FinTech and Bank Profitability in India: An Econometric Analysis with Chow Test

Manisha Verma
Sr. Research Scholar
Maulana Azad National Institute of Technology, Bhopal
Orcid Id- 0000-0003-4374-028X
manisha@mcu.ac.in / 213121004@stu.manit.ac.in

Dr. Nenavath Sreenu
Associate Professor
Maulana Azad National Institute of Technology, Bhopal
srinunaikphd@gmail.com

Prof. Shuchi Srivastava
Professor
Maulana Azad National Institute of Technology, Bhopal
shuchi_rajendra@yahoo.co.in
Orcid Id- 0000-0003-4352-8158

Dr. Gyaneshwar Singh Kushwaha
Associate Professor
Maulana Azad National Institute of Technology, Bhopal
gyanbhu@gmail.com - 9578540151
Orcid Id- 0000-0002-6048-0662

Abstract

The technological sector has made significant improvements that have impacted the way in which individuals execute task. Financial technology (FinTech) encompasses the implementation of sophisticated technologies in various financial sectors includes insurance, retail banking, wealth management, lending, payment, and financial settlement. This article explores the evolving connection between financial performance and the adoption of FinTech, while also examining how the size of a bank may influence its performance during digital transformation. The fully modified ordinary least squares (FMOLS) model with Chow test is evaluated for 57 Indian banks between 2010 and 2023. The econometric analyses show a positive and substantial relationship between bank profitability and FinTech adoption, implying that more digital involvement by banks translates into improved profitability. According to our research, there is a moderating influence of bank size on the association between profitability and digital investments. Investments in financial technology help larger banks more, which enhances their performance. Our research has significant implications for policies since it indicates that banks may improve their performance by investing more in FinTech, especially in view of the bank's size.

Keywords: FMOLS model, Bank Profitability, Financial technologies, FinTech, Private sector, public sector, FinTech development.

Introduction

India is one of the largest nations with abundant resources of marble, minerals, and tourists. However, a large tribal and rural region has weak economic development, poverty, and exclusion from formal banking services (Singh, Malik, and Jain 2021; Meyer and Okoli 2023). The destitute have greater financial management needs than anybody else because of their sporadic and unpredictable income (Le et al. 2021; Nguyen, Tran, and Ho 2022). To satisfy a wide range of financial needs, including simple access to savings, microcredits, insurance, payment, and transfer services, they need a broad choice of affordable and

appropriate financial services. However, they employ informal channels, which are more costly, less secure, and less dependable than standard services, since they have limited access to official financial services (Medyawati,Yunanto,and Hegarini 2021; Wang et al. 2024).

Since emerging from the global financial crisis of 2007–2008, financial technology firms, known as FinTechs, have revolutionized the financial sector by bringing innovative technologies to the market (Al-Shari and Lokhande 2023; Kaddumi et al. 2023). Information technology and electronic money transfer systems are the two pillars on which modern banking development is built (technology-based banking) (Nugroho and Sugiyanto 2023). Another factor contributing to the cause's rise over the last ten years has been the quick spread of mobile networks in deprived areas and communities in India (Sunardi and Tatariyanto 2023; Song, Yu, and He 2023). In addition to online and mobile banking, payment banks have offered a different way for customers in rural and semi-urban areas to bank, which has helped to increase efficiency and reduce costs (Alshehadeh and Al-Khawaja 2022; Khan, Khan, and Ghafoor 2023; Jefri et al. 2024). The rise of new, specialized competitors and innovative companies blending business with technology has lowered the entry barriers for traditional banking services (Baker et al. 2023; Yunita 2021)

Numerous perspectives exist in the literature about how financial technology investments affect bank profitability. In fact, research(Dwivedi, Alabdooli, and Dwivedi 2021). indicates that productivity does not rise with increased usage of information technology. Additionally, (Lee et al. 2021) finds that Internet banking usage in Australian credit unions had no positive impact on bank performance.

Recent studies have demonstrated that investing in financial technology positively influences profitability (Chen, You, and Chang 2021; Wu et al. 2023; Chen, Yang, and Ma 2022; Murinde, Rizopoulos, and Zachariadis 2022; Kharrat, Trichilli, and Abbes 2024; Alshari and Lokhande 2022). The research (Deng et al. 2021) provides evidence that using cutting-edge technology greatly improves financial performance. The positive effect will be attributed to the fact that the management of credit risk (Zheng et al. 2023) is enhanced by the implementation of advanced software and online banking services, which also reduce information access costs (Aloulou et al. 2024) and operating expenses (Zhao et al. 2022). Furthermore, as (Chuc, Atayah, and Özer 2023) shows, the FinTech system plays a significant role in helping businesses save expenses and boost profitability. Research (Beltrame, Zorzi, and Grassetti 2022) suggests that FinTech reduces the cost of financial intermediation while boosting banks' profitability and improving risk management. Similarly, (Wilter, Kambura, and Mugoche 2023) highlights that FinTech innovation enhances the performance of Chinese banks. Likewise, (Almashhadani and Almashhadani 2022), which focuses on Chinese banks, demonstrates that FinTech enhances banking credit services, especially for large banks. Similarly, numerous studies contend that the size of a bank is a key factor influencing profitability (Katsiampa et al. 2022). Differences in the activities and investments in financial technology between small and large banks could result in varying conclusions about the relationship between FinTech and profitability. In fact, (Sajid et al. 2023) indicates that bigger banks have a wider range of business ventures than smaller ones, with a concentration on intermediation. In addition, (Hu, Zhao, and Yang 2024) and (Huang and Tan 2024) imply that larger banks are able to take advantage of greater economies of scale than smaller ones. Large banks are reportedly investing more in technology, according to reports (Alshari and Lokhande 2023) and (Alsmadi et al. 2023). Research (Li, Elahi, and Zhao 2022) exhibits that smaller businesses might adopt FinTech at a faster rate compared to larger enterprises.

This article looks at the changing link between 57 Indian banks' profitability and FinTech implementation from 2010 to 2023. We further explore the moderating role of bank size on the adoption and profitability relationship of fintech. To identify the most suitable model for estimation, our approach relies on econometric tests for cointegration, structural breaks, and stationarity. According to the structural break test, 2016 was a crucial year because of the Indian demonetization event, which sped up the use of digital technology. Cointegration tests validate the variables' long-term link. As a result, we calculate a cointegrated panel model (FMOLS) for 2010–2023 as a whole as well as for its two sub corresponding periods

(2010–2016 and 2017–2023).

This paper seeks to provide two major insights. First, we assess the effect of FinTech adoption on Indian banks before and after 2016 by developing a comprehensive FinTech adoption index that incorporates various types of variables, such as the volume of digital transactions, the number of mobile banking users, and the frequency of FinTech-related keywords in annual reports. Due to demonetization and the introduction of the Unified Payments Interface (UPI), India's digital financial ecosystem has undergone a substantial change this year. Secondly, we examine the extent to which the scale of a bank impacts the profitability of various bank categories in India as a result of FinTech adoption.

The subsequent sections of this research are organized as follows: The second section examines existing literature on the adoption of fintech, the size of banks, and financial performance in India. The third part contains information on the factors and sample, as well as our unique FinTech adoption index. The empirical model is presented in section four. Section five presents the study results and emphasizes how the adoption of FinTech has varying effects on banks of different sizes and over different periods of time. In conclusion, the sixth segment offers implications for bank strategy and policy in India's quickly developing digital financial environment.

FinTech trends in Indian banking sector

Centralized Network services enabled by cloud technology allow banks to offer their goods anywhere in the globe. These methods allow data retrieval without requiring the installation of specialist software on the device. Big data then utilizes the evaluation of extraordinarily varied digital data from sources such as the web, sensor readings, corporate document archives, devices, etc. to provide personalized offers for clients.

API is a system component designed to enable communication with clients. An operating system, application, or service may offer functions, classes, procedures, structures, and constants for integration into third-party software products (Melnyk, Kuchkin, and Blyznyukov 2022).

AI-driven technologies are revolutionizing the payment landscape, enabling transactions from any device and location. We can anticipate the future behavior of the client and recommend payment solutions with lower rates by analyzing their consumption patterns, previous transactions, and other actions. The ability to do transactions by speech is one of the biggest advancements. They need specific security and verification methods, which are currently mostly in the early stages of development. Financial data has emerged as a highly valuable asset. Integrating payment solutions with other systems allows businesses to improve customer experiences, boost retention, and gain valuable insights into client purchasing behaviors.

Financial data from consumers can be securely accessed by trusted third parties through open banking. The process, outlined under open banking, follows a specific format and is accessible only with the customer's consent. Businesses may get a thorough picture of their clients' financial status by using their services. Furthermore, it presents clients with a transparent understanding of the allocation of their funds.

Traditional Bank Branches Impacted by FinTech

The banking sector is experiencing both advantages and disadvantages from the development of financial technology. Technology offers banks various ways to improve their services. For example, chatbots can enhance customer interactions, mobile apps enable real-time account access, and machine learning helps detect and prevent fraud. Nevertheless, FinTech is challenging financial services and traditional banking from all directions, posing a threat to the long-term viability of many well-established companies.

