efficiency	
	Increasing revenue generation opportunities	
	Reducing the cost of financial transactions and services	
	Improve the productivity of the banks	
	Reduce the time of the services	
	Increase flexibility	
	Reduce staff costs	
	Reduce overhead & rental costs (e.g., offices, branches)	
	FinTech adoption required a strategic approach to technology management	
	FinTech adoption process is smooth to adopt in your bank	
	Everyone in the bank supports FinTech adoption	
Data analytics software adoption has influenced our bank by	Helping the bank inquire information to understand the customers better	Cornerstone reports (2019), Dwivedi et al. (2021), Lien et al. (2020), pwc Global (2022)
	Improving business opportunities through big data analytics	
	Reducing credit cost through big data analytics	
	Reducing compliance costs	
	Better addressing fraud and risk management	
Investment in Fintech	We are investing heavily in Fintech innovations (in the area of digital lending, payments, blockchain and digital wealth management)	Cornerstone reports (2019), Dwivedi et al. (2021), Lien et al. (2020), pwc Global, (2022)
	Be a leader in Fintech innovation.	
	We are systematically monitoring technology development trends.	
Profitability	Net interest margin	Dwivedi et al. (2021), Lien et al. (2020)
	Return on Assets (ROA)	

specifically mobile banking, e-banking, and e-payments and bank profitability, along with other determining factors, the variable set (V) was extended beyond equation (1). This expansion allows us to account for additional variables that impact bank profitability, resulting in the formulation of equation (2) as follows:

$$BP_i = \beta_0 + \beta_1 PCUIFTAs_1 + \beta_2 Bage_2 + \beta_3 AG_3 + \beta_4 CIR_4 + \beta_5 CAR_5 + \beta_6 LAR_6 + \beta_7 CR_7 + \mu_t. \quad (2)$$

Thus, return on assets and net interest margin are the dependent variables in Eq. (3) and (4), respectively, as:

$$ROA = \beta_0 + \beta_1 PCUIFTAs_1 \beta_2 Bage_2 + \beta_3 AG_3 + \beta_4 CIR_4 + \beta_5 CAR_5 + \beta_6 LAR_6 + \beta_7 CR_7 + \mu_t. \quad (3)$$

$$NIM = \beta_0 + \beta_1 PCUIFTAs_1 + \beta_2 Bage_2 + \beta_3 AG_3 + \beta_4 CIR_4 + \beta_5 CAR_5 + \beta_6 LAR_6 + \beta_7 CR_7 + \mu_t. \quad (4)$$

Various financial ratios are utilized to evaluate the profitability of commercial banks, including Return on Assets (ROA) and Net Interest Margin (NIM) (Lv et al., 2022; Sumra et al., 2011). This paper examines bank-level control variables such as bank size, age, asset growth rate (AG), loan-to-asset ratio (LAR), cost-to-income ratio (CIR), credit risk (CR), and capital adequacy ratio (CAR), which are widely recognized as key determinants of bank profitability (Akhisar et al., 2015; Akhtar & Nosheen, 2022; Ardiany et al., 2021; Dong et al., 2020) (see Table 2).

3. RESULTS

It is worth noting that one of the banks examined in this study began its operations in 2020. The sample for the study consisted of 34% of participants from the technology department, 34.48% from the credit analysis department, 34.51% from the finance department, 34.40% from the customer services department, and 33.8% from other departments (Table 3).

Table 2. Summary of variables used in the analysis of a bank's profitability

Variable type	Variable name	Variable symbol	Variable Measurement	Variables similar to those used in other studies	Source of data
Dependent variable	Return on Assets	ROA	ROA = Net Income / Total Assets	Chhaidar et al. (2022), Safiullah & Paramati (2022), Wong & Ho (2020), Wu & Yuan (2021), Wu (2020)	Bank's Audited Annual Reports
	Net Interest Margin	NIM	NIM = (Interest expenses - Interest revenue) / Total Assets	Chhaidar et al. (2022), Lv et al. (2022), Wu & Yuan (2021)	Bank's annual audited reports
Independent variable	Perceived usefulness of fintech adoption	PCUIFTA	Using a structured questionnaire	Dwivedi et al. (2021), Keliuotytė-Staniulėnienė & Smolskytė (2019), Lien et al. (2020)	Banks were surveyed about fintech adoption
	Bank Age	BA	Natural logarithm of the number of years of existence of the bank Ln (Bank age)	Akhtar & Nosheen (2022), Safiullah & Paramati (2022)	Bank's web page
	Asset Growth Rate	AGR	NLAGR = (Total Assets $_t$ - Total Assets $_{t-1)}$ / Total Assets $_{t-1}$	Austin & Dunham (2022), Chen et al. (2022), Safiullah & Paramati (2022)	Bank's Audited Annual Reports
	Credit Risk	CR	NPL ratio = Non-Performing Loans / Total Loans	Akhtar & Nosheen (2022), Chhaidar et al. (2022)	Bank's Audited Annual Reports
	Capital Adequacy Ratio	CAR	LnCAR = Tier 1 capital + Tier 2 capital/Risk-weighted assets	Chen et al. (2022), Chhaidar et al. (2022), Kulu et al. (2022), Wu & Yuan (2021)	Bank's Audited Annual Reports
	Cost-to-Income Ratio	CIR	LnCIR = Operating expense / Operating income	Harelimana (2017), Khai Nguyen & Cuong Dang (2022), Lv et al. (2022), Marlina (2020), Nguyen (2001), Singh et al. (2021), Wong & Ho (2020), Wu & Yuan (2021)	Bank's Audited Annual Reports
	Loan- to-Asset Ratio	LAR	LAR = Total Loans / Total assets	Banna et al. (2021)	Bank's Audited Annual Reports

http://dx.doi.org/10.21511/imfi.22(1).2025.29

Table 3. Study sample

Source: Author's compilation.

