

## Research Article

# The Role of Fintech on Bank Risk-Taking: Mediating Role of Bank's Operating Efficiency

Rabbia Sajid <sup>1</sup>, Huma Ayub <sup>1</sup>, Bushra F. Malik <sup>2</sup>, and Abida Ellahi <sup>3</sup>

<sup>1</sup>Department of Business Administration, Fatima Jinnah Women University, Pakistan

<sup>2</sup>Department of Business Analytics, Lewis University, Romeoville, IL, USA

<sup>3</sup>Department of Management Science, Abbottabad University of Science & Technology, Pakistan

Correspondence should be addressed to Abida Ellahi; [abia.ell@gmail.com](mailto:abia.ell@gmail.com)

Received 23 September 2022; Revised 12 November 2022; Accepted 20 December 2022; Published 30 January 2023

Academic Editor: Zheng Yan

Copyright © 2023 Rabbia Sajid et al. This is an open access article distributed under the Creative Commons Attribution License, which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited.

Fintech revolutionized the traditional banking business models in emerging countries. The effect of fintech on banks' operating efficiency and risk-taking behavior is still inconclusive. The study is aimed at exploring the effect of fintech products on banks' operating efficiency and risk-taking behavior. The study used a quantitative research approach by collecting secondary data from annual reports of 50 commercial banks from emerging countries, namely, China, India, Pakistan, and Bangladesh, for the period 2014 to 2021. The study used panel data for path analysis and structural equation modeling (SEM) to test the theoretical mediation model by using STATA. The results show that the fintech product reduces the bank's risk-taking behavior by enhancing the bank's operating efficiency. The path analysis results show that operating efficiency mediates the relationship between fintech products and bank risk-taking behavior in emerging countries. The paper offers useful recommendations for central bank and commercial bank policymakers. The study is also beneficial for commercial banks that use fintech solutions to increase operational effectiveness and reduce risk. The study is the first empirical investigation into the connection between the growth of fintech products, bank operational effectiveness, and risk-taking behavior in developing nations.

## 1. Introduction

The global financial industry has been rapidly changing with the advancement of financial technology over the last few years. New emerging technologies such as Internet finance, blockchain, and mobile banking are penetrating, forming the fintech that revolutionized the whole financial industry. It offered lower-cost services with more choices for consumers to buy financial services that shift their financial behavior to digitalization. The rise of financial technology (fintech) has brought about significant changes in the financial industry, including the way banks manage risk. Fintech has introduced new tools and technologies that enable banks to more accurately assess and manage risk, as well as new business models that challenge traditional approaches to risk-taking.

The pace of fintech development in developed and emerging economies countries is different. In developed

countries such as the UK, USA, and Europe, fintech extended the financing transaction methods through algorithmic trading, helping the manager to build better compliance systems to manage risk, and it also improves the electronic payment systems for both domestic and cross-border payments [1]. However, in developing countries, fintech adoption has been slow despite having growth and expansion opportunities in the digital economy (Zhang et al., 2020). Fintech has expanded financial services digitally across countries, particularly during the COVID-19 pandemic. During the pandemic, the usage of fintech services and products has increased tremendously as identified in research [2].

To remain competitive, banks, along with traditional banking, adopt fintech products to provide more efficient services to their customers to satisfy their needs. There is diverse opinion in the literature on the impact of fintech products used for the reduction of bank's risk-taking

behavior by enhancing bank's operating efficiency [3–5]. Wang, Liu, and Luo [6] concluded that fintech plays a significant role to alter a bank's risk-taking behavior to achieve the bank's corporate objectives and maintain customers by providing quality services on time and reducing costs. Global investment in fintech is sharply increased. Banks adopt fintech products and services to increase their operating efficiency as it lowers the transaction cost and operating expenses and lowers the bank's risk-taking. However, on the other side, the development of fintech with its technological advancement increases the competition for banks by providing cost-efficient products and services to their customers that in turn erodes the profit of banks and increases the risk-taking level of banks [5].

The aim of the study is to explore the impact of emerging fintech on bank risk-taking behavior and how the banks operating efficiency is affected by the fintech industry. There is limited literature available on how bank risk-taking behavior is affected by adopting fintech products [5, 6], and recent literature mainly focuses on the impact of fintech on efficiency [7]. However, this study identifies the gap and explores the mediating effect of a bank's operating efficiency and explores whether the bank's risk-taking behavior increases or decreases by adopting fintech products and services and how it affects bank efficiency in emerging countries. The study also explores the usage of fintech products and services to increase bank operating efficiency by lowering bank transaction costs. The study mainly focuses on emerging countries such as China, India, Pakistan, and Bangladesh. These emerging countries are considered in this study as they serve a leading fintech market, despite of the fact that they are also typical bank-based financing countries where banks still constitute the dominant part of the financial system and there, excessive bank risk-taking behavior of banks could have more detrimental effects than those in the countries that are less bank dependent [8]. The main objective of the study is to examine the impact of fintech product development on bank risk-taking and efficiency in emerging countries. Furthermore, to examine the bank's risk-taking behavior changes by increasing the bank efficiency after adopting fintech products. Research questions of the study are as follows: Do the fintech product developments affect the bank's risk-taking behavior? Does the bank's operating efficiency mediate the relation between fintech and bank risk-taking? The study is beneficial for commercial banks to reconsider and redesign the business model and bring new development opportunities and adopt fintech products to achieve bank efficiency. The study may also be beneficial for the policymakers of central banks to formulate policy to regulate the implication of fintech products in banking operations. The paper is structured as follows: Section 2 presents the literature review, Section 3 illustrates the methodology, Section 4 presents the results, and the final section presents the conclusion and recommendations.

## 2. Literature Review

Fintech provides new models and digital services to the banking industry including but not limited to digital currency, digital cash, online payment, digital invoicing, online

investment, wealth management, digital leasing, digital advising, online insurance, and crowdfunding; blockchain and artificial intelligence penetrate the banking industry by enabling the financial institutions to provide services more effectively [9]. The COVID-19 pandemic has accelerated opportunities for collaboration between fintech companies and banks. Financial institutions are continuously adapting and using digital products to remain competitive.