FinTech has enabled non-financial companies to offer financial products. For instance, employees can now use an interest-bearing cash account to save money and a Gusto-branded debit card, provided by an online HR and benefits platform, for making purchases. Additionally, Vodafone and the online insurance company Element have joined together to develop a new internet-safety insurance plan for individual subscribers of Vodafone mobile users. Many sectors are being affected by automation and digital

transformation, with the financial services industry being one of the most significantly impacted.

According to Business Insider, disruptive technologies such as AI, blockchain, and alternative funding are revolutionizing the financial services sector (Siska, Kuspriyono, and Sebastian 2023). As digital startups gain more clout, traditional financial branches and institutions still play a vital role in the market by providing a wide range of facilities and incorporating digital services to remain competitive. Technology has had a major influence on consumers' ability to utilize their financial service platforms (Otonne, Melikam, and Ige 2023). In this sense, banks and other financial organizations might assign basic customer service and approval processes to artificial intelligence algorithms.

Financial services customers continue to get some trust from face-to-face interactions. Fifty percent of banking consumers surveyed recently said they would rather apply in person for a new loan or create a new deposit account. Furthermore, 25% of the respondents said they weren't interested in opening an account with a banking institution with no regional offices. Local banks should have pleasant individuals to greet their customers. Despite the shift to digital channels for simple transactions, branches and ATMs still have a significant role in the banking industry since they are still helpful for more complex transactions. Particularly for first-time consumers, some transactions need direct personal contact because of stringent anti-money laundering and KYC regulations. Many buyers find value in individualized product suggestions even after doing internet research. In a similar vein, a large number of millennials would rather visit a branch to open a new account, learn about estimating, and look at retiring choices. Branches offer a sense of stability and security that online banks find hard to replicate, especially when addressing security concerns.

FinTech Market in India

The banking sector in India is vital in supporting the Indian financial system and makes a significant contribution to Indian Economic Growth. Public, private, and non-banking financial companies (NBFCs) dominate the banking industry in India. Enhanced banking efficiency enables banks to generate profits and maintain competitiveness. Public sector banks in India need to limit their non-performing assets and efficiently manage their operational costs if they want to increase profitability. The banking industry has to enhance its credit offerings on customer accounts and draw in more deposits from the general public in the form of direct investment in order to effectively compete with private banks in the market. As per (Harsono and Suprapti 2024), the Indian banking system has undergone a significant revolution starting before independence. It has experienced various transformations including the establishment of a legislative framework, expansion of branches, nationalization of banks, introduction of cooperative and private banks, and modernization. Each stage is susceptible to operational, commercial, and regulatory risks (Guo and Zhu 2022). According to the study conducted by (Lamine 2024), the Indian banks served as a vital contributor to the expansion of industrialization, although its impact was not especially significant in rural regions. Due to the lack of a banking system, local lenders are exploiting the situation by imposing exorbitant interest rates on small farmers who are unable to get finance from banks. Financial institutions should enhance their credit facilities and expand their reach to rural regions in order to improve banking services. Kumari's (2020) study on "Banker and Customer Relationship" concluded that consumer expectations, rather than traditional factors like administration, competition, regulation, and a private economy, were the primary drivers of significant change in the Indian banking industry. A major catalyst for transformation in the banking sector is the bank management's strategy for improving client services.

According to a study conducted by (Wang, Liu, and Luo 2021), the banking sector is seen as the fundamental support of the Indian economy. However, significant measures are still required to ensure that financial services are accessible to the majority of the Indian people. Furthermore, she emphasized that the advent of international banks has established a premium on providing high-quality services to the client. This is the era that signals a pivotal transformation in the Indian financial sector. Based on the research conducted by (Karthika,

Neethu, and Lakshmi 2022) the E-banking platform has been identified as a significant milestone in the banking industry's digitization process, contributing to the development of the Indian economy. The use of digital platforms in recent years has revolutionized the Indian banking industry, resulting in the proliferation of services like net banking and mobile banking.

According to a study article (Ojor, Nwoha, and Okwo 2023) called "Indian Banking Industry—Overview," the main problem in India's early banking stage was the lack of management specialists and the paucity of operators. The banking system was unstable in the second wave when branch growth was the main emphasis. This was due to rapid changes in the sector and insufficient regulatory supervision. However, it was not until the third phase that the bank acknowledged the necessity of utilizing modern technology to improve its operational efficiency. Although most research on the banking system in India focuses on the general efficiency of banking, there is a lack of study specifically examining banking efficiency in terms of profitability. The Indian banking industry is often regarded as a well-regulated sector with robust regulatory authorities that operate independently from political intervention in rules. In the current landscape, the existence of international and private banks is posing a significant challenge to traditional public sector banks. Consequently, the need for efficiency has become paramount, not only in terms of profitability but also in terms of market survival. Moreover, the use of innovative technology, recent regulatory changes, and increasing financial inclusion compel banks to rigorously examine their effectiveness and promptly adopt measures to guarantee maximum profitability (Yao and Song 2021). Furthermore, the number of FinTech enterprises exceeds 2100, with over 67 percent of them being established within the last 5 years. India's FinTech sector has seen a significant surge in funding, with investments amounting to over $8 billion committed at different stages of the investment process in 2021 (Moşteanu et al. 2020). Expected to expand at a CAGR of 20%, the value of FinTech transactions is anticipated to grow from US$71 billion in 2019 to US$142 billion in 2023. India saw substantial growth in digital payments as of October 2022, with over 5.9 billion transactions per month, totalling around US$3 trillion. (Hui 2022).

The growth of FinTech

India emerged as an important participant in the 21st century, showcasing a diverse array of inventive concepts and innovations, and positioning itself as one of the top nations in this era. The 2008 Global Financial Crisis further created the ideal conditions for the FinTech industry to thrive and expand rapidly. Over time, individuals progressively switched away from the existing banking system and developed trust in the emerging alternatives. Google Wallet, Apple Pay, and Bitcoin v0.1 were instrumental in providing the expansion of the FinTech sector in India (Otonne and Ige 2023). India's focus on customer-centric financial services and products can be attributed to its significant development in recent years. The 2016 demonetization effort had a substantial influence on the field of FinTech. The Indian government provides substantial assistance to FinTech companies as part of its attempts to advance Digital India and create a cashless, financially inclusive economy in the nation. The market has been increasingly shared by FinTech start-ups via collaboration, after the challenges faced by established banks in integrating their financial services with the SWIFT system. The SWIFT system offers strong security features along with extensive transaction monitoring via initiatives like SWIFT GPI. The FinTech sector in India offers extensively diverse prospects for delivering innovative and cost-effective financial solutions. The rapid adoption of FinTech resulted in the creation of many Indian enterprises within a short span of time, such as Paytm, Phonepe, and Mobikwik. This phenomenon guarantees the ongoing expansion and dominance of smartphone use as the primary means by which individuals handle their financial matters.

India currently exhibits a remarkable quantity of more than 2000 FinTech enterprises, with a significant increase in numerous FinTech start-ups observed in the past five years. The prevailing conditions necessitated a re-evaluation of strategies by conventional banks, prompting them to adopt a greater integration of FinTech into their services in order to appeal to the technologically proficient customers of the

present era. The conventional banking sector has adopted Open Banking and BaaS, enabling other service providers to access the financial data of its customers. BaaS enabled the rapid expansion of digital banks and neo-banks into the Indian market. FinTech advancements such as mobile payments, automated investing apps (Robo-advisors), online lenders, and crowdfunding platforms have successfully revolutionized the financial industry (Chan et al. 2022).

Numerous studies have been conducted to explore the impact of FinTech on profitability. The research examined the effect of adopting Internet channels on an array of 73 commercial banks that have been operating in Spain between 1994 and 2002 (Muda et al. 2021). This study provides empirical evidence that the use of the Internet channel by banks resulted in an enhancement of both ROA and ROE. Moreover, this research looks at how three different types of IT— home banking, retail Internet, and corporate Internet—might affect the financial situation of 3741 banks spread across 29 European countries in 2013(Mirza et al. 2023). The results of their study disclosed a clear and linear relationship between every classification of IT investments and the financial success of European banks. Moreover, (Aysan et al. 2022) examined the correlation between Internet banking and the financial performance of banks by utilizing ROE and ROA metrics for 32 European nations from 2005 to 2013. This research shows a clear relationship between performance and Internet banking.

The present research enhances the existing body of knowledge by offering actual data derived from the Indian banking industry, which is recognized as one of the biggest and most rapidly expanding FinTech sectors globally. We use an extensive FinTech adoption index that encompasses many aspects of digital transformation, such as the utilization of mobile banking, the quantities of digital transactions, and investments in FinTech infrastructure. The findings have substantial ramifications for commercial strategy and policy in the Indian banking sector. The authors propose that while the use of FinTech often enhances bank profitability, bigger banks possess a relative advantage in achieving these advantages. This highlights the significance of economies of scale inefficiently adopting and commercializing FinTech advancements. For policymakers, our results emphasize the importance of taking into account the size of banks when developing rules and programs to encourage the use of FinTech. It may be deduced that the use of IT enhances the financial stability of the bank during periods of crisis.