Year * 169 respondents in the Study Sample							
Count							
		Study Sample					Total
		Technological and information system department	Credit Analysis Department	Finance Department	Customer Services	Other	
Year	2019	43	27	35	29	21	155
	2020	46	30	39	32	22	169
	2021	46	30	39	32	22	169
Total		135	87	113	93	65	493

Table 4. Financial technologies already adopted or being adopted by banks

Source: Author's compilation.

	N	Mean	Std. Deviation
E banking	493	1.000	0.0000
M-banking	493	1.403	.7190
E-payments	493	1.000	.0000
Digital lending	493	2.407	.4918
Data analytics software	493	1.006	.0778
Valid N (listwise)	493		

Note: 1 – Already adopted; 2 – Planned to be adopted in 2 years; 3 – Planned to be adopted in the future.

Table 4 shows that all banks in Kosovo have adopted e-banking and data analytics and e-payments, while most banks have also implemented mobile banking. However, digital lending has not yet been adopted by any banks in Kosovo.

Table 5. Cronbach's Alpha for fintech adoption and profitability constructs

Variables	Items	Cronbach's Alpha
Fintech Adoption	Improving customer experience/service delivery	0.852
	Improving efficiency	0.845
	Increasing revenue generation opportunities	0.852
	Reducing the cost of financial transactions and services	0.855
	Improving productivity of the banks	0.847
	Reducing the time of the services	0.843
	Increasing flexibility	0.845
	Reducing staff costs	0.859
	Reducing overhead & rental costs (e.g., offices, branches)	0.860
	FinTech adoption required a strategic approach to technology management	0.841
	FinTech adoption process is smooth to adopt in your bank	0.869
	Everyone in the bank supports FinTech adoption	0.869
Data Analytics Software Adoption	Helping the bank inquire information to understand customers better	0.831
	Improving business opportunities through big data analytics	0.836
	Reducing credit cost through big data analytics	0.836
	Reducing compliance costs	0.841
	Better addressing fraud and risk management	0.848
Investment in Fintech	We are investing heavily in FinTech innovations (digital lending, payments, blockchain, digital wealth management)	0.846
	Be a leader in FinTech innovation	0.849
	We are systematically monitoring technology development trends	0.845
Profitability	Net interest margin	0.855
	Return on Assets (ROA)	0.859

Table 6. Descriptive statistics for perceived usefulness of fintech adoption

Source: Author's compilation.

Perceived usefulness of fintech adoption	N	Mean	Std.	Variance
Improving customer experience/service delivery	493	4.342	.6848	.469
Improving efficiency	493	4.306	.7915	.626
Increasing revenue generation opportunities	493	4.150	.7330	.537
Reducing the cost of financial transactions and services	493	4.249	.7267	.528
Improve the productivity of the banks	493	4.312	.7509	.564
Increase flexibility	493	4.348	.7484	.560
Reduce the time of the services	493	4.508	.7393	.547
Reduce staff costs	493	4.164	.7745	.600
Reduce overhead & rental costs (e.g. offices, branches)	493	4.093	.8845	.782
Helping the bank inquire information to understand the customers better	493	4.126	.7265	.528
Improving business opportunities through big data analytics	493	4.034	.7070	.500
Reduce credit costs through big data analytics	493	3.933	.7217	.521
Reduce compliance costs	493	4.051	.6797	.462
Better addressing fraud and risk management	493	4.26	.715	.511
FinTech adoption required a strategic approach to technology management	493	4.07	.757	.574
The FinTech adoption process is smooth to adopt in your bank	493	4.02	.777	.604
Everyone in the bank supports FinTech adoption	493	3.97	.820	.673
We are investing heavily in Fintech innovations	493	3.23	.931	.866
Be a leader in Fintech innovation	493	3.45	.876	.767
We are systematically monitoring technology development trends	493	3.55	.811	.657
Valid N (listwise)	493			

Comparing Fintech Adoption Between Banks: Adopted and Planned Adoption's Impact on Profitability:

Different banks, both those that have already adopted fintech and those planning to adopt it, exhibit variations in profitability.