In the technology advancement era, banks are engaged in adopting fintech products by investing the part of bank's capital in fintech startups, through collaboration where banks can use the platform provided by fintech firms or enter into a joint venture with fintech firms. Banks can also develop their fintech products, such as contactless payments and Robo advisor. At the same time, the banks can also acquire the fintech firm to get access to technological products [10]. Banks either develop their fintech subsidiary or the Internet giants cooperate with them, using their mature, cutting-edge technologies and Internet application scenarios to promote banking business transformation [11].

Technology spillover theory suggests that the adoption and use of technology in one industry or sector can have a spillover effect on other industries and sectors, leading to the diffusion of new technologies and innovations. In the context of fintech (financial technology) in banks, this means that the adoption of fintech solutions and innovations in the banking industry could potentially lead to the adoption of similar technologies in other industries. For example, the widespread adoption of mobile payment systems in the banking industry could lead to the adoption of similar systems in the retail and hospitality industries. The adoption of fintech in banks can also have a spillover effect on the banking industry itself, leading to changes in the way that financial services are provided and consumed. For example, the use of fintech solutions such as online banking and mobile payment apps may lead to the closure of traditional branches, the development of new business models, and changes in the way that banks interact with their customers. Technology spillover theory can help to explain these changes and their potential impacts on the banking industry and the broader economy [6]. Banks are constantly reshaping the ways of providing their services to customers. The fintech product development affects the bank's traditional banking. The adoption of fintech products by banks improves bank efficiency. Fintech products improve the bank's efficiency in various ways. They facilitate financial innovation, shape the way banks conduct business, promote the development of innovative financial products, and reduce the bank cost, thus positively affecting the bank's efficiency. Through fintech products and services, banks can provide their customers with online services that help customers access conveniently any services.

Fintech products streamline the banking industry's operations and services and help them improve business processes. Streamlining banking operations enhance the efficiency and effectiveness of banks. Fintech products improve the bank's operating efficiency, making the financial transaction easy and secure, reducing bank risk-taking behavior, and improving service efficiency [12]. Ahamed

and Mallick [13] discussed that inclusive financial inclusion reduces marginal costs and thus lowers banks' risk-taking behavior. The fintech products not only improve bank efficiency and lower bank risk-taking behavior by lowering operational costs and by improving operational management. According to the research study by Li et al. [14], the use of fintech products in banks can lower costs and increase efficiency, which will make institutions less inclined to take risks. For instance, big data is used by banks to manage risk, manage investments, and optimize operations.

Fintech, on the other hand, offers banks a replacement for their products, significantly increasing competition for banks. Fintech businesses also benefit from lower operating expenses, better information sharing, and customer acquisition. As a result, the growth of fintech has the potential to steal customers from traditional banks and reduce bank profitability. This has a substitution effect that raises bank risk. Both a partner and a rival to banks is fintech. Banks should use financial technology and invest in fintech to stay competitive and increase efficiency.

Fintech products increase bank risk, threatening the protection of customers and the efficiency and stability of the financial sector [15]. Fintech reduces the bank's transaction cost, improves bank efficiency, and improves financial business complexity. However, it not only reduces the bank's risk but also brings many risks, including technology, systematic, and operational risks.

Deng et al. [5] examine the relationship between fintech and bank risk-taking behavior. The research study analyzed the sample size of 155 small- and medium-sized banks and explored how fintech development decreases bank risk-taking behavior. Isnurhadi et al. [16] evaluated the relationship between bank efficiency, capital, and bank risk in the existing literature. The study's findings showed that bank risk-taking behavior is significantly influenced by efficiency. When bank capital is large, the bank's incentive to take a risk is decreased by the increased bank efficiency.

In the financial industry, fintech brings fundamental changes from how institutions operate to how they raise capital and even changes the currency into digital. Fintech not only brings changes in traditional banking business models but also requires many regulatory changes. Fintech has been developed rapidly in the global market, particularly in India, China, and the UK. At the same time, Fintech is still in its infancy in the Asian market [17]. There are a lot of opportunities available for fintech growth. This area has been still unidentified and unaddressed in Asian countries. Academic study is also required to give commercial banks a way to reduce risk-taking while implementing fintech products in their operations. Therefore, the objective of the current study is to investigate how fintech products affect bank risk-taking practices.

Risk-taking behavior is an important phenomenon for the efficiency and stability of banks [18]. Banna and Alam [19] argued that organizations take risk for sustainability. The research study concluded that firms should take the risk to the extent that they can bear it if they take intolerable risks that will negatively affect them. Banks also take risks to remain competitive and achieve stability. This research

study examined the relationship between digital financial inclusion and banks' risk-taking behavior using a sample of 283 commercial banks. They deployed panel-corrected standard errors and a dynamic panel two-step generalized method of estimators. A strong relationship showed that digital financial inclusion reduces the bank's risk, default risk, and portfolio risk. Bank competition is one of the main determinants influencing bank risk-taking behavior and affects the bank's stability and performance [20]. Moreover, banks, therefore, to remain competitive involved in different risk-taking behaviors. Therefore, the competitive pressure of fintech promotes the banks to review their competitive strategy to achieve bank efficiency.

In the era of technological advancement, traditional commercial banks adopt fintech products to remain competitive. The advancement of financial technology has blurred financial boundaries, bringing new businesses and new risks. Wang et al. [6] studied that the fintech development affects the risk-taking behavior of a bank. The sample size of the study consists of China's commercial banks. The results show that a U-shaped trend exists between fintech and bank risk-taking. The U-shaped trend shows that initially, fintech increases bank risk-taking and then decreases bank risk-taking. Initially, the banks invested in new technological products, and the overall investment for investing in fintech products is huge.

The relationship between fintech products and bank risk-taking behavior is studied by researchers [5, 21]. The development of fintech significantly reduces commercial bank risk-taking behavior. Fintech has both the characteristics of finance and technology, which have a greater impact on bank risk-taking behavior. The risk mitigation effect is more pronounced in larger banks, as the larger banks are more involved in adopting fintech products. They have better financial infrastructure, risk mitigation capabilities, and larger investment capabilities to invest in technological products. At the same time, the research study of Liao [22] analyzed the impact of Internet finance on the risk-taking behavior of commercial banks. The research study found that a positively significant relationship exists between Internet finance and bank risk-taking.