The first hypothesis is formulated below:

H1: Implementation of technologies has a positive impact on Indian banking profitability.

FinTech Investments, Bank Size and Profitability

Previous research has shown the relationship between bank size and information technology as well as its importance in deciding bank profitability. In this particular setting, they suggested that large banks are more likely than smaller ones to utilize FinTech. Furthermore, the economies of scale largely contribute to the safety, greater stability, and higher profitability of big banks compared to small ones. The aforementioned effects are further inclined to enhance the financial technology used by major banks. Nevertheless, (Aysan et al. 2022) shows that technological advancement has a greater impact on profitability for smaller companies compared to large ones. This is because small firms are able to adjust to it more rapidly, while large ones may be slower to react due to their stable market position and outdated systems that require significant modifications.

FinTech advancements may provide more substantiation of the disparities between major and small banks. Based on (Assefa 2024), it is hypothesized that small and large banks might have different business strategies. Although large banks may offer more diverse services and benefit from economies of scale in client management, small banks primarily focus on intermediation activities(Bousrih 2023). The present work examines the impact of bank asset size on bank performance. Data collected from Singapore banks indicates that larger banks demonstrate lower efficiency, resulting in worse ROA and ROE compared to smaller banks. In (Igor'B 2023), SWIFT suggested that digital innovation significantly impacts long-term profitability, with this effect being more pronounced for small banks than for large ones.

In (Yoon, Lee, and Oh 2023) major banks adopt and integrate FinTech more rapidly than smaller regional banks. Analysis of (Carbó-Valverde, Cuadros-Solas, and Rodríguez-Fernández 2021) demonstrates that the various banks in the US banking sector have a substantial impact on cost efficiency and returns to scale. In (Rahman 2023) indicates that major banks allocate a greater amount of funds towards technology compared to smaller ones. The researcher (Igor'B and Shashkina 2023) further said that there exists a positive correlation between the size of assets and the impact of overall productive variables. Indeed, he elucidates this influence by highlighting the banks' capacity to allocate resources towards FinTech, resulting in enhanced operational effectiveness. The analysis further reveals a statistically important and direct correlation between a bank's profitability and the number of its branches, which serves as an indicator of its size.

From the aforementioned study, we present the subsequent hypothesis:

H2: The impact of financial technology adoption on bank profitability is moderated by the size of the bank.

Research Method

Sampling

The aim of this work is to examine the impact of FinTech implementation on the profitability of banks in India. Comprehensive data was gathered from a representative subset of Indian banks spanning the timeframe of 2010 to 2023. The complete sample composition consisted of 57 banks, including both the public and private banks in India. The decision to concentrate on India was driven by the notable expansion of its FinTech ecosystem and the substantial digital revolution taking place in its banking industry. The time span from 2010 to 2023 enables us to analyze the impact of FinTech adoption throughout a significant era characterized by significant technology advancements and a growing FinTech presence in India. Primary data was collected from many sources, such as bank annual reports, the RBI database, and financial databases. From these sources, financial measures such as ROA, ROE, net interest margin (NIM), and other pertinent variables were acquired. An index was developed to quantify the adoption of FinTech by analyzing banks' statements on their digital projects and collaborations with FinTech companies. Data on macroeconomic control factors such as GDP growth and inflation were obtained from official government databases. This extensive dataset enables us to do rigorous research on the influence of FinTech on bank profitability in one of the biggest and most rapidly expanding FinTech sectors globally.

Table 1. Sample of 57 Indian banks

S. No.	Bank Name	Type of Bank
1.	State Bank of India (SBI)	Public Sector
2.	Punjab National Bank (PNB)	Public Sector
3.	Bank of Baroda (BoB)	Public Sector
4.	Canara Bank	Public Sector
5.	Union Bank of India	Public Sector
6.	Fincare Small Finance Bank	Private Sector
7.	Jana Small Finance Bank	Private Sector
8.	North East Small Finance Bank	Private Sector
9.	Indian Bank	Public Sector
10.	Central Bank of India	Public Sector
11.	Bank of India (BoI)	Public Sector
12.	UCO Bank	Public Sector
13.	HDFC Bank	Private Sector
14.	ICICI Bank	Private Sector
15.	Axis Bank	Private Sector

S. No.	Bank Name	Type of Bank
16.	Kotak Mahindra Bank	Private Sector
17.	IndusInd Bank	Private Sector
18.	Yes Bank	Private Sector
19.	IDFC First Bank	Private Sector
20.	Bank of Maharashtra	Public Sector
21.	Punjab & Sind Bank	Public Sector
22.	Indian Overseas Bank	Public Sector
23.	Oriental Bank of Commerce (merged)	Public Sector
24.	Allahabad Bank (merged)	Public Sector
25.	Andhra Bank (merged)	Public Sector
26.	Corporation Bank (merged)	Public Sector
27.	Syndicate Bank (merged)	Public Sector
28.	United Bank of India (merged)	Public Sector
29.	Dena Bank (merged)	Public Sector
30.	Vijaya Bank (merged)	Public Sector
31.	Shivalik Small Finance Bank	Private Sector
32.	Utkarsh Small Finance Bank	Private Sector
33.	Capital Small Finance Bank	Private Sector
34.	Unity Small Finance Bank	Private Sector
35.	Paytm Payments Bank	Private Sector
36.	Airtel Payments Bank	Private Sector
37.	Federal Bank	Private Sector
38.	South Indian Bank	Private Sector
39.	RBL Bank	Private Sector
40.	Bandhan Bank	Private Sector
41.	City Union Bank	Private Sector
42.	DCB Bank	Private Sector
43.	Karur Vysya Bank	Private Sector
44.	Lakshmi Vilas Bank (merged)	Private Sector
45.	Tamilnad Mercantile Bank	Private Sector
46.	Jammu & Kashmir Bank	Private Sector
47.	Karnataka Bank	Private Sector
48.	Nainital Bank	Private Sector
49.	Catholic Syrian Bank (CSB Bank)	Private Sector
50.	IDBI Bank	Private Sector
51.	Dhanlaxmi Bank	Private Sector
52.	Saraswat Bank	Private Sector
53.	Suryoday Small Finance Bank	Private Sector
54.	Ujjivan Small Finance Bank	Private Sector
55.	Equitas Small Finance Bank	Private Sector
56.	AU Small Finance Bank	Private Sector
57.	ESAF Small Finance Bank	Private Sector

Data

The dependent variable in this research is bank profitability, which is assessed using ROA and ROE. When calculating ROA, divide the net income by the total assets. On the other hand, ROE is determined by the division of the net income by the equity of the investors. The primary independent variable is a metric that quantifies the extent to which banks embrace and invest in FinTech. We have constructed a comprehensive FinTech adoption index by including many factors, which include:

1. Digital transaction volume as a percentage of total transactions
2. Number of active mobile banking users
3. Investment in digital infrastructure and technologies as a percentage of total assets
4. Number of FinTech partnerships and collaborations
5. Frequency of FinTech-related keywords in annual reports, using a method similar to Kriebel and Diebner (2019)

The FinTech-related keywords used for the textual analysis included "digital banking", "mobile banking", "UPI", "artificial intelligence", "blockchain", "cloud computing", "big data analytics", "robotic process automation", and other relevant terms specific to the Indian FinTech landscape. This comprehensive index provides a more holistic measure of FinTech adoption compared to using a single indicator. We also included several control variables such as NPL ratio, capital adequacy ratio, bank size, and macroeconomic factors like GDP growth and inflation rate.

In simple terms, DIG (annual report $_{t,i}$) = ln ($\sum_{m=1}^{M} nt$) is a statistical measure that examines the phrase frequency of a keyword in a given report. It considers the total word count of the report and the number of search terms analyzed, which was 18 in this instance.

A logarithmic transformation of the total assets is used to measure bank size (Size); cash to deposit ratio is used to measure LIQ; The solvency ratio (SOLV) is computed by dividing the overall equity of shareholders by overall assets; NPL to total loans is used to measure credit risk ratio; and CAR is calculated as follows: $\frac{\text{Tier 1+ Tier 2}}{\text{risk-weighted assets}}$. Furthermore, we made use of the GDP growth ratio and the inflation ratio (INF).

Descriptive Statistics

Below is a summary of the statistical information for the factors analyzed, as presented in Table 2.

The result displayed in Table 2 reveals that the mean and median ROA are 2.38% and 1.89%, respectively. ROA increases across the range of -28.31% to 4.58%. In banks, the ROA ratio around 1% is seen as rather acceptable (Lukosiunas, 2017). In addition, we observed that the majority of the ROA observations are positive, with just a few exceptions.