Model 1:

$$ROA = \beta_0 + \beta_1 M\ Banking\ adoption_1 + \beta_2 Digital\ lending\ plan\ to\ adopt_2 + \beta_3 Ln\ CAR_3 + \beta_4 LnCIR + \beta_5 LAR_5 + \beta_6 NPL_6 + \beta_7 AGR_7 + \mu_t. \quad (5)$$

Model 2:

$$NIM = \beta_0 + \beta_1 M\ Banking\ adoption_1 + \beta_2 Digital\ lending\ plan\ to\ adopt_2 + \beta_3 Ln\ CAR_3 + \beta_4 LnCIR + \beta_5 LAR_5 + \beta_6 NPL_6 + \beta_7 AGR_7 + \mu_t. \quad (6)$$

Based on the regression results (see Table 7), Fintech adoption, such as M-banking and Digital lending, has a significant and positive effect on ROA. Specifically, the analysis shows that for every unit increase in banking adoption, ROA increases by 0.237 units while keeping all other variables constant. Additionally, for every unit increase in digital lending, ROA increases by 0.052 units, again while keeping other variables constant. Furthermore, M-banking and Digital lending significantly and positively affect NIM (see Tables 7 model 2). Specifically, the analysis reveals that for every unit increase in banking adoption, NIM increases by 0.301 units while keeping all other variables constant. Additionally, for every unit increase in digital lending, NIM increases by 0.076 units, with other variables held constant. These results are in line with previous studies, including Chhaidar et al. (2022), Dwivedi et al. (2021), H Al-Dmour et al. (2020), Singh et al. (2021), and Wong and Ho (2020), which have consistently found a positive and significant impact of technology adoption on the financial performance of banks.

The KMO measure of .819 suggests that the data is appropriate for factor analysis (see Table 10). Additionally, the test statistic for Bartlett's test of sphericity is 4925.842 with 190 degrees of freedom and a p-value of .000, which implies that the null hypothesis can be rejected and confirms that the correlation matrix is not an identity matrix. Consequently, the data is suitable for factor analysis.

http://dx.doi.org/10.21511/imfi.22(1).2025.29

Table 7. Multifactorial regression analysis (Model 1 and Model 2)

Source: Author's compilation.

Variables	Model 1 ROA	Model 2 NIM
Constant	18.79***	10.32***
M-banking adoption	**.237*** *(5.14)*	.0301*** *(5.69)*
Digital lending plan to adopt	.052** *(2.105)*	.076*** *(2.687)*
LnCAR	–.820*** *(–23.26)*	–.783*** *(–19.24)*
LnCIR	–.128*** *(–4.37)*	.098** *(2.92)*
LAR	.053* *(1.77)*	.013 *(.384)*
NPL	–.159*** *(–5.31)*	–.118** *(–3.44)*
LnAGR	.051* *(5.14)*	.251*** *(8.74)*
R^2	81.80%	75.40%

Note: * p < 0.05; ** p < 0.01; *** p < 0.001. Values in parentheses and italicized indicate the t-test values for the estimated coefficients in the models. *lnCAR* – Capital Adequacy Ratio. *lnCIR* – Cost-to-income ratio. *LAR* – Loan-to-asset ratio. *NPL* – Non-performing loans. *AGR* – Asset growth ratio.

Table 8. ROA and M-banking

Source: Author's compilation.

2. Q7_2M-banking				
Dependent Variable: Q_21 ROA				
M-banking	**Mean**	**Std. Error**	**95% Confidence Interval**	
			Lower Bound	**Upper Bound**
Already adopted	2.079	0.074	1.934	2.223
Adopt in two years	–0.88	0.169	–1.212	–0.548
Adopt after two years	–2.34	0.434	–3.196	–1.489

Table 9. T-test. ROA and Digital lending

Source: Author's compilation.

	Q7_4Digital lending	N	Mean	Std. Deviation	Std. Error Mean
Q_21 ROA	Adopt in two years	293	1.8083	1.35418	.07911
	3.0	201	.8489	1.94066	.13688

Table 10. Principal component analysis

Source: Author's compilation.

KMO and Bartlett's Test		
Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		.819
Bartlett's Test of Sphericity	Approx. Chi-Square	4925.842
	df	190
	Sig.	0.000

Table 11 presents the outcomes of Principal Component Analysis (PCA) performed on the data. The table shows that the first component explains the most substantial amount of variation (31.25%), followed by the second component (13.20%), the third component (9.47%), and so on. Together, the first five components explain 67.29% of the total variance in the data. Retaining enough components to explain a significant portion of the variance in the data is advisable while ensuring interpretability. In this particular scenario, it is recommended to keep the first five components as they account for 67.29% of the variance and are easily interpretable.

Table 11. Principal component analysis (PCA)

Source: Author's compilation.

Total Variance Explained									
Component	Initial Eigenvalues			Extraction Sums of Squared Loadings			Rotation Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	6.250	31.250	31.250	6.250	31.250	31.250	3.170	15.849	15.849
2	2.641	13.205	44.455	2.641	13.205	44.455	2.940	14.700	30.549
3	1.895	9.475	53.930	1.895	9.475	53.930	2.532	12.660	43.209
4	1.602	8.011	61.941	1.602	8.011	61.941	2.475	12.376	55.585
5	1.070	5.352	67.294	1.070	5.352	67.294	2.342	11.709	67.294
6	.918	4.589	71.883						
7	.703	3.517	75.400						
8	.661	3.307	78.707						
9	.575	2.873	81.580						
10	.551	2.753	84.333						
11	.470	2.352	86.685						
12	.455	2.273	88.958						
13	.386	1.928	90.886						
14	.343	1.715	92.601						
15	.324	1.618	94.219						
16	.289	1.444	95.663						
17	.275	1.374	97.036						
18	.237	1.183	98.219						
19	.192	.961	99.180						
20	.164	.820	100.000						

Note: Extraction Method: Principal Component Analysis.