Cheng and Qu [23] examined the effect of fintech on the bank credit risk of Chinese commercial banks. The study analyzed the data collected from 60 commercial banks from 2008 to 2017. Their findings revealed that the development of fintech is faster in state-owned banks, and fintech products are negatively associated with bank credit risk. It showed that the fintech products reduce the bank credit risk. The banks employing fintech improve banks' efficiency, thus reducing their risk-taking behavior. However, on the other hand, fintech product development also increases the bank's risk-taking behavior, as fintech products bring operational risk due to the lack of understanding of fintech technology by the new employees and the customers, financial fraud, and the risk of customer privacy leakage. Based on the above discussion, the following hypothesis is proposed.

*Hypothesis 1.* Fintech product development significantly affects the risk-taking of commercial banks in emerging countries.

Technologies such as Robo advisor and regtech change the business models and bring innovation to the business models of financial institutions. Fintech reduces transaction costs and provides good means to allocate financial resources more effectively. The research studies explored the bank's risk effect on banks' efficiency. Srairi [24] explored that in GCC countries, the profit efficiency scores were better than cost-efficiency estimates for banks. The development of fintech also affects the efficiency of commercial banks [6]. Fintech lenders have a higher tendency to refinance, which benefits the borrowers.

Financial institutions are heading aggressively toward fintech adoption. By adopting new products and technologies from WhatsApp chat box to personalized experience, they are providing a new experience to their customers. Conversational AI also improves customers' experience by collecting data on a specific problem and user's demographics and helps them provide faster solutions. Several studies examined the beneficial aspects of conversational commerce [25, 26]; however, others [27] claimed that chatbot reduces the customer's purchase rate. AI chatbots with the technological benefits of big data computing and faster quantitative learning reduce the customers waiting time to get the answer which helps the banks to lower labor costs. Fintech chatbots have become a mature fintech application because it provides real-time communication, artificial intelligence, and also financial expertise that help human beings to take a financial investment decision. The conversational recommendation system (CRS) has also attracted attention in the dialogue community as it collects relevant information from users and provides useful solutions. Jia et al. [28] presented a large-scale dataset, namely, E-ConvoRec, which is an authentic Chinese dialogue dataset consisting of over 25k dialogues and 770k utterances to assist decision-making by apply leading technologies to deliver services in a more efficient and cost-saving manner.

Fintech influences the efficiency of commercial banks in several different ways. It saves fixed costs (such as the salaries of financial advisors and maintenance of physical offices). Robo advisors can reduce minimum investment requirements and lower fees. Banks adopt cloud computing support, and other technologies adopted by banks can efficiently store and manage customer data, thereby alleviating information asymmetry and realizing payment and settlement more conveniently and efficiently than traditional methods [29]. Wang et al.'s [6] study results showed that fintech development negatively affects the low efficient banks. Fintech development makes banks more efficient and lowers their risk-taking behavior. Fintech products increase the bank's operating efficiency, which lowers the bank's risk-taking behavior. Based on the above discussion, the following hypothesis is proposed.

*Hypothesis 2.* Bank operating efficiency mediates the relationship between fintech product development and the risk-taking of commercial banks in emerging countries.

Fintech development is an important financial innovation that has a profound impact on the bank. Banks, by adopting fintech products, improve productivity and make the technology progress. In addition, the bank developed a

credit system based on big data technology to reduce transaction risk [30], while fintech also improves internal management efficiency to make communication more efficient. Lee et al., [7] examined whether the fintech development affects banks' cost-efficiency. The study applies the principal component analysis (PCA) and GMM technique to analyze the sample including 86 commercial banks in china during the period 2003-2017. The results showed that the fintech development not only improves the bank's cost-efficiency while it also enhances the technology used by the banks.

Based on the above discussion following hypothesis is proposed:

*Hypothesis 3.* Fintech product development significantly affects the operating efficiency of commercial banks in emerging countries.

Banks operating efficiency greatly affects the bank's risk-taking behavior. Inefficient banks tend to take more risks to achieve high bank profit as compared to efficient banks. The research study of Prakash et al. [31] examined the relationship between banks' risk-taking, capital, and efficiency. The research sample included the Indian banking sector for the period 2008-2019. They concluded that high capital reduces the bank's risk of insolvency. Technical efficient banks reduce their risk-taking behavior, while the bank's inefficiency increases the insolvency and bank risk. Casu and Girardone [32] examined the impact of capital and operating efficiency on bank risk. The study showed that a significant relationship exists between bank efficiency and risk-taking. A negative relationship is examined as the lower bank efficiency motivates the banks to increase the bank's return and increases the credit risk; an increase in credit risk involves additional bank cost and managerial efforts, which decrease the bank's technical efficiency. Based on the above discussion, the following hypothesis is proposed.

*Hypothesis 4.* Bank operating efficiency affects the risk-taking of commercial banks in emerging countries.

The effect of fintech on bank risk-taking also varies across the bank's specific features such as its size, liquidity position, and income diversification strategies. There are mixed results in the literature on the impact of fintech in large- and small-sized banks. It is argued that large banks participate in technological advancement by establishing or cooperating with fintech companies. The establishment of a fintech company requires a huge cost that the smaller banks are unable to bear. Moreover, larger banks diversify their funding sources and loan investments to reduce their risk; thus, larger banks are less risky and are more stable [33]. Investors also believe that large banks are too big to fail and have better resources to deal the unexpected financial problems [34]; thus, the larger banks may encourage to take greater risks. On the contrary, Goetz et al. [35] concluded that the larger and more complex, geographically diversified bank is more likely to lend to corporate insiders which worsen the loan quality. Based on the above discussion, the following hypothesis is proposed.

*Hypothesis 5.* Bank size significantly affects the risk-taking of commercial banks in emerging countries.

Literature supports that the bank's liquidity significantly affects its risk-taking [36, 37]. Increased liquidity encourages the bank's aggressive policies to lend at easy terms, which leads to an increase in bank risk in the end [38, 39]. There is also an inverse relationship between liquidity and risk-taking, inferring that the availability of highly liquid assets causes the risk to decrease [40]. In developing economies, banks prefer to hold higher liquid assets as compared to developed countries. They find that banks with higher liquidity in terms of deposits tend to take lower risks. Based on the above discussion, the following hypothesis is proposed.