Table 2. Descriptive statistics

Statistic	SIZE	DIG	ROA	LIQ	SOLV	NPL	CAR	GDP	INF
Mean	21.798	-0.387	2.384	102.076	11.419	8.305	17.077	0.427	3.679
Median	19.311	-0.962	1.897	65.943	6.593	1.311	13.84	2.519	-0.742
Maximum	74.335	0.522	4.58	1153.67	16.709	20.94	31.962	25.562	7.813
Minimum	15.79	-49.963	-28.315	13.26	2.977	0.919	-19.067	-15.901	-1.543
Std. Dev	5.206	7.755	1.586	131.133	3.848	3.145	0.723	3.687	0.045
Skewness	0.273	-0.653	1.239	4.447	-1.038	2.251	0.945	6.002	-0.041
Kurtosis	6.063	26.388	8.05	33.148	35.333	8.476	6.167	60.731	1.94

Table 2 presents the DIG factor, which has a median value of -0.962 and a spread ranging from -49.963 to 0.522. Most of the occurrences of the value "0" were observed during the initial years of the study (2010-2013 periods) due to the limited level of digitalization commitment among the sampled banks. Their involvement in digitalization saw significant growth from 2016 to 2023.

Table 2 provides a detailed analysis of important financial and economic factors examined in this study. These factors include ROA, Digitalization (DIG), Size (SIZE), Solvency (SOLV), Liquidity (LIQ), CAR, NPL, Inflation (INF), and GDP growth. The ROA variable reveals a mean of 2.384, with a median of 1.897, indicating modest average returns but considerable performance variation, as shown by the maximum of 4.58 and minimum of -28.315, and a standard deviation of 1.586. The DIG variable, which measures digitalization, has a mean of -0.387 and a median of -0.962, highlighting a generally low engagement in digitalization with significant variability, evidenced by a standard deviation of 7.755. SIZE, representing bank size, shows a mean of 21.798 and a median of 19.311, indicating moderate variability with a standard deviation of 5.206. SOLV, measuring solvency, presents a mean of 11.419 and a median of 6.593, with moderate variability as indicated by the standard deviation of 3.848. LIQ reveals a mean of 102.076 and a median of 65.943, suggesting banks typically have adequate liquidity, although variability is high with a standard deviation of 131.133. CAR, with a mean of 17.077 and a median of 13.84, indicates that most banks meet Basel III requirements, though variability is low with an SD of 0.723. NPL has a mean of 8.305 and a median of 1.311, reflecting significant issues with non-performing loans, and moderate variability as shown by the standard deviation of 3.145. INF has a mean of 3.679 and a median of -0.742, indicating moderate inflation rates with low variability, and a standard deviation of 0.045. GDP growth shows a mean of 0.427 and a median of 2.519, representing moderate economic growth with substantial variability, demonstrated by a standard deviation of 3.687. In summary, these descriptive statistics highlight considerable variability in the financial performance and economic conditions of the sampled banks, underscoring the importance of analyzing FinTech adoption's impact on bank performance in the Indian banking area.

Evolution of the Digitalization Score

We first partitioned the DIG variable according to its constituent elements to assess the digitalization score's time variation. This division helps to address potential challenges that could affect the accurate depiction of the digitalization score's progress. Figure 1 illustrates the cumulative occurrence of every phrase observed in all the banks analyzed throughout the research period.

Figure 1. The overall frequency of all keywords related to FinTech

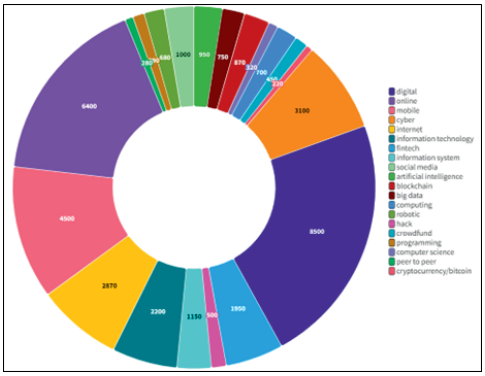
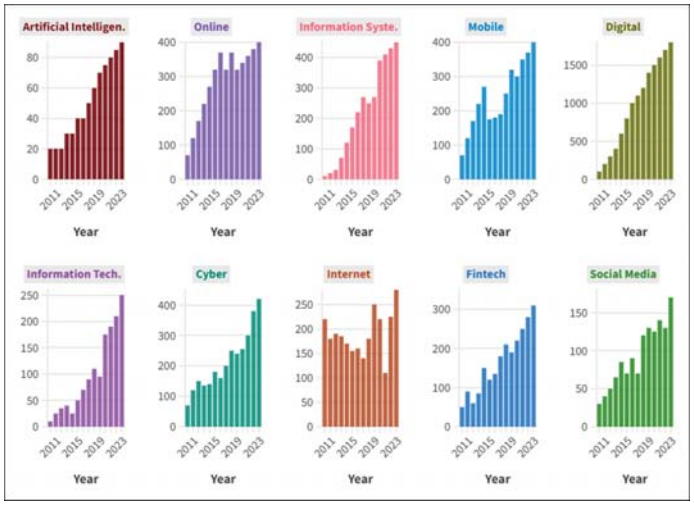


Figure 2 illustrates the development of the top ten most often used keywords from 2010 to 2023. The prevalence of the term "digital" may be ascribed to its broad and inclusive character. The term "digital" often co-occurs with several other particular terms intimately associated with the digitalization vocabulary, including "digital application", "digital banking" "digital finance", "digital payment," and "digital solutions".

Other general search terms such as "online," "mobile," and "Internet" also appear frequently and coexist with particular keywords to form new terms such as "online banking," "online brokerage," "online trading," "mobile banking,", "Internet banking", "mobile app," "mobile payment", and "Internet advisory." This analysis highlights the increasing emphasis on digitalization within the Indian banking sector, reflecting the growing adoption of FinTech solutions and their integration into traditional banking services over the study years.

Figure 2. The trend of the top ten most popular keywords throughout the period



Furthermore, a significant frequency degree was seen in the case of the term "cyber." It is possible to elucidate its significance by the growing apprehension about system security and the growing recognition of a new kind of bank risk. Alternative terms such as IT, financial technology, AI, and big data are less often used.

Our findings indicate that the majority of the digital phrases utilized display two distinct frequency levels. Keywords related to IT, information systems, social media, and AI had a historically low frequency of use over the period of 2010-2013. Nevertheless, until 2015, the frequency of these terms showed an increase (high level). This trend may be attributed to the fact that the related keywords mirror emerging financial technology and may indicate varying amounts of investment before and after 2014.

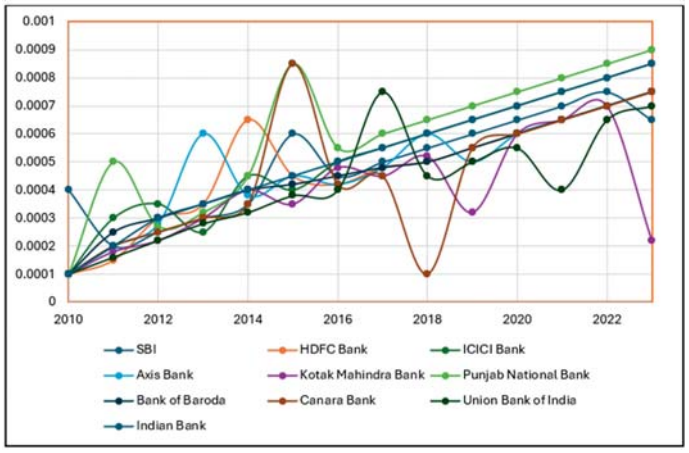
Figure 3 showcases the continuous growth of digitalization commitment for ten prominent Indian banks from 2010 to 2023. This graph accurately represents the level of digital commitment and expenditures over the years.

Figure 2 above presents the opportunity to observe a change in the series' path that began in 2015 for all evaluated banks. Therefore, it is adequate to analyze whether there was a significant change in the structure in 2015 regarding the digital factor and to assess how various stages of digital investments (high and low) impact the profit of banks

Preliminary Tests and Empirical Model

It is crucial to determine the stationarity of the factors before choosing the panel model. The stationarity test verifies the time-dependent nature of the factors..

Figure 3. The digitization commitment level of each bank



The three experiments conducted are included in (Demir et al. 2022; Suharti and Ardiansyah 2020; Mawey and Tasik 2019), and the three models used are referenced in the paper (Jünger and Mietzner 2020). The three aforementioned models are intercepted with trend, intercept alone, and no model. It is necessary for the p-value for the majority of the models in the three tests to be above 0.05 to accept the null

hypothesis for the non-stationary series. The variable that has been differentiated frequently occurs with a letter D, such as DROA, which signifies that the factor ROA has undergone variation once.

In the majority of the models, the examination of Table 3 shows that the total p values for most of the variables examined exceeded 0.05. Therefore, all the series presented in this work exhibit non-stationarity. Since none of the variables are stable, we apply a first differentiation (D) to each series and evaluate each one's stationarity to ascertain the integration order. Table 3 presents data indicating the stationarity of all the series after a single variance, demonstrating integration in sequence 1:I (1). We used the Pedroni cointegration test since every predicted series shows non-stationarity in an identical sequence. All seven cointegration evaluations in the set are illustrated in Table 4.