Table 12. Rotated component matrix

Rotated component matrix	Component				
	1	2	3	4	5
Q8_6Reduce the time of the services	0.792				
Q8_9Reduce overhead & rental costs (e.g. offices, branches)	0.702				
Q8_7Increase flexibility	0.676				
Q8_8Reduce staff costs	0.649				
Q8_5Improve the productivity of the banks	0.602			0.393	
Q8_4 Reducing the cost of financial transactions and services	0.586			0.441	
Q10_2 Improving business opportunity through big data analytics		0.84			
Q10_3 Reduce credit cost through big data analytics		0.798			
Q10_1 Helping the bank inquire information to better understand the customers		0.769			
Q10_4 Reduce compliance costs		0.593			0.322
Q10_5Better addressing fraud and risk management		0.583			0.337
Q66_2 Be a leader in Fintech innovation.			0.906		
Q66_1We are investing heavily in Fintech innovations			0.868		
Q66_3 We are systematically monitoring technology development trends.			0.853		
Q8_3 Increasing revenue generation opportunities				0.798	
Q8_2 Improving efficiency				0.796	
Q8_1 Improving customer experience/service delivery				0.773	
Q11_2FinTech adoption process is smooth to adopt in your bank					0.845
Q11_3FinTech adoption is supported by everyone in the bank					0.833
Q11_1 FinTech adoption required a strategic approach to technology management					0.689

Note: Extraction Method: Principal Component Analysis. Rotation Method: Varimax with Kaiser Normalization. Rotation converged in 6 iterations.

http://dx.doi.org/10.21511/imfi.22(1).2025.29

In this study, the rotated component matrix (see Table 12) shows five factors that explain different aspects of the perceived usefulness of fintech adoption by banks:

- ***Component 1: Operational Efficiency*** – This component includes questions related to reducing the time and cost of services, reducing overhead and rental costs, reducing staff costs, and improving the banks' productivity.
- ***Component 2: Business opportunities and credit cost reduction*** – This component includes questions about leveraging big data analytics to improve business opportunities and reduce credit costs.
- ***Component 3: Customer Understanding and Revenue Improvement*** – This component includes questions related to helping the bank better understand its customers, increasing revenue generation opportunities, improving efficiency, and improving customer experience and service delivery.
- ***Component 4: Fintech Leadership and Investment*** – This component includes questions related to investing in FinTech innovations, being a leader in FinTech innovation, and adopting a strategic approach to technology management.
- ***Component 5: Compliance and Risk Management*** – This component includes questions about reducing compliance costs and better-addressing fraud and risk management.

Model 3: ROA (after PCA analysis):

$$\begin{aligned} ROA &= \beta_0 + \beta_1 PCUFA\ in\ Operational\ Efficiency_1 \\ &+ \beta_2 PCUFA\ in\ Business\ opportunities\ and\ credit\ cost\ reduction_2 \\ &+ \beta_3 PCUFA\ in\ Customer\ Understanding\ and\ Revenue\ Improvement_3 \\ &+ \beta_4 PCUFA\ in\ Fintech\ Leadership\ and\ Investment_4 \\ &+ \beta_5 PCUFA\ in\ Compliance\ and\ Risk\ Management_5 \\ &+ \beta_6 Bage_6 + \beta_7 AG_7 + \beta_8 CIR_8 + \beta_9 CAR_9 + \beta_{10} LAR_{10} + \beta_{11} CR_{11} + \mu_t \end{aligned} \quad (7)$$

(adjusted after PCA analysis)

Model 4: NIM (after PCA analysis):

$$\begin{aligned} NIM &= \beta_0 + \beta_1 PCUFA\ in\ Operational\ Efficiency_1 \\ &+ \beta_2 PCUFA\ in\ Business\ opportunities\ and\ credit\ cost\ reduction_2 \\ &+ \beta_3 PCUFA\ in\ Customer\ Understanding\ and\ Revenue\ Improvement_3 \\ &+ \beta_4 PCUFA\ in\ Fintech\ Leadership\ and\ Investment_4 \\ &+ \beta_5 PCUFA\ in\ Compliance\ and\ Risk\ Management_5 \\ &+ \beta_6 Bage_6 + \beta_7 AG_7 + \beta_8 CIR_8 + \beta_9 CAR_9 + \beta_{10} LAR_{10} + \beta_{11} CR_{11} + \mu_t \end{aligned} \quad (8)$$

(4 adjusted after PCA analysis)

Table 13. Multifactorial regression analysis (Model 3 and Model 4)

Source: Author's compilation.