*Hypothesis 6.* Liquidity significantly affects the risk-taking of commercial banks in emerging countries.

Income diversification plays an important role in sustained bank profit and in controlling risk. However, income diversification benefits the banks if the diversified activities are less risky and bring a high return. Ahamed [41] concluded that the increased share of noninterest income increases risk-adjusted profitability (stability) in Indian banks. The study analyzed whether the bank shift to noninterest income improves the bank efficiency of Indian banks. They concluded that noninterest income positively affects bank risk behavior. Hunjra et al. [42] examined the impact of income diversification on bank risk-taking in Asian emerging countries. The study applied the generalized method and analyzed 116 banks from ten Asian countries for the years 2010-2018. The result showed that income diversification minimizes the bank's risk-taking behavior. On the contrary, Zhou [43] found that diversification has no significant relationship with bank risk-taking behavior. Based on the above discussion, the following hypothesis is proposed.

*Hypothesis 7.* Income diversification significantly affects the risk-taking of commercial banks in emerging countries.

After the 2008 financial crisis, shadow banking increases the bank's risk due to their limited exposure to strict regulations. Claessens et al. [35] examined the academic literature focused on the role of shadow banking in creating "safe" collateral to reduce counterparty risk, facilitate financial transactions, and satisfy the global demand for relatively safe assets for liquidity and hedging purposes. Wang et al. [6] explored that shadow banking negatively affects bank risk-taking behavior. This indicates that the bank being more involved in interbank business results in more problematic loans. On the contrary, the study of Zhou and Tewari [45] explored the relationship between shadow banking, risk-taking, and monetary policy in emerging countries. The study concluded that a positive association exists between shadow banking and bank risk. Based on the above discussion, the following hypothesis is proposed.

*Hypothesis 8.* Shadow banking significantly affects the risk-taking of commercial banks in emerging countries.

China is a leading fintech market; in 2018, the world's most significant fintech investment was Alibaba's Ant financials which raised \$14 billion [6]. According to the "global fintech adoption rate index, 2019" reported by EY (Ernst & Young), in China and India, fintech adoption rate is 87% which is greater than the global average of 64%. In China, many commercial banks are involved in the adoption of fintech. Banks investing in fintech products affect the bank's risk-taking behavior. Deng et al. [5] and Muganyi et al. [46] examined the impact of fintech on bank risk-taking in China. The results showed that fintech reduces bank risk-taking, and the emergence of fintech products such as artificial intelligence, cloud computing, and Internet banking improves the performance of banks. To further promote the development of fintech, the People's Bank of China (PBOC) [47] released the financial technology development plan for 2019-2021. The plan includes the guidelines, development goals, and principles to enhance the application of fintech products and services [48].

Among the emerging countries, India is a leading country in adopting digital technology. Indian government under the program of "Digital India" outreach program is digitalizing services and educating their citizens about technology. Bhasin and Rajesh [49] analyzed the opportunities and challenges faced by the Indian banking industry. Many initiatives have been taken by the government of India and the reserve bank of India to promote fintech. Investment in fintech products has increased tremendously in recent years. They provide fintech products and services on digital platforms that act as major fintech disruptors such as peer-to-peer payment systems, artificial intelligence, machine learning, Robo advisor, big data, blockchain, and cloud computing. The reserve bank of India provides guidelines for India's overall financial inclusion strategy for 2019-2024.

In Pakistan, fintech companies offer a wide range of products including mobile wallets, digital payment, management consulting, mobile payment, and investment networks [50]. Rizvi et al. [50] qualitatively explored the economic, demographic, and technological factors that are necessary for the penetration of fintech growth in Pakistan. Pakistan has a robust regulatory framework which includes laws such as PSPs (payment service providers), PSOs (payment system operators), and also state bank of Pakistan issued the branchless banking regulation, which strengthens the application of fintech products. The regulatory authority's acts lead to the growth of fintech in a country.

In Bangladesh, banks lead the fintech transformation. The innovative fintech approach of Bangladesh is based on mobile financial services (MFS). It refers to branchless banking or mobile banking. Due to COVID-19, contactless transactions have accelerated the adoption of e-wallets. The government of Bangladesh is trying to adopt different strategies to digitalize the nation. The government has already set the period to create the first national financial inclusion strategy (NFIS) from 2019 to 2024 as a part of the government's vision for 2021 [51].

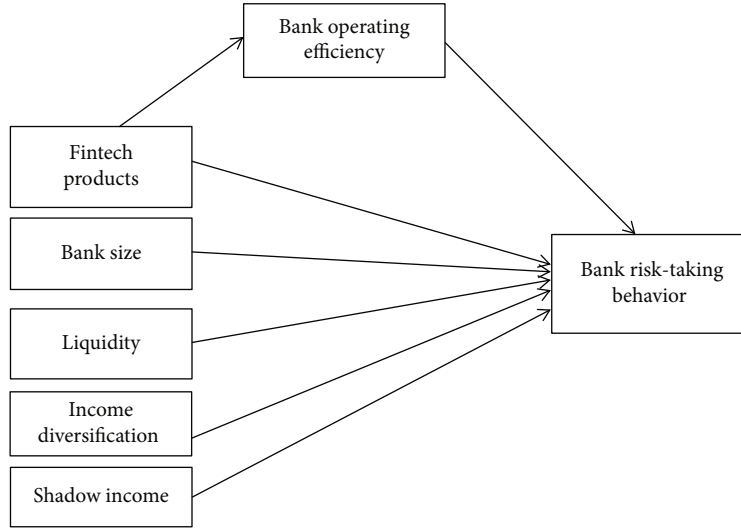


FIGURE 1: Theoretical framework of the study.

The research study mainly focuses on fintech product development in emerging countries particularly China, India, Pakistan, and Bangladesh. There are many research studies focused on the relationship between fintech products and risk-taking [5, 6]. However, there is a lack of evidence to establish a clear relationship between fintech, bank operating efficiency, and bank risk-taking behavior, especially in the Asian region. Though fintech plays an important role in the banking industry of the region, empirical evidence about the relationship between fintech, operating efficiency, and risk-taking is missing, specifically in the Asian countries. The research study focused on whether the bank efficiency can be improved through bank fintech products and also on whether the bank fintech affects the bank's risk-taking behavior. The research model has been shown in Figure 1.