The majority of the tests (Buchak et al. 2018) present results that reject the null hypothesis of non-co-integration, as illustrated in Table 4. Based on the evidence, it suggests the factors are essential and there is a strong connection among them. Thus, it is appropriate to estimate the model using the FMLOS approach.

Chow Test

We used the Chow test, Gregory Chow(1960) developed, to assess the idea of a structural break based on the observed variations in the DIG variable across the time frame being studied.

The test outcomes are shown in Table 5, revealing that in 2014, the structural change hypothesis was validated. This is evident from the fact that the probability remained consistently below the significance threshold for most banks. Therefore, considering the findings of the Chow test, it is advisable to break down the examined timeframe into two distinct sub-periods: 2010-2016 and 2017-2023.

Table 3. Results of the Stationarity test

Variables	None			Intercept			Intercept & Trend		
	PP: Fisher	ADF	Levin & Lin	PP: Fisher	ADF	Levin & Lin	PP: Fisher	ADF	Levin & Lin
DROA	25.800 (0.001)***	23.600 (0.003)***	-3.573 (0.005)***	26.081 (0.001)***	10.987 (0.038)**	-4.007 (0.065)**	0.814 (0.281)	-0.539 (0.065)**	-1.868 (0.065)**
ROA	85.012 (0.123)	88.221 (0.098)	-4.177 (0.065)*	88.308 (0.138)	20.456 (0.154)	-4.172 (0.097)*	0.679 (0.281)	-0.112 (0.083)**	-0.539 (0.065)**
DIG	35.192 (0.001)***	32.315 (0.003)***	-2.131 (0.010)**	41.699 (0.001)***	9.486 (0.034)**	-3.107 (0.065)**	0.652 (0.281)	-0.865 (0.065)**	-1.868 (0.065)**
DDIG	40.315 (0.001)***	28.315 (0.003)***	-1.431 (0.020)**	46.002 (0.001)***	8.935 (0.032)**	-3.107 (0.065)**	0.868 (0.281)	-1.868 (0.065)**	-1.868 (0.065)**
SIZE	28.517 (0.001)***	26.700 (0.003)***	-2.131 (0.010)**	38.423 (0.001)***	8.495 (0.031)**	-2.462 (0.065)**	0.944 (0.281)	-0.944 (0.065)**	-0.944 (0.065)**
DSIZE	22.317 (0.001)***	20.888 (0.003)***	-1.849 (0.020)**	34.423 (0.001)***	7.605 (0.029)**	-1.984 (0.065)**	0.894 (0.281)	-0.894 (0.065)**	-0.894 (0.065)**
CAR	19.988 (0.001)***	18.988 (0.003)***	-1.489 (0.020)**	24.423 (0.001)***	6.075 (0.027)**	-1.860 (0.065)**	0.636 (0.281)	-1.636 (0.065)**	-1.636 (0.065)**
DCAR	14.895 (0.001)***	13.902 (0.003)***	-2.260 (0.099)**	14.200 (0.001)***	5.181 (0.025)**	-1.781 (0.065)**	0.655 (0.281)	-0.655 (0.065)**	-0.655 (0.065)**
SOLV	16.011 (0.001)***	17.081 (0.003)***	-3.098 (0.000)***	57.137 (0.001)***	38.650 (0.000)***	-3.650 (0.000)***	0.800 (0.281)	-1.800 (0.065)**	-1.800 (0.065)**

Variables	None			Intercept			Intercept & Trend		
	PP: Fisher	ADF	Levin & Lin	PP: Fisher	ADF	Levin & Lin	PP: Fisher	ADF	Levin & Lin
DSOLV	25.865 (0.001)***	21.706 (0.003)***	-3.098 (0.000)***	17.610 (0.001)***	16.049 (0.000)***	-3.049 (0.000)***	0.750 (0.281)	-1.750 (0.065)**	-1.750 (0.065)**
LIQ	96.858 (0.001)***	66.011 (0.003)***	-4.131 (0.000)***	20.865 (0.001)***	10.251 (0.000)***	-4.251 (0.000)***	0.655 (0.281)	-1.655 (0.065)**	-1.655 (0.065)**
DLIQ	86.012 (0.001)***	55.221 (0.003)***	-3.177 (0.000)***	40.308 (0.001)***	20.456 (0.000)***	-4.172 (0.000)***	0.879 (0.281)	-1.112 (0.065)**	-1.539 (0.065)**
NPL	75.800 (0.001)***	53.600 (0.003)***	-2.573 (0.000)***	36.081 (0.001)***	15.987 (0.000)***	-3.007 (0.000)***	0.814 (0.281)	-1.539 (0.065)**	-1.865 (0.065)**
DNPL	65.192 (0.001)***	42.315 (0.003)***	-1.431 (0.020)**	31.699 (0.001)***	19.486 (0.000)***	-3.107 (0.000)***	0.652 (0.281)	-1.865 (0.065)**	-1.868 (0.065)**
INF	50.315 (0.001)***	38.315 (0.003)***	-1.431 (0.020)**	26.002 (0.001)***	18.935 (0.000)***	-3.107 (0.000)***	0.868 (0.281)	-1.868 (0.065)**	-1.868 (0.065)**
DINF	40.517 (0.001)***	28.700 (0.003)***	-2.131 (0.010)**	28.423 (0.001)***	15.495 (0.000)***	-2.462 (0.000)***	0.944 (0.281)	-1.944 (0.065)**	-1.944 (0.065)**
GDP	30.317 (0.001)***	26.888 (0.003)***	-1.849 (0.020)**	24.423 (0.001)***	17.605 (0.000)***	-1.984 (0.000)***	0.894 (0.281)	-1.894 (0.065)**	-1.894 (0.065)**
DGDP	29.988 (0.001)***	20.988 (0.003)***	-1.489 (0.020)**	20.423 (0.001)***	16.075 (0.000)***	-1.860 (0.000)***	0.636 (0.281)	-1.636 (0.065)**	-1.636 (0.065)**

Table 4. Results of the Cointegration test

Test	No Deterministic Intercept or Trends		Deterministic Intercept and Trends		No Deterministic Trends	
	Stat	Pb	Stat	Pb	Stat	Pb
Group ADF-Stat	-5.127	0.00***	-3.962	0.00***	-3.89	0.00***
Group PP-Stat	-6.119	0.00***	-35.154	0.00***	-13	0.00***
Group rho-Stat	3.746	0.99	7.832	1	4.658	1
Panel PP-Stat	-5.285	0.00***	-5.238	0.00***	-8.47	0.00***
Panel rho-Stat	-6.027	0.00***	2.519	1	4.029	1
Panel ADF-Stat	-5.532	0.00***	-6.927	0.00***	-5.16	0.00***
Panel v-Stat	-1.749	0.99	-3.815	1	-4.284	0.97

At the 10%, 5%, and 1% levels, respectively, *,**, and *** show the rejection of non-co-integration.

Empirical Model

The present work used completely modified ordinary least squares for the purpose of estimate. We chose this calculation method as most of the predicted series exhibit non-stationarity with comparable degrees of trend stability, and all of the variables in the study are cointegrated.

This study estimated two models to investigate the relationship between financial success (as calculated by ROA) and investment in FinTech. The first research looked at the influence of DIG on operational performance. In the next method, we incorporated the interaction variable DIG*SIZE to examine the potential impact of bank size on the relationship between technological investment and performance. Both models contained control variables such as INF, NPL, SOLV, CAR, SIZE, LIQ, and GDP growth. Afterward, we performed estimates for three distinct time periods: the entire time frame, the initial sub-period, and the subsequent subperiod. The first sub-period exhibits a more limited level of digitalization compared to the more advanced digitalization seen in the second sub-period.

Table 5. Results of Chow test

Bank	Prob. F	Break-point	Bank	Prob. F	Break-point
1	0.0556*	2015	29	0.0047**	2015
2	0.0092**	2016	30	0.8412	2022
3	0.0655*	2014	31	0.0814*	2016
4	0.0784*	2015	32	0.0115**	2017
5	0.0031**	2021	33	0.0145**	2018
6	0.0192**	2014	34	0.0210**	2014
7	0.0167**	2021	35	0.0524**	2019
8	0.0981*	2010	36	0.0012***	2014
9	0.0346**	2014	37	0.0035**	2020
10	0.0346**	2014	38	0.34	2014
11	0.0220**	2014	39	0.0569*	2014
12	0.0383**	2014	40	0.0383**	2023
13	0.0047**	2014	41	0.0556*	2017
14	0.8318	2019	42	0.0092**	2016
15	0.0779*	2014	43	0.0566*	2015
16	0.0105**	2012	44	0.0734*	2014
17	0.0071**	2014	45	0.0027**	2014
18	0.0152**	2013	46	0.0188**	2015
19	0.0441**	2014	47	0.0167**	2018
20	0.0009***	2014	48	0.0981*	2016
21	0.0022**	2011	49	0.0346**	2017
22	0.34	2014	50	0.0346**	2014
23	0.0584*	2015	51	0.0220**	2021
24	0.0383**	2019	52	0.0383**	2018
25	0.0615*	2016	53	0.0556*	2016
26	0.0112**	2020	54	0.0092**	2015
27	0.0612*	2013	55	0.0566*	2013
28	0.0762*	2015	56	0.0734*	2015
29	0.0035**	2023	57	0.0027**	2023

The FMOLS model depends on the following panel regression method:

$$Y_{it} = \alpha_i + \beta X_{it} + e_{it} \quad (1)$$

$$X_{it} = X_{it-1} + \varepsilon_{it}$$

Where, error terms are denoted ε and e and

$i = 1,2, \ldots 23, t = 2010, \ldots, 2023.$

Y_{it} is the dependent variable $(ROA_{it}), X_{it}$

is the vector of exogenous variables $(DIG_{it}, SIZE_{it}, SOLV_{it}, LIQ_{it}, CAR_{it}, NPL_{it}, INF_{it}, GDP_{it})$.