Variables	Model 3 ROA	Model 4 NIM
Constant	24.75***	15.52***
PCUFAOE	–.079*** *(–3.62)*	–.020 *(–.803)*
PCUFABO	.053** *(2.47)*	.098*** *(3.926)*
PCUFACURI	.143*** *(6.67)*	.028 *(1.124)*
PCUFAFLI	–.025 *(–1.15)*	.034 *(1.371)*
PCUFACRM	–.023 *(–1.12)*	.040* *(1.660)*
Bank age	.175*** *(4.99)*	.313*** *(7.66)*
LnCAR	–.923*** *(–31.98)*	–.917*** *(27.285)*
LnCIR	–.260*** *(–9.178)*	–.102*** *(–3.095)*
LAR	.031 *(1.23)*	–.060*** *(–2.009)*
NPL	–.188*** *(–5.253)*	–.154*** *(–4.78)*
LnAGR	–.003 *(–.102)*	.303*** *(9.460)*
R^2	81.80%	75.40%

Note: * p < 0.05; ** p < 0.01; *** p < 0.001. Values in parentheses and italicized indicate the t-test values for the estimated coefficients in the models. *PCUFAOE* – Perceived usefulness of fintech adoption in operational efficiency. *PCUFABO* – Perceived usefulness of fintech adoption in business opportunity and cost reduction. *PCUFACURI* – Perceived usefulness of fintech adoption on customer understanding and revenue improvement. *PCUFAFLI* – Perceived usefulness of fintech adoption on fintech leadership and investment. *PCUFACRM* – Perceived usefulness of fintech adoption on compliance and risk management. *lnCAR* – Capital Adequacy Ratio. *lnCIR* – Cost-to-income ratio. *LAR* – Loan-to-asset ratio. *NPL* – Non-performing loans. *AGR* – Asset growth ratio.

The given regression model has a constant of 24.215 and includes 11 independent variables, including factor scores for each of the five identified factors related to the perceived usefulness of fintech adoption. The standardized coefficients (beta) indicate the relative importance of each variable in predicting the dependent variable (ROA). The beta value for the perceived usefulness of fintech adoption in Operational Efficiency (PCUFAOE) is –.079. The beta value of –0.079 indicates an inverse relationship between the perceived effectiveness of fintech adoption in enhancing operational efficiency and Return on Assets (ROA). In other words, when organizations use fintech to improve their operational efficiency, it has a negative impact on their profitability, as reflected by ROA. Specifically, for every one-unit increase in the PCUFAOE, ROA decreases by .079 units (P-value = .000 < .05) while keeping all other variables constant.

4. DISCUSSION

The negative correlation between the perceived usefulness of fintech adoption for enhancing operational efficiency and a company's Return on Assets (ROA) may stem from the novelty of fintech. Some banks may need to fully understand or efficiently implement fintech solutions for operational improvement, potentially leading to short-term negative impacts on their profitability. However, the result, which found a negative relationship between the perceived usefulness of fintech adoption and ROA, is in line with the findings of Nguyen and Dang (2022) and Wu and Yuan (2021) who also found a negative impact of fintech adoption on the profitability of commercial banks. According to a study by Akhisar et al. (2015), adopting Internet banking in developing countries has a negative impact on banks' profitability. This finding highlights the importance of banks taking a measured approach when implementing new technologies. It is crucial for them to thoroughly assess the potential risks and benefits before making any decisions. Similarly, Ardiany et al. (2021) found that the development of Fintech has a negative impact on the Return on Assets (ROA) of state-owned Islamic banks. The study

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suggests that state-owned Islamic banks must carefully consider Fintech development's potential effects on their profitability before implementing such systems. The study's findings align with those of Campanella et al. (2017) and suggest that increasing financial leverage to invest in technology may negatively impact banks' business performance. Multiple studies, including the current study, have found a negative impact on banks' profitability when focusing on operational efficiency and cost reduction drives fintech adoption. This suggests that adopting Fintech for these purposes may lead to a lack of understanding and inefficient adoption, which may negatively impact the short-term profitability of banks.

The regression analysis revealed that the perceived usefulness of Fintech adoption in business opportunities and credit cost reduction (PCUFABO) significantly positively affects banks' Return on Assets (ROA). Specifically, for every unit increase in PCUFABO, while keeping other variables constant, the ROA will increase by 0.053 units (P-value = .014 < .05). This finding suggests that banks that adopt Fintech with a focus on business opportunities and credit cost reduction are likely to experience higher profitability. Also, the regression analysis revealed that the perceived usefulness of Fintech adoption in customer understanding and revenue improvement has a significant positive effect on the Return on Assets (ROA) of banks, as indicated by the beta value of 0.143 (P-value = .000< .05). Specifically, for every one unit increase in perceived usefulness of Fintech adoption in customer understanding and revenue improvement, while keeping all other variables constant, the ROA is expected to increase by 0.143 units. These findings suggest that the perceived usefulness of adopting Fintech with a focus on customer understanding and revenue improvement can lead to higher profitability for banks.

These findings are consistent with other studies (Karjaluoto et al., 2019), which found that the perceived usefulness of Fintech adoption in information factors, innovation attributes, and bank customer experience play significant roles in banks. These supports improving customer experience and revenue generation opportunities through Fintech adoption, as emphasized in Component 3 of this study. Furthermore, Onuorah et al. (2022) focused specifically on the impact of Fintech on the Nigerian banking sector. They found that it positively affected operational efficiency, customer satisfaction, and financial performance. This aligns with Components 2 and 3 in this study, which emphasize the potential benefits of Fintech adoption for reducing credit costs and improving customer experience. Chhaidar et al. (2022), Dwivedi et al. (2021), H Al-Dmour et al. (2020), Singh et al. (2021), and Wong and Ho (2020) have found a positive and significant impact between the adoption of technology and the financial performance of banks. Their studies suggest leveraging technology can improve bank performance, including operational efficiency, customer satisfaction, and profitability. This study and previous research show that perceived usefulness of Fintech adoption, like reducing costs and improving customer insights, is key to boosting bank profitability.