### 3. Methodology

The research study uses the sample size of 50 commercial banks from emerging countries, namely, China, India, Pakistan, and Bangladesh, for the period from 2014 to 2021. The study uses secondary data from the commercial bank's annual statements. The study uses the Z-score proxy to measure the bank's risk-taking behavior [52]. Fintech product development was measured through content analysis technique. Table 1 shows all keywords used in the research study. Fintech product development was measured using five dimensions adopted from the previous research [2]. The instrument contains 30 items. All the commercial banks are coded under these (5) five dimensions for (7) seven years. If a certain item is reported in annual reports of the commercial banks in a particular year, it will be coded as "1" and "0" otherwise. In addition, the study uses bank efficiency as a mediator variable. The study uses structural equation modeling (SEM) to test the model.

Table 2 presents the operationalization of the variables of the study.

The following econometric equations specify the relationship among the variables:

$$BRT_{i,t} = \alpha_1 + \beta_1 FTI_{i,t} + \beta_2 AS_{i,t} + \beta_3 LR_{i,t} + \beta_4 ID_{i,t} + \beta_5 SI_{i,t} + \varepsilon_{i,t}, \quad (1)$$

$$OE_{i,t} = \alpha_1 + \beta_1 FTI_{i,t} + \beta_2 AS_{i,t} + \beta_3 LR_{i,t} + \beta_4 ID_{i,t} + \beta_5 SI_{i,t} + \varepsilon_{i,t}, \quad (2)$$

$$BRT_{i,t} = \alpha_1 + \beta_1 FTI_{i,t} + \beta_2 AS_{i,t} + \beta_3 LR_{i,t} + \beta_4 ID_{i,t} + \beta_5 SI_{i,t} + \beta_6 OE_{i,t} + \varepsilon_{i,t}, \quad (3)$$

where BRT is the bank risk-taking, FTI is the fintech development index, OE is the operating efficiency, AS is the asset size, LR is the liquidity ratio, ID is the income diversification, and SI is the shadow income. The following are the keywords are used in the study.

### 4. Results and Discussion

Table 3 shows the summary statistics, i.e., mean and the standard deviation of variables of the study. The result shows that the data is normally distributed. The results of VIF and the value of tolerance show that there is no multicollinearity among independent variables.

Table 4 shows the Pearson correlation analysis to check the correlation among the variables. The results show that the fintech product is significantly negatively correlate with asset size and income diversification  $(-0.156, -0.135, p < 0.1)$ .

The result in Table 5 shows that the fintech product is a negative predictor of operating efficiency  $(\beta = -1.454)$  at 1% significance level. The significant values of path "a" imply that the usage of fintech products improves the bank's operating efficiency by reducing its cost. The bank's operating efficiency is measured as the operating cost of the total income in the research study. The larger the bank's operating efficiency, the greater the operating expense and the less

TABLE 1: Fintech keywords.

Dimension		Keywords					
1	Information transfer (info)	E-bank	Internet bank	Online bank	Abbreviation for online banks	Network banking	Internet banking
2	Risk management (risk)	Internet finance	Credit information system	Online insurance	Network car insurance	Online finance	Internet insurance
3	Resource allocation (resource)	Online lending	Network investment	P2P	Internet investment	Crowdfunding	Smart investment
4	Clearing and payment (payment)	Cross-bank clearing	Online payment	Internet payment	Mobile payment	Network payment	Third-party payment
5	Technical base (tech)	Big data	Cloud computing	Artificial intelligence	Blockchain	Biometrics	Strategic-decision support

TABLE 2: Measurement of variables.

Variable	Definition	Reference	
1	Bank risk-taking Z-score	Natural logarithm of $(1 + (ROA + EA)/\sigma(ROA))$	Wang & Sui [52]
	Fintech development		
2	Fintech	In fintech index, content analysis is adopted. Bank fintech is classified into five categories such as information transfer, risk management, resource allocation, clearing and payment, and technical base	Wang et al. [6]
3	Bank efficiency Control variables	The ratio of operating cost to total income	Wang et al. [6]
	Size	Banks' assets as a share of the total assets	Cubillas and González [53]
4	Liquidity	The ratio of liquid assets to total assets	Hong et al. [54]
	Income diversification	The ratio of noninterest income to total income	Wang et al. [6]
	Shadow income	The ratio of the share of interbank business in total assets	Wang et al. [6]

efficient it is. This result is in conformity with Lee et al.'s [7] work which also supports that fintech development improves banks' cost-efficiency. Fintech products adopted by banks, such as blockchain, artificial intelligence, and digitalizing the process of credit and payment systems, enhance the banks operating efficiency.

Similarly, the path "b" from operating efficiency to risk-taking is negatively significant ( $\beta = -0.311$ ,  $p < 0.01$ ) showing that the bank's operating efficiency decreases the bank's risk-taking behavior. The lower bank operating efficiency in terms of cost increases the bank's stability. The more efficient banks increase the bank profit and reduce bank risk-taking by providing a range of products at affordable prices and maintaining a sufficient level of liquidity so that they can absorb possible risks that will arise. The result shows that the direct effect of fintech products on bank risk-taking behavior is insignificant while the indirect path between fintech products and bank risk through mediator operating efficiency ( $\beta = 0.453$ ,  $p < 0.05$ ). The path analysis results support the full mediation which implies that the operating efficiency mediates the relationship between fintech products and risk-taking behavior, and thus, Hypothesis 2 is accepted. The results of the control variable in the model show that asset size is a negative significant predictor of bank risk-taking ( $\beta = -0.193$ ,  $p < 0.01$ ) which is in line

with the work of A. Kasman and S. Kasman [33] and implies that large banks exhibit low risk-taking in emerging countries, whereas the relationship between another control variable, i.e., liquidity to bank risk-taking, is insignificant ( $\beta = -0.253$ ) which is contrary to the significant role of liquidity proposed by Rokhim and Min [37]. Another control variable, i.e., income diversification, has a significant positive impact on bank risk-taking ( $\beta = 1.238$ ,  $p < 0.01$ ). This result is in line with the work of Mostak Ahamed [41] which implies that greater involvement of banks in income diversification activities will result into more risk in banking sector of emerging countries. Furthermore, shadow income has insignificant impact on bank risk-taking which is contrary to the results of Wang et al. [6]; this result implies that the banks' risk-taking in emerging countries is affected by their shadow banking business.