α_i is a factor that describes the uniqueness of banks.

The calculation of the β estimator is as follows:

$$\beta^*_{NT} = N^{-1} \sum_{i=1}^{N} \left(\sum_{t=1}^{T} (X_{it} - \bar{X}_i)^2 \right)^{-1} \times$$

$$(\sum_{t=1}^{T} (X_{it} - \bar{X}_i)^2 Y^*_{it} - T\hat{\tau}_i) \quad (2)$$

$$Y^*_{it} = (Y_{it} - \bar{Y}_i) - \frac{\hat{L}_{21i}}{\hat{L}_{22i}} \Delta X_{it} \text{ where } \hat{\tau}_i = \hat{\Gamma}_{21i} + \Omega^0_{21i} - \frac{\hat{L}_{21i}}{\hat{L}_{22i}} (\hat{\Gamma}_{22i} - \Omega^0_{22i})$$

Here, the long-run covariance matrix is denoted by $\Omega_i = \Omega^0_i + \Gamma_i + \Gamma'_i$.

We ran a correlation test to find any correlations between the variables that can bias the findings before running the model we estimated.

Analysis of the correlation matrix (Table 6) reveals that all correlation coefficients are below 0.5, suggesting a lack of significant association between the factors. Therefore, our estimating model is deemed valid.

Table 6. Correlation matrix

	LIQ	SOLV	DIG	SIZE	CAR	NPL	INF	GDP
LIQ	1							
SOLV	-0.028	1						
DIG	0.004	-0.042	1					
SIZE	-0.036	-0.445	0.026	1				
CAR	-0.235	0.002	0.000	-0.094	1			
NPL	-0.058	0.068	0.024	-0.037	-0.426	1		
INF	0.096	0.031	-0.065	-0.056	-0.121	0.108	1	
GDP	-0.071	-0.032	0.034	0.021	0.115	0.091	-0.263	1

Results and Discussion

Result Analysis

This work analyzes the influence of technological investment on ROA. In addition, we analyzed how the size of banks and their level of technology adoption affect the relationship between FinTech investment and ROA. We calculated the methods for the whole 2010–2023 period as well as for the 2010–2016 and 2017–2023 sub-periods. The outcome of the model's calculation can be found in Table 7.

Examination of Table 7 indicates that the R-squared values in all the calculated frameworks exceed 85%. We are inclined to conclude that all of the estimates of these frameworks are of high quality, as R-squared approaches 1. Considering the p-value, we observed that the majority of variables exhibit statistical significance at the 1%, 5%, and 10% levels. The capital adequacy ratio is the only factor which lacks significance in most of the models, with the exception of the low-level expenditure phase.

Table 7. Estimation result Analysis

Variables	Total period (2010-2023)		Low level of investment (2010 to 2016)		High level of investment (2017 to 2023)	
	Model 1	Model 2	Model 1	Model 2	Model 1	Model 2
SIZE	0.559*** (0.000)	0.326*** (0.000)	3.564*** (0.000)	2.132*** (0.000)	2.682** (0.039)	2.314** (0.049)
CAR	-2.139 (0.173)	-2.698 (0.225)	-1.457* (0.093)	-2.145* (0.071)	-2.114 (0.287)	-1.0456 (0.489)
SOLV	3.127*** (0.000)	2.948** (0.032)	3.754* (0.049)	1.114* (0.069)	2.165*** (0.000)	3.854*** (0.004)

Variables	Total period (2010-2023)		Low level of investment (2010 to 2016)		High level of investment (2017 to 2023)	
	Model 1	Model 2	Model 1	Model 2	Model 1	Model 2
DIG	6.089*** (0.000)	5.234*** (0.000)	2.152* (0.084)	3.321* (0.087)	7.785*** (0.000)	6.352*** (0.000)
LIQ	-2.813*** (0.000)	-1.022*** (0.000)	-2.894* (0.074)	-1.658* (0.055)	-3.235*** (0.000)	-2.657*** (0.000)
DIG X		2.045*** (0.000)	-	2.536*** (0.000)	-	2.015*** (0.000)
INF	-0.062** (0.016)	-0.043** (0.031)	-0.073** (0.053)	-0.091** (0.042)	-0.053** (0.035)	-0.075** (0.000)
NPL	-0.071** (0.043)	-0.239** (0.025)	-0.072** (0.032)	-0.081** (0.055)	-0.081** (0.023)	-0.082** (0.043)
GDP	0.031** (0.024)**	0.031** (0.022)	0.041*** (0.000)	0.052*** (0.000)	0.135*** (0.000)	0.258*** (0.000)
Adjusted - squared	0.811779	0.827918	0.767635	0.761345	0.787443	0.812387
Observations	225	225	110	110	110	110
R-squared	0.826763	0.819643	0.745535	0.974831	0.812345	0.833143

Indeed, the coefficient prediction of the DIG has statistical significance and a positive correlation with bank performance. Furthermore, our findings indicate that the impact of investing in FinTech is more pronounced at higher levels. The level-low investment coefficient (2.152) is lower than the high-level investment coefficient (7.785) in the first model. In the second model, the density of interest (DIG) coefficient was 6.352 at the high level and 3.321 at the low investment period. Additionally, it was observed that the DIG coefficients have a greater impact during times of high investment than during periods of low investment. The threshold for statistical significance is 12% in the low investment phase, but it drops to just 2% during periods of high investment.

The findings from the estimate of interaction terms under the time periods of 2010-2023, 2010-2016, and 2017-2023 demonstrate a positive and substantial impact of bank size on the relationship between FinTech investment and financial performance. Furthermore, the inclusion of the interaction component enhances the accuracy of the estimate since the R-squared value rises in all time periods. Our analysis of the control factors reveals that the liquidity ratio consistently has a statistically significant impact, showing an inverse relationship with the bank's performance. There exists a positive and substantial correlation between solvency and the financial performance of a bank. The capital adequacy ratio is not statistically significant in most cases, but during the low investment period, it significantly negatively affects the bank's financial performance, with an impact of 12%. The NPL ratio exerts a notable negative effect on the profitability of banks. The size coefficient significantly and positively influences the bank's financial performance. Through our analysis of macroeconomic circumstances, we have determined that inflation has a detrimental and substantial impact on bank profitability.

Discussions

The results reveal that a higher level of FinTech adoption markedly boosts banks' financial profitability. The obtained outcome confirms our premise that advancements in financial technology improve the profitability of Indian banks. In accordance with the findings of (Alsahlawi 2021; Utomo, Prasaja, and Rahmawati 2024; Cappa et al. 2022), our results show that FinTech strengthens banks' financial performance by encouraging the implementation of better efficient business models, lowering operational expenses, and enhancing the effectiveness of service.

Also, our analysis highlights the moderating role that bank size plays in the interaction between FinTech adoption and operational performance. Larger banks get more advantages from FinTech investments due to their possession of the requisite resources and skills to efficiently execute and oversee digital initiatives. This result is consistent with the assertion made by (Rehman et al. 2023), which posits that larger banks possess the ability to invest in and oversee new digital initiatives more effectively than smaller banks. Additionally, bigger banks may diversify the risks linked to FinTech initiatives and use specialist resources such as marketing and IT infrastructure. The examination of control factors indicates that liquidity negatively impacts financial profitability. This is because high liquidity ratios suggest an abundance of cash reserves, which restrict future investment prospects. Banking performance is adversely affected by credit risk, which is quantified by non-performing loans, as a result of the detrimental consequences of client defaults on the balance sheet and income statement. Analysis reveals that inflation is inversely correlated with bank success, as the increase in interest rates and expenses surpasses the rise in income. In contrast, the rise of GDP has a beneficial impact on the profitability of banks by augmenting the demand for loans and deposits during periods of growth in the economy.

These findings support the notion that more widespread use of fintech improves banks' financial performance, with a greater impact on bigger banks. In addition, the financial performance of Indian banks is significantly influenced by factors such as liquidity, credit risk, inflation, and GDP. The results of this study have significant consequences for bank strategy and policy, indicating that greater allocation of resources towards FinTech might improve bank performance, especially for bigger institutions.