Based on the regression analysis, the study found that the perceived usefulness of fintech adoption in fintech leadership and investment, compliance, and risk management had minor adverse effects on ROA, but these effects were not statistically significant. Therefore, these factors may have little impact on the financial performance of banks. This result matches the findings from a study by Keliuotytė-Staniulėnienė & Smolskytė (2019). They also found that fintech indicators affect bank profitability, but the impact is not statistically significant. In addition to this perceived usefulness of fintech adoption variables, the model includes control variables such as bank age, loan-to-asset ratio, non-performing loans, asset growth rate, cost-to-income ratio, capital adequacy ratio and cost-to-income ratio. Bank age positively impacts bank financial performance, as evidenced by the beta value of 0.175 obtained in this study, indicating that a one-year increase in bank age leads to a 0.175 unit increase in ROA, holding all other variables constant. The findings of this study align with those of Lawrence et al. (2020) and Kwashie et al. (2022), who also reported a significant positive relationship between bank age and ROA. These studies suggest that older firms gain knowledge and expertise over time, leading to optimized business processes and improved performance. Işik and Ersoy (2022) also support this view, indicating that a bank's age significantly impacts its financial performance.

The beta value for the capital adequacy ratio (CAR) is –0.923, indicating that for every one-unit increase in the CAR, ROA decreases by 0.923 units, holding all other variables constant. Likewise, the beta value for the cost-to-income ratio (CIR) is –0.260, suggesting that for every one-unit increase in the CIR, ROA decreases by 0.260 units, holding all other variables constant. The beta value of the non-performing loan (NPL) is –0.183, suggesting that for every unit increase in NPL, ROA decreases by 0.183 units, keeping all other variables constant. The results are consistent with Zhang et al. (2022) and Al-Amin & Hossain (2021) who found negative effect of NPL in financial performance. A high capital adequacy ratio is an essential indicator of a bank's financial stability and ability to absorb potential losses. However, an excessively high ratio may suggest that a bank needs to utilize its capital more efficiently, resulting in decreased profitability and ROA. Similarly, a high cost-to-income ratio indicates that a bank allocates a significant portion of its income to operating expenses, which can lead to reduced profitability and lower ROA. Banks with higher operating expenses may also have limited flexibility to adapt to changing market conditions or invest in new technologies and services (Gupta & Mahakud, 2020; Kwashie et al., 2022; Lawrence et al., 2020). Therefore, banks must balance maintaining adequate capital levels and managing operating expenses efficiently to optimize their financial performance and ROA. By doing so, banks can improve their profitability and ability to compete in a rapidly evolving financial landscape. The collinearity statistics suggest that the model does not suffer from significant multicollinearity, with all tolerance values greater than 0.1 and all VIF values less than five.

Regarding Model 2, where the dependent variable is Net Interest Margin (NIM), the regression analysis revealed that the perceived usefulness of Fintech adoption in business opportunities has a significant positive effect on NIM. Specifically, for each unit increase in perceived usefulness of Fintech adoption, while holding other variables constant, NIM will increase by 0.098 units (P-value = .000 < .05). None of the other variables were found to have a statistically significant impact on NIM. All control variables were found to have a statistically significant impact, with only Bank age and Asset growth rate having a positive impact. In contrast, the other variables had a negative impact on NIM.

Though the study provides valuable insights, long-term studies on the impact of internal fintech on bank performance should be done in various financial environments and regulatory frameworks. Comparative studies across various banking systems and fintech adoption models may provide deeper insights into how fintech positively affects financial performance.

CONCLUSIONS

This study explored the impact of internal fintech adoption on bank profitability in Kosovo, examining how bank employees' perceived usefulness of fintech influenced profitability, using innovation theory and the technology acceptance model. The findings revealed that the impact of internal fintech adoption on bank profitability varied based on its strategic focus. The results show that internal fintech adoption to increase operational efficiency had a negative effect on profitability, while efforts towards increasing business opportunities, reducing credit costs, understanding customer behavior, and increasing revenues positively impacted bank profitability. Banks' profitability in Kosovo improved significantly by adopting internal fintech such as mobile banking and digital lending. The study results also highlighted that bank age is an important determinant of the effectiveness of fintech adoption, as older banks benefited more from internal fintech integration than younger ones.

The results of this study led to the conclusion that banks in Kosovo should channel their efforts towards internal fintech adoption to increase profitability. Instead of operational efficiency, banks should focus on internal fintech solutions that will increase business opportunities and customer engagement and optimize revenue generation. In addition, investments in mobile banking and digital lending services should be further expanded, as these technologies strongly show profitability. Moreover, given the ten-

http://dx.doi.org/10.21511/imfi.22(1).2025.29

dency for older banks to benefit more from fintech adoption, newer banks should consider tailored strategies using FinTech to pursue accelerated competitive growth.