Table 6 presents the country-wise path analysis results of selected emerging countries. Among them, the results of China show that the path "a," that is, fintech products, is a significant negative predictor of operating efficiency ( $\beta = -0.408$ ,  $p < 0.05$ ). The path "b" coefficient, i.e., operating efficiency to risk-taking, is insignificant. The results show that operating efficiency does not mediate the relationship between fintech products and risk-taking in China. However, the path coefficient from fintech products to risk-

TABLE 3: Summary statistics.

Variables	Obs.	Mean	Std. dev.	VIF	1/VIF
1 BRT	493	4.185	2.022		
2 FP	493	0.362	0.160	1.05	0.955
3 OE	193	0.451	1.620		
4 AS	493	9.392	1.465	1.06	0.939
5 LR	493	0.349	0.429	1.01	0.992
6 ID	493	0.273	0.487	1.02	0.977
7 SI	493	0.069	0.205	1.04	0.958

Note: BRT: risk-taking; FP: fintech product; OE: operating efficiency; AS: asset size; LR: liquidity ratio; ID: income diversification; SI: shadow income.

TABLE 4: Correlation matrix.

Variable	FP	AS	LR	ID	SI
1 FP	1				
2 AS	-0.156*	1			
3 LR	-0.018	-0.012	1		
4 ID	-0.135*	0.071	0.038	1	
5 SI	0.073	-0.192*	-0.073	-0.027	1

FP: fintech product; AS: asset size; LR: liquidity ratio; ID: income diversification; SI: shadow income. \* $p < 0.1$ .

taking is positive and significant ( $\beta = 4.854, p < 0.01$ ). Previous literature confirmed that the fintech product reduces bank risk-taking and enhances bank stability. However, in China, a significant positive relationship has been observed between fintech products and risk-taking which may be due to the involvement of larger banks in the income diversification practices that may result in increased nonperforming loans. Chinese banks have huge investments in fintech product development which may result in technological and credit risk contrary to the findings of Deng et al. [5]. Table 6 presents insignificant results of control variables.

Table 6 presents the path analysis results of Pakistan which shows that the fintech product is a significant negative predictor of operating efficiency ( $\beta = -1.12, p < 0.05$ ). The result shows that the path “a” is significant at 1% implying that banks adopting fintech products positively affect the bank operating efficiency in Pakistan. Banks adopting fintech products lower their operating efficiency in Pakistan by lowering their operating expenses and enhancing their total income, while the path “b” coefficient from operating efficiency to risk-taking is negatively significant ( $\beta = -0.359, p < 0.05$ ). The path analysis results of Pakistan show that the indirect path is significant ( $\beta = 0.404, p < 0.1$ ). The path analysis results support the full mediation for banking sector of Pakistan which implies that the operating efficiency mediates the relationship between fintech products and risk-taking behavior, and thus, Hypothesis 2 is accepted. In Pakistan, banks are continuously adopting fintech products to bring efficiency to their operations and reduce their risk-taking initiatives. Banks are adopting fintech products such as Internet banking, mobile banking facilitating microlending, digital wallets, digital payment solutions, and mobile financial services [50]. The results

TABLE 5: Consolidated path analysis results.

		OE $\beta$	Ln BRT $B$	Indirect effect
1	FP (a)	-1.454***	0.173	0.453**
2	OE (b)		-0.311***	
3	AS		-0.193***	
4	LR		-0.253	
5	ID		1.238***	
6	SI		0.128	

FP: fintech product; BRT: risk-taking; OE: operating efficiency; AS: asset size; LR: liquidity ratio; ID: income diversification; SI: shadow income. \*\*\* $p < 0.01$  and \*\* $p < 0.05$ . “a” and “b” show direct effects.

of the control variable in the model show that the coefficient of asset size, liquidity, and income diversification to risk-taking is insignificant. This shows that the bank’s asset size, liquidity, income diversification, and shadow income do not affect the bank’s risk-taking in Pakistan.

Table 6 also presents the path analysis results of the Indian banking sector which show that path “a” is significant as the fintech product is a significant negative predictor of operating efficiency ( $\beta = -0.108, p < 0.01$ ). The path “b” that is the path coefficient from operating efficiency to risk-taking is positively significant ( $\beta = 15.55, p < 0.01$ ), while the path coefficient from fintech products to risk-taking is negatively significant ( $\beta = -3.600, p < 0.01$ ). However, the indirect path between fintech products and risk-taking is significant ( $\beta = 1.692, p < 0.05$ ). The path analysis results support the partial mediation for the banking sector of India which implies that the operating efficiency partially mediates the relationship between fintech products and risk-taking.

These results are aligned with Deng et al. [5] study which supports that the development of fintech significantly reduces commercial bank risk-taking behavior. Fintech products as a new emerging technology reduce the cost of searching for information, improve customer acquisition speed, and use blockchain to build the trust mechanism that reduces the bank’s risk-taking behavior. Fintech products adopted by the banks improve the cost-efficiency; the management efficiency of banks, such as cloud computing in credit, improves the management efficiency of the banks, making information communication more efficient between departments that help the banks expand their organizational scale. The results of the control variable in the model show that asset size is a positive and significant predictor of banks’ risk-taking ( $\beta = 1.188, p < 0.1$ ). The coefficient of liquidity to risk-taking is insignificant which is contrary to the significant role of liquidity proposed by Rokhim and Min [37]. While the coefficient of income diversification to risk-taking is positive and insignificant, however, shadow income is a significant negative predictor of risk-taking ( $\beta = -14.396, p < 0.01$ ) in the Indian banking sector.

Table 6 also presents the path analysis results of Bangladesh’s banking sector which show that the path “a” from fintech product to operating efficiency is significant ( $\beta = -6.400, p < 0.01$ ). The path “b” from operating



TABLE 6: Country-wise path analysis results.