Conclusion

This study primarily aims to explore how bank size influences the effect of FinTech adoption on the profitability of banks in India. Two distinct sub-periods of the study period, namely 2010–2016 and 2017–2023, have been examined using econometric tests including stationarity, cointegration, and structural break analysis. The year 2016 saw a significant transformation in the digital financial landscape of India due to the implementation of demonetization. In this study, we use the FMOLS estimation technique. Our analysis reveals a significant and robust positive relationship between FinTech incorporation and bank performance in both sub-periods. The association is particularly pronounced from 2017 to 2023. Additionally, across all the time periods examined, size serves as a moderating factor that influences the link between profitability and digital investments. Consequently, this results in the following validation of hypotheses 1 and 2.

The results of this work enhance our understanding of the current knowledge base, clearly showing that the Indian subcontinent has achieved significant advancements in financial technology. In addition, this study suggests that FinTech also improves bank performance. Furthermore, our results suggest that the size of a bank has an influence on the correlation between its financial performance and its allocation of resources towards financial technology. The key policy implications of our results are that banks engaged in digitalization could improve their performance by increasing their investments in FinTech, especially in bigger institutions. Thus, these findings are important for the Basel Committee and regulators, as they highlight the beneficial effect of FinTech on the profitability of banks.

References

- Almashhadani, H. A., and Almashhadani, M. 2022. "The Impact of Financial Technology on Banking Performance: A Study on Foreign Banks in UAE." International Journal of Scientific and Management Research 6(1): 1–21.
- Almulla, D., and Aljughaiman, A. A. 2021. "Does Financial Technology Matter? Evidence from an Alternative Banking System." Cogent Economics & Finance 9(1): 1934978.
- Aloulou, M., Grati, R., Al-Qudah, A. A., and 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.
- Alsahlawi, A. M. 2021. "The Role of Hedging and Derivatives Techniques and Fintech Adoption on Financial Risk Management in Saudi Banks." Cuadernos de Economía 44(126): 10–22.
- Alshari, H. A., and Lokhande, M. A. 2022. "Merits of Adopting FinTech and Their Impact on the Banks' Performance in the Least Developed Countries." International Journal of Mechanical Engineering 7(5): 695–714.
- Alshari, H. A., and Lokhande, M. A. 2023. "Analysis of Constraints and Their Impact on Adopting Digital FinTech Techniques in Banks." Electronic Commerce Research: 1–34.
- Al-Shari, H. A., and Lokhande, M. A. 2023. "The Relationship Between the Risks of Adopting FinTech in Banks and Their Impact on the Performance." Cogent Business & Management 10(1): 2174242.
- Alshehadeh, A. R., and Al-Khawaja, H. A. 2022. "Financial Technology as a Basis for Financial Inclusion and Its Impact on Profitability: Evidence from Commercial Banks." International Journal of Advances in Soft Computing & Its Applications 14(2).
- Alsmadi, A. A., Alrawashdeh, N., Al-Gasaymeh, A., Al-Malahmeh, H., and Moh'd Al_hazimeh, A. 2023. "Impact of Business Enablers on Banking Performance: A Moderating Role of Fintech." Banks and Bank Systems 18(1): 14–25.
- Assefa, G. 2024. "The Influence of Financial Technology (Fintech) on Banking Efficiency in Developing Economies in Ethiopia." International Journal of Finance and Accounting 9(3): 62–73.
- Aysan, A. F., Belatik, A., Unal, I. M., and Ettaai, R. 2022. "Fintech Strategies of Islamic Banks: A Global Empirical Analysis." FinTech 1(2): 206–215.
- Aysan, A. F., Belatik, A., Unal, I. M., and Ettaai, R. 2022. "Fintech Strategies of Islamic Banks: A Global Empirical Analysis." FinTech 1(2): 206–215.
- Baker, H., Kaddumi, T. A., Nassar, M. D., and Muqattash, R. S. 2023. "Impact of Financial Technology on Improvement of Banks' Financial Performance." Journal of Risk and Financial Management 16(4): 230.
- Baker, H., Kaddumi, T. A., Nassar, M. D., and Muqattash, R. S. 2023. "Impact of Financial Technology on Improvement of Banks' Financial Performance." Journal of Risk and Financial Management 16(4): 230.
- Beltrame, F., Zorzi, G., and Grassetti, L. 2022. "The Effect of FinTech Investments on Listed Banks: Evidence from an Italian Sample." Risk Governance & Control: Financial Markets & Institutions 12(2): 47–55.
- Bousrih, J. 2023. "The Impact of Digitalization on the Banking Sector: Evidence from Fintech Countries." Asian Economic and Financial Review 13(4): 269–278.
- Buchak, G., Matvos, G., Piskorski, T., and Seru, A. 2018. "Fintech, Regulatory Arbitrage, and the Rise of Shadow Banks." Journal of Financial Economics 130(3): 453–483.
- Cappa, F., Collevecchio, F., Oriani, R., and Peruffo, E. 2022. "Banks Responding to the Digital Surge through Open Innovation: Stock Market Performance Effects of M&As with Fintech Firms." Journal of Economics and Business 121: 106079.
- Carbó-Valverde, S., Cuadros-Solas, P. J., and Rodríguez-Fernández, F. 2021. "FinTech and Banking: An Evolving Relationship." In Disruptive Technology in Banking and Finance: An International Perspective on FinTech, 161–194.
- Chan, R., Troshani, I., Rao Hill, S., and Hoffmann, A.

2022. "Towards an Understanding of Consumers' FinTech Adoption: The Case of Open Banking." International Journal of Bank Marketing 40(4): 886–917.

- Chen, B., Yang, X., and Ma, Z. 2022. "Fintech and Financial Risks of Systemically Important Commercial Banks in China: An Inverted U-Shaped Relationship." Sustainability 14(10): 5912.
- Chen, X., You, X., and Chang, V. 2021. "FinTech and Commercial Banks' Performance in China: A Leap Forward or Survival of the Fittest?" Technological Forecasting and Social Change 166: 120645.
- Chow, G. C. 1960. "Tests of Equality between Sets of Coefficients in Two Linear Regressions." Econometrica: Journal of the Econometric Society, 591–605.
- Chuc, A. A. M., Atayah, A. A., and Özer, S. Q. 2023. "Impact of Financial Technology (FinTech) on Financial Performance of Micro Finance Institutions in Bahrain." African Journal of Emerging Issues 5(17): 1–11.
- Demir, A., Pesqué-Cela, V., Altunbas, Y., and Murinde, V. 2022. "Fintech, Financial Inclusion and Income Inequality: A Quantile Regression Approach." The European Journal of Finance 28(1): 86–107.
- Deng, L., Lv, Y., Liu, Y., and Zhao, Y. 2021. "Impact of Fintech on Bank Risk-Taking: Evidence from China." Risks 9(5): 99.
- Dwivedi, P., Alabdooli, J. I., and Dwivedi, R. 2021. "Role of FinTech Adoption for Competitiveness and Performance of the Bank: A Study of Banking Industry in UAE." International Journal of Global Business and Competitiveness 16(2): 130–138.
- Guo, L., and Zhu, K. 2022. "FinTech, Bank Risks, and Business Performance: From the Perspective of Inclusive Finance." China Economic Transition = Dangdai Zhongguo Jingji Zhuanxing Yanjiu 5(2): 242–261.
- Harsono, I., and Suprapti, I. A. P. 2024. "The Role of Fintech in Transforming Traditional Financial Services." Accounting Studies and Tax Journal (COUNT) 1(1): 81–91.
- Hu, D., Zhao, S., and Yang, F. 2024. "Will Fintech Development Increase Commercial Banks' Risk-Taking? Evidence from China." Electronic Commerce Research 24(1): 37–67.
- Huang, A., and Tan, D. 2024. "The Study and Overview of FinTech's Impacts on the Risk-Taking of the Traditional Bank Industry." Theoretical Economics Letters 14(4): 1441–1454.
- Hui, Z. 2022. Analysis of the Differences between the US Financial Market and the Chinese Financial Market. (No journal or publisher provided.)
- Igor'B, T., and Shashkina, E. O. 2023. "Methodological Approach to the Assessment of the National Banking Sector Transformation under the Influence of Fintech." RUDN Journal of Economics 31(2): 299–315.
- Jefri, R., Surianto, N. M., Putra, W. K. E., and Novitasari, M. 2024. "Impact of Financial Technology on the Financial Performance of Conventional Banks in Indonesia." Jurnal Ilmiah Akuntansi 9(1).
- Jünger, M., and Mietzner, M. 2020. "Banking Goes Digital: The Adoption of FinTech Services by German Households." Finance Research Letters 34: 101260.
- Kaddumi, T. A., Baker, H., Nassar, M. D., and A-Kilani, Q. 2023. "Does Financial Technology Adoption Influence Bank's Financial Performance: The Case of Jordan." Journal of Risk and Financial Management 16(9): 413.
- Karthika, M., Neethu, K., and Lakshmi, P. 2022. "Impact of Fintech on the Banking Sector." Integrated Journal for Research in Arts and Humanities 2(4): 109–112.
- Katsiampa, P., McGuinness, P. B., Serbera, J. P., and Zhao, K. 2022. "The Financial and Prudential Performance of Chinese Banks and Fintech Lenders in the Era of Digitalization." Review of Quantitative Finance and Accounting 58(4): 1451–1503.
- Khan, H. H., Khan, S., and Ghafoor, A. 2023. "Fintech Adoption, the Regulatory Environment and Bank Stability: An Empirical Investigation from GCC Economies." Borsa Istanbul Review 23(6): 1263–1281.
- Kharrat, H., Trichilli, Y., and Abbes, B. 2024. "Relationship Between FinTech Index and Bank's

Performance: A Comparative Study Between Islamic and Conventional Banks in the MENA Region." Journal of Islamic Accounting and Business Research 15(1): 172–195.