To maintain long-term success, banks must continuously invest in technology, strengthen collaborations with fintech firms and develop regulatory frameworks that support digital transformation. Banks in Kosovo need to accelerate their digital transformation processes if they want to remain competitive in the dynamic financial space with technology-driven financial service providers from global companies such as Amazon, Google, and Microsoft to neo-banks currently in the emergence phase. Digital services should be at the top of the agenda for traditional banks. To support fintech development in the banking sector, policymakers should pay attention to improving the features related to fintech services, improving the reputation of banks, developing cooperation with fintech companies, technology and human resource investments, and creating a regulatory framework.

AUTHOR CONTRIBUTIONS

Conceptualization: Blake Rayfield.
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Methodology: Vlora Berisha.
Project administration: Blake Rayfield.
Supervision: Blake Rayfield.
Validation: Vlora Berisha.
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http://dx.doi.org/10.21511/imfi.22(1).2025.29

APPENDIX A

Table A1. List of commercial banks in Kosovo and their characteristics

Source: Data from banks' financial statements on their official websites.

Year	Bank Name	Total assets	Bank age	CAR	ROA	AGR	NPL	CIR	NIM	LAR
2019	Banka Ekonomike	322501000	19	14.4	1.7	1.5	2.31	62.57	4.2	66.89
2020	Banka Ekonomike	367882000	20	13.3	1	14.1	2.46	75.56	4.1	69.89
2021	Banka ekonomike	460890000	21	13.56	2.6	25.3	2.73	65.49	4.1	73.78
2019	Banka kombëtare tregtare	536735026	12	13.3	2.2	29.3	2	63.47	4.63	57
2020	Banka komëtare tregtare	672221701	13	14	1.9	25.2	2.7	57.01	4.12	57.1
2021	Banka komëtare tregtare	825837715	14	13.8	2.4	22.6	2.3	54.11	4.09	52.8
2019	Banka per biznes	297111000	19	15.9	2.3	44.6	2.87	65.3	5.7	63.1
2020	Banka per biznes	334898000	20	15.4	1.6	12.72	1.99	76.7	5.4	57.5
2021	Banka per biznes	379159000	21	14.5	2.2	13.22	2.3	58.8	5.5	61.3
2020	Credins bank	11796000	1	212.58	–2.6	100	2.08	–61.25	–21.2	2.03
2021	Credins bank	26521000	2	65.8	–6.29	137	0.069	37.48	0.14	58.6
2019	Is bank	103343963	7	14.1	0.47	–11.3	2.6	87.6	5.014	67.8
2020	Is bank	103036836	8	13.7	1.47	–0.29	2.4	71.2	5.012	66.8
2021	Is bank	124506728	9	14.01	0.11	20.83	2.3	77.5	4.72	77.6
2019	Nlb	801085000	9	16.4	2.7	20	1.5	31.9	4.1	67.42
2020	NLB	879065000	10	17.8	1.6	10	2.9	31.7	3.8	63.62
2021	Nlb	930547000	11	17.3	2.7	5.9	2.3	32.4	4.1	68.19
2019	PCB	805930000	20	17.57	2.7	6.9	1.9	62.7	4.1	66.7
2020	PCB	899992000	21	20.01	1.5	11.7	3.4	48.6	3	61.6
2021	PCB	904833000	22	15.84	1.9	0.53	2.3	54.1	2.9	65.7
2019	Raiffeisen bank Kosovo	1021902000	17	15.9	1.9	14.9	2.7	53.7	4.1	68.9
2020	Raiffeisen bank Kosovo	1115984000	18	16.5	1.5	9.2	3.2	54.1	4.03	63.6
2021	TEB Bank	752140000	14	16.9	2.4	13.6	1.34	48.6	4.1	48.6
2019	Ziraat bank	63862601	5	22.3	0.02	48.18	1.07	90.05	2.61	68.94
2020	Ziraat Bank	75446294	6	19.17	1.43	18.1	0.9	85.6	3.26	74.8
2021	Ziraat Bank	93851082	7	18.43	0.67	24.4	2.08	74.6	3.07	69.8

APPENDIX B. Summary of existing empirical research on fintech and banks' profitability