	Pakistan			China			India			Bangladesh		
	OE $\beta$	BRT $\beta$	Indirect effect	OE $\beta$	BRT $\beta$	Indirect effect	OE $\beta$	BRT $\beta$	Indirect effect	OE $\beta$	BRT $\beta$	Indirect effect
FP (a)	-1.12**	-0.03	0.404*	-0.40***	4.85***	0.195	-0.10***	-3.600***	1.692**	-6.4**	1.853	1.386*
OE (b)		-0.35**			-0.478			15.55***			-0.216**	
AS		0.461			9.861			1.188*			-0.098*	
LR		0.007			-0.616			0.453			-2.538*	
ID		1.168			0.118			15.556			0.764**	
SI		2.317			-0.179			-14.3***			3.623	

FP: fintech product; BRT: risk-taking; OE: operating efficiency; AS: asset size; LR: liquidity ratio; ID: income diversification; SI: shadow income. \*\*\* $p < 0.01$ , \*\* $p < 0.05$ , and \* $p < 0.1$ . “a” and “b” show direct effects.

efficiency to risk-taking is negatively significant ( $\beta = -0.216$ ,  $p < 0.05$ ), while the results show that the indirect effect is also positively significant ( $\beta = 1.386$ ,  $p < 0.1$ ). The path analysis results support the full mediation which implies that the operating efficiency mediates the relationship between fintech products and risk-taking behavior, and thus, Hypothesis 2 is accepted. This confirms that fintech products lower the banks operating efficiency and also lower the bank risk-taking behavior. In Bangladesh, banks are adopting fintech products, and the fintech industry is mainly presented by mobile financial services (MFS) providers, payment system operators (PSO), and payment service providers (PSP). Adoption of fintech lowers the bank’s operating efficiency and hence also lowers the bank’s risk-taking behavior. The banks adopting fintech products lower the bank operating efficiency by enhancing net income and lowering the cost and bank risk-taking behavior. This result is aligned with Lee et al. [7] that concluded fintech product positively improves the banks operating efficiency and ultimately reduce the bank’s risk-taking behavior. The results for control variables such as asset size show that there is a negative and significant impact of it on risk-taking behavior of banks ( $\beta = -0.098$ ,  $p < 0.1$ ) which is in line with the work of A. Kasman and S. Kasman [33] and implies that large banks exhibit low risk-taking in Bangladesh’s banking sector. The results also show that coefficient of liquidity is negative and significant predictor of banks risk-taking ( $\beta = -2.538$ ,  $p < 0.1$ ). This result is in line with the work of Dahir et al. [40] inferring that the availability of highly liquid assets causes the risk to decrease, specifically in developing economies; banks prefer to hold higher liquid assets as compared to developed countries. They find that banks with higher liquidity in terms of deposits tend to take lower risks. Another control variable income diversification has a significant positive impact on bank risk-taking ( $\beta = 0.764$ ,  $p < 0.05$ ). This result is in line with the work of Ahamed [41] which implies that greater involvement of banks in income diversification activities will result into more risk in banking sector of Bangladesh’s banking sector. Furthermore, shadow income has insignificant impact on bank risk-taking which is contrary to the results of Wang et al. [6]; this result implies that the banks’ risk-taking in emerging countries is affected by their shadow banking business.

## 5. Conclusion and Recommendations/ Implications of the Study

The evolution of digital technology has changed the world drastically. The COVID-19 pandemic changed the whole business structure. The customers’ increasing demand for fintech products increases the competition in the financial industry. To retain their customers and remain competitive in the industry, traditional banks adopted fintech products. So that they can deliver efficient, accessible, and low-cost financial services to their customers with the help of technology. Fintech has facilitated the banking industry with better user experience and lower costs by using technological advancement.

The primary objective of the study is to explore the relationship between fintech products and bank risk-taking behavior with mediating role of a bank’s operating efficiency using a sample of commercial banks from China, India, Pakistan, and Bangladesh. The empirical evidence shows that the bank’s risk-taking behavior decreases, and bank stability is improved with the development of fintech products. Fintech products improve the bank’s operating efficiency. The effect of fintech products on bank risk-taking is more pronounced in countries such as China and India because they are extensively using fintech products in their operations. Banks are adopting fintech products such as artificial intelligence blockchain, mobile banking, and Internet banking. The results show that the banks adopting fintech products in their initial phase increase the bank risk-taking behavior, and then later on, it decreases the bank risk-taking behavior by improving their operating efficiency.

The following recommendations are drawn from the results of the study:

- (1) Fintech product improves the bank’s operating efficiency, reduces transaction cost, and also lowers the bank’s operating cost. Therefore, banks should need to adopt fintech products and simplify their operation and organizational structure to respond to environmental changes rapidly
- (2) The development of fintech companies provides cost-efficient products and delivers contactless

services to their customers during the COVID-19 pandemic. So active cooperation is essential between banks and fintech companies

- (3) Fintech development reduces bank risk-taking behavior and reduces the bank credit risk and liquidity risk in the case of emerging countries. Therefore, commercial banks should actively adopt fintech products to lower their risk-taking behavior
- (4) Income diversification reduces the bank's risk-taking and improves bank stability when banks invest in less risky projects with high returns. Banks need to diversify their income and invest in more fintech products
- (5) Fintech products also have some adverse effects on commercial banks including technical risk, operational risk, and regulatory risk. Therefore, commercial banks need to introduce risk mitigation measures such as introducing laws, introducing entry and exit principles, risk monitoring indicators, and risk preparation requirements
- (6) A significant relationship exists between fintech products and bank risk-taking behavior showing that the fintech product can bring groundbreaking growth in the banking industry. Hence, policymakers and regulators should need to make effective policies and take immediate steps to implement fintech products in the banking industry to effectively tackle any effects of adverse situations like the COVID-19 pandemic

## Data Availability

Data will be available on request.

## Conflicts of Interest

The authors declare that they have no conflicts of interest.