- Kriebel, J., and Debener, J. 2019. "The Effect of Digital Transformation on Bank Performance." SSRN. https://ssrn.com/abstract=3461594
- Kurniawati, R. 2023. "The Influence of Fintech and Banks Collaboration towards Banks Performance: Indonesian Banks Listed." Journal of Business Management and Social Studies 2(4): 166–174.
- Lamine, H. A. N. I. 2024. "The Effects of Fintech on the Performance of Islamic Banks in Africa." Remittances Review 9(1): 1669–1682.
- Le, T. T., Mai, H. N., Phan, D. T., Nguyen, M. N., and Le, H. D. 2021. "Fintech Innovations: The Impact of Mobile Banking Apps on Bank Performance in Vietnam." International Journal of Research and Review 8(4): 391–401.
- Lee, C. C., Li, X., Yu, C. H., and Zhao, J. 2021. "Does Fintech Innovation Improve Bank Efficiency? Evidence from China's Banking Industry." International Review of Economics & Finance 74: 468–483.
- Li, G., Elahi, E., and Zhao, L. 2022. "Fintech, Bank Risk-Taking, and Risk-Warning for Commercial Banks in the Era of Digital Technology." Frontiers in Psychology 13: 934053.
- Mawey, K., and Tasik, H. 2019. "Analysis of the Effect of Interest Rate on Loan and Financial Loan in the Presence of Fintech in Indonesia." Jurnal EMBA: Jurnal Riset Ekonomi, Manajemen, Bisnis dan Akuntansi 7(3).
- Medyawati, H., Yunanto, M., and Hegarini, E. 2021. "Financial Technology as Determinants of Bank Profitability." Journal of Economics, Finance and Accounting Studies 3(2): 91–100.
- Melnyk, M., Kuchkin, M., and Blyznyukov, A. 2022. "Commercial Banks: Traditional Banking Models vs. FinTechs Solutions." (No journal name or volume provided).
- Meyer, D., and Okoli, T. T. 2023. "Financial Technology Development: Implications for Traditional Banks in Africa." Investment Management and Financial Innovations 20(3): 166–176.
- Mirza, N., Umar, M., Afzal, A., and Firdousi, S. F. 2023. "The Role of Fintech in Promoting Green Finance, and Profitability: Evidence from the Banking Sector in the Euro Zone." Economic Analysis and Policy 78: 33–40.
- Moşteanu, D. N. R., Faccia, D. A., Cavaliere, L. P. L., and Bhatia, S. 2020. "Digital Technologies' Implementation within Financial and Banking System during Socio Distancing Restrictions–Back to the Future." International Journal of Advanced Research in Engineering and Technology 11(6).
- Muda, R., Lateff, M. S. M., Arshad, R., Rashdan, A. A., Oladapo, I. A., and Othman, J. 2021. "Does Fintech Revolution Lead to the Disintermediation of Banks? A Study into Islamic Bank Income." In Fintech, Digital Currency and the Future of Islamic Finance: Strategic, Regulatory and Adoption Issues in the Gulf Cooperation Council, 169–185.
- Murinde, V., Rizopoulos, E., and Zachariadis, M. 2022. "The Impact of the FinTech Revolution on the Future of Banking: Opportunities and Risks." International Review of Financial Analysis 81: 102103.
- Nguyen, L., Tran, S., and Ho, T. 2022. "Fintech Credit, Bank Regulations and Bank Performance: A Cross-Country Analysis." Asia-Pacific Journal of Business Administration 14(4): 445–466.
- Nugroho, H. H., and Sugiyanto, F. X. 2023. "The Impact of Financial Technology on Banking Profitability." Ikraith-Ekonomika 6(2): 255–264.
- Ojor, S. O., Nwoha, C. E., and Okwo, I. M. 2023. "Effect of Financial Technology (FinTech) on Corporate Performance of Banks in Nigeria, 2009 to 2021." British International Journal of Applied Economics, Finance and Accounting 7(4): 14–33.
- Otonne, A., and Ige, O. T. 2023. "Exploring the Influence of Financial Technology on Banking Services in Nigeria." International Journal of Financial, Accounting, and Management 5(3): 323–341.
- Otonne, A., Melikam, W., and Ige, O. T. 2023. "Adoption of Financial Technology and Performance of

Deposit Money Banks in Nigeria." Futurity Economics & Law 3(2): 95–114.

- Rahman, M. M. 2023. "The Effect of Business Intelligence on Bank Operational Efficiency and Perceptions of Profitability." FinTech 2(1): 99–119.
- Rehman, S. U., Al-Shaikh, M., Washington, P. B., Lee, E., Song, Z., Abu-AlSondos, I. A., and Allahham, M. 2023. "FinTech Adoption in SMEs and Bank Credit Supplies: A Study on Manufacturing SMEs." Economies 11(8): 213.
- Sajid, R., Ayub, H., Malik, B. F., and Ellahi, A. 2023. "The Role of Fintech on Bank Risk-Taking: Mediating Role of Bank's Operating Efficiency." Human Behavior and Emerging Technologies 2023(1): 7059307.
- Singh, R., Malik, G., and Jain, V. 2021. "FinTech Effect: Measuring the Impact of FinTech Adoption on Banks' Profitability." International Journal of Management Practice 14(4): 411–427.
- Siska, E., Kuspriyono, T., and Sebastian, D. R. 2023. "Analyzing the Effect of Stock Market Capitalization and Financial Technology Adoption on Bank Profitability." Jurnal Apresiasi Ekonomi 11(2): 272–282.
- Song, X., Yu, H., and He, Z. 2023. "Heterogeneous Impact of Fintech on the Profitability of Commercial Banks: Competition and Spillover Effects." Journal of Risk and Financial Management 16(11): 471.
- Suharti, E., and Ardiansyah, T. E. 2020. "Fintech Implementation on the Financial Performance of Rural Credit Banks." Jurnal Akuntansi 24(2): 234–249.
- Sunardi, N., and Tatariyanto, F. 2023. "The Impact of the COVID-19 Pandemic and FinTech Adoption on Financial Performance Moderating by Capital Adequacy." International Journal of Islamic Business and Management Review 3(1): 102–118.
- Utomo, A. S., Prasaja, M. G., and Rahmawati, N. F. 2024. "The Impact of Blockchain Technology to the Efficiency and Profitability Bank in Indonesia." Al-Kharaj: Journal of Islamic Economic and Business 6(2).
- Wang, R., Liu, J., and Luo, H. 2021. "Fintech Development and Bank Risk Taking in China." The European Journal of Finance 27(4–5): 397–418.
- Wang, Y., Yu, X., Yao, Q., Lu, Y., Che, W., Jiang, J., and Chen, S. C. I. 2024. "Assessing the Impact of Financial Technology Innovations on the Sustainable Profitability of Listed Commercial Banks in China." FinTech 3(3): 337–348.
- Wilter, M. M., Kambura, M. S., and Mugoche, M. A. 2023. "Effect of Adoption of Fintech Payments on Financial Performance of Commercial Banks in Meru County, Kenya." International Research Journal of Economics and Finance 5(3).
- Wu, X., Jin, T., Yang, K., and Qi, H. 2023. "The Impact of Bank FinTech on Commercial Banks' Risk-Taking in China." International Review of Financial Analysis 90: 102944.
- Yao, T., and Song, L. 2021. "Examining the Differences in the Impact of Fintech on the Economic Capital of Commercial Banks' Market Risk: Evidence from a Panel System GMM Analysis." Applied Economics 53(23): 2647–2660.
- Yoon, S. S., Lee, H., and Oh, I. 2023. "Differential Impact of Fintech and GDP on Bank Performance: Global Evidence." Journal of Risk and Financial Management 16(7): 304.
- Yunita, P. 2021. "The Digital Banking Profitability Challenges: Are They Different Between Conventional and Islamic Banks?" Jurnal Akuntansi dan Keuangan Indonesia 18(1): 4.
- Zhao, J., Li, X., Yu, C. H., Chen, S., and Lee, C. C. 2022. "Riding the FinTech Innovation Wave: FinTech, Patents and Bank Performance." Journal of International Money and Finance 122: 102552.
- Zheng, C., Rahman, M. A., Hossain, S., and Moudud-Ul-Huq, S. 2023. "Does Fintech-Driven Inclusive Finance Induce Bank Profitability? Empirical Evidence from Developing Countries." Journal of Risk and Financial Management 16(10): 457.