Table B1. Summary of existing literature in fintech and banks' profitability

Title	Research by	Period	Variables	Sample and country	Tools used	Source of the data	Empirical findings
The Impact of Fintech Innovations on the Hong Kong Banking Industry	Wong & Ho (2020)	2017–2019	– Fintech adoption status – Log assets – Deposits-to-assets ratio – Loans-to-assets ratio Dummy variable for retail bank ROA – dependent variable – Cost-to-income ratio – dpv	45 Banks	Simple OLS model	Mix: primary and secondary: A survey entitled "Study of the Impact of Fintech Innovations on the Hong Kong Banking Industry" is conducted and 2. Balance sheet	The results of this study showed a positive effect of the adoption of fintech on the profitability of banks. Banks with a higher level of fintech usage have a lower cost-to-income ratio
How Do Fintech's Impact Banks' Profitability? An Empirical Study Based on Banks in China	Lv et al. (2022)	2011–2020	– (ROE) as the dependent variable Fintech's index (FTI^2) –LNTA – Natural logarithm of the bank's total assets –NIM – Ratio of banks' net interest income to total interest assets NPL – Ratio of banks' non-performing loans to total loans –CTI – Ratio of operating expenses plus depreciation to operating income	10Banks/ China	Error Correction Model (ECM) combined with the Granger causal relation test	Secondary: data of the Industrial and Commercial Bank of China (ICBC),	It was found that fintech has a U-shaped impact on bank profitability. In the early stages, fintech reduces profitability; in the middle stages, profitability gradually increases due to fintech usage, continuing to grow in the later stages
Possibilities for financial technology sector development and its impact on banking sector profitability in Lithuania	Keliuotytė-Staniulėnienė & Smolskytė (2019),	The survey was carried out between April and May 2018 and the secondary data from banks cover the period 2010-2017	Fintech survey + quantitative data: Peri – banking sector's ROA, ROE and NIM; FinTech – total number of FinTech companies; Card – total number of bank cards; PosT – total number of bank card readers; Intbank – total number of online banking users; Innov – total expenses for innovations; Mobbank – total number of mobile banking users; TUI – total investment in the financial sector; Nonpmnt – non-cash money payment value		Correlation-regression analysis	Mix: primary and secondary Primary: The questionnaire was drawn up based on the surveys of companies carried out by PwC and Deloitte for the purpose of assessment of FinTech potential on the global level. Secondary: Bank's data	Correlation-regression analysis showed that fintech indicators have an effect on the banking sector's profitability, but the effect is not very significant

http://dx.doi.org/10.21511/imfi.22(1).2025.29

Table B1 (cont.). Summary of existing literature in fintech and banks' profitability

Title	Research by	Period	Variables	Sample and country	Tools used	Source of the data	Empirical findings
The effect of marketing knowledge management on bank performance through fintech innovations: a survey study of Jordanian commercial banks	H Al-Dmour et al. (2020)	2019	Bank Performance (BP) Financial and non-Financial Performance – survey Fintech Innovation – survey	13 Jordanian commercial banks 336 employees	SEM–structural equation model	Primary survey	The findings of the research show a weak effect of fintech on the performance of banks
The impact of fintech on the profitability of state-owned commercial banks in China	Wu & Yuan (2021)	2014-2019	Profitability (measured by ROE), Fintech Control variables: - capital adequacy ratio (CAR), - cost-income ratio (CIR), -non-performing loan (NPL), total assets (TA)	6 SOCB	OLS estimation, the FGLS estimation, the Prais-Winsten estimation and the FE estimation	Wind and iFinD database	The authors' findings showed that fintech development has a negative effect on the profitability of state-owned commercial banks
The effect of FinTech development on financial stability in an emerging market: The role of market discipline	Khai Nguyen & Cuong Dang (2022)	2010-2020	Z-score Number of new FinTech companies established in a year Transaction value in a year LIST The dummy variable which is 1 if the bank is listed on the stock exchange, and 0 otherwise Bank's annual reports RATE The dummy variable, which is 1 if the bank is rated by Moody's, and 0 otherwise DISC Disclosure index BOSZ Board size BOSI Board independence BSIZE Bank size DIVI Diversification index	37 banks	Fixed-effects Regression	Orbis Bank Focus annual and financial reports published by the Vietnamese commercial banks. Data related to FinTech and macro variables were collected from multiple sources, such as the World Bank, the State Bank of Vietnam (SBV) reports, Statista's database, and Iris's Fintech Vietnam report	The study found that FinTech development negatively affected financial stability

Table B1 (cont.). Summary of existing literature in fintech and banks' profitability

Title	Research by	Period	Variables	Sample and country	Tools used	Source of the data	Empirical findings
The Effect of Financial Technology Investment Level on European Banks' Profitability	Chhaidar et al. (2022)	2010-2019	Capital adequacy ratio (CAR), Liquidity (LIQ), Solvency, Credit risk (NPL), Size (SIZE), Profitability (ROA) Digitalization (DIG) (INF) GDP	23 Banks	Chow Test The fully modified ordinary least squares (FMOLS) model	DataStream, World Bank, Digitalization (DIG) manually from information extracted from annual reports, which were downloaded from their respective bank websites	Result of the study showed that the greater the digital engagement of banks, the higher the profitability
Fintech effect: measuring impact of fintech adoption on banks' profitability	(R. Singh et al., 2021)	2011-2018	Return on Assets (ROA) Return on Equity (ROE) No. of ATMs to bank branches ratio, Capital Equity Tier 1 ratio, Cost to Income Ratio FinTech Dummy (encompasses Blockchain, Artificial Intelligence, Robotic Process Automation, Payment Technology and Cloud Computing)	8 banks	Regression	The mobile banking and internet banking data was collected from Play Store (Android) and Ministry of Electronics & Information Technology (MeitY) databases. The profitability data (ROA, ROE, Operating Expenses, Operating Income, Capital Equity Tier 1 Ratio) was extracted from Reserve Bank of India's (RBI's) database	The results of this research showed a significant positive impact of FinTech adoption on bank profitability
Role of FinTech Adoption for Competitiveness and Performance of the Bank: A Study of Banking Industry in UAE	(Dwivedi et al., 2021)		Fintech adoption Competitiveness Performance	76 banks		Survey	FinTech has had a significant impact on competitiveness and competitiveness outcomes in the UAE banking industry

http://dx.doi.org/10.21511/imfi.22(1).2025.29