## References

- [1] D. W. Arner, J. Barberis, and R. P. Buckley, "The evolution of Fintech: A new post-crisis paradigm," *Georgetown Journal of International Law*, vol. 47, p. 1271, 2015.
- [2] I. Vasenska, P. Dimitrov, B. Koyundzhyska-Davidkova, V. Krastev, P. Durana, and I. Poulaki, "Financial transactions using fintech during the COVID-19 crisis in Bulgaria," *Risks*, vol. 9, no. 3, p. 48, 2021.
- [3] A. Fuster, M. Plosser, P. Schnabl, and J. Vickery, "The role of technology in mortgage lending," *The Review of Financial Studies*, vol. 32, no. 5, pp. 1854–1899, 2019.
- [4] S. V. Scott, J. Van Reenen, and M. Zachariadis, "The long-term effect of digital innovation on bank performance: An empirical study of SWIFT adoption in financial services," *Research Policy*, vol. 46, no. 5, pp. 984–1004, 2017.
- [5] L. Deng, Y. Lv, Y. Liu, and Y. Zhao, "Impact of Fintech on bank risk-taking: evidence from China," *Risks*, vol. 9, no. 5, p. 99, 2021.
- [6] R. Wang, J. Liu, and H. Luo, "Fintech development and bank risk taking in China," *The European Journal of Finance*, vol. 27, no. 4-5, pp. 397–418, 2020.
- [7] C. Lee, X. Li, C. Yu, and J. Zhao, "Does fintech innovation improve bank efficiency? Evidence from China's banking industry," *International Review of Economics & Finance*, vol. 74, pp. 468–483, 2021.
- [8] R. S. Kroszner, L. Laeven, and D. Klingebiel, "Banking crises, financial dependence, and growth," *Journal of financial Economics*, vol. 84, no. 1, pp. 187–228, 2007.
- [9] P. Gomber, J. A. Koch, and M. Siering, "Digital Finance and FinTech: current research and future research directions," *Journal of Business Economics*, vol. 87, no. 5, pp. 537–580, 2017.
- [10] V. Murinde, E. Rizopoulos, and M. Zachariadis, "The impact of the FinTech revolution on the future of banking: Opportunities and risks," *International Review of Financial Analysis*, vol. 81, article 102103, 2022.
- [11] Y. Li, R. Spigt, and L. Swinkels, "The impact of FinTech startups on incumbent retail banks' share prices," *Financial Innovation*, vol. 3, no. 1, pp. 1–16, 2017.
- [12] W. P. W. Anjalika and H. M. S. Priyanath, "Effect of service quality on customer satisfaction: an empirical study of customers who have bank accounts in both public and private banks in Sri Lanka," *International Journal of Marketing and Technology [e-Journal]*, vol. 8, no. 1, pp. 1–35, 2018.
- [13] M. M. Ahamed and S. K. Mallick, "Is financial inclusion good for bank stability? International evidence," *Journal of Economic Behavior & Organization*, vol. 157, pp. 403–427, 2019.
- [14] Y. Li, C. Stasinakis, and W. M. Yeo, "Fintech and banking efficiency: evidence from Chinese commercial banks," 2021, <https://ssrn.com/abstract=3782616>.
- [15] G. Elia, V. Stefanelli, and G. B. Ferilli, "Investigating the role of Fintech in the banking industry: what do we know?," *European Journal of Innovation Management*, 2022.
- [16] I. Isnurhadi, M. Adam, S. Sulastri, I. Andriani, and M. Muizzuddin, "Bank capital, efficiency and risk: evidence from Islamic banks," *Journal of Asian Finance, Economics and Business*, vol. 8, no. 1, pp. 841–850, 2020.
- [17] F. Z. Ayoungman, N. H. Chowdhury, N. Hussain, and P. Tanchangya, "User attitude and intentions towards FinTech in Bangladesh," *International Journal of Asian Business and Information Management*, vol. 12, no. 3, pp. 1–19, 2021.
- [18] A. Saunders, E. Strock, and N. Travlos, "Ownership structure, deregulation, and bank risk taking," *Journal of Finance*, vol. 45, no. 2, pp. 643–654, 1990.
- [19] H. Banna and M. R. Alam, "Does digital financial inclusion matter for bank risk-taking? Evidence from the dual-banking system," *Journal of Islamic Monetary Economics and Finance*, vol. 7, no. 2, pp. 401–430, 2021.
- [20] C. Barra and R. Zotti, "Market power and stability of financial institutions: evidence from the Italian banking sector," *Journal of Financial Regulation and Compliance*, vol. 28, no. 2, pp. 235–265, 2019.
- [21] D. Hu, S. Zhao, and F. Yang, "Will Fintech Development Increase Commercial Banks Risk-Taking? Evidence from China," *Electronic Commerce Research*, pp. 1–31, 2022.
- [22] W. Liao, "Research on the impact of Internet finance on risk level of commercial banks," *American Journal of Industrial and Business Management*, vol. 8, no. 4, pp. 992–1006, 2018.

- [23] M. Cheng and Y. Qu, "Does bank FinTech reduce credit risk? Evidence from China," *Pacific-Basin Finance Journal*, vol. 63, article 101398, 2020.
- [24] S. A. Srairi, "Cost and profit efficiency of conventional and Islamic banks in GCC countries," *Journal of Productivity Analysis*, vol. 34, no. 1, pp. 45–62, 2009.
- [25] T. Rungvithu and C. Kerdivulvech, "Conversational commerce and cryptocurrency research in urban office employees in Thailand," *International Journal of e-Collaboration*, vol. 15, no. 3, pp. 34–48, 2019.
- [26] S. Yuan, X. Shen, Y. Zhao et al., "MCIC: multimodal conversational intent classification for E-commerce customer service," in *CCF International Conference on Natural Language Processing and Chinese Computing*, pp. 749–761, Springer, Cham, 2022.
- [27] X. Luo, S. Tong, Z. Fang, and Z. Qu, "Frontiers: machines vs. humans: the impact of artificial intelligence chatbot disclosure on customer purchases," *Marketing Science*, vol. 38, no. 6, pp. 913–1084, 2019.
- [28] M. Jia, R. Liu, P. Wang et al., "E-ConvRec: a large-scale conversational recommendation dataset for E-commerce customer service," in *Proceedings of the Thirteenth Language Resources and Evaluation Conference*, pp. 5787–5796, Marseille, France, June 2022.
- [29] M. Baker and J. Wurgler, "Do strict capital requirements raise the cost of capital? Bank regulation, capital structure, and the low-risk anomaly," *American Economic Review*, vol. 105, no. 5, pp. 315–320, 2015.
- [30] K. E. Dynan, D. W. Elmendorf, and D. E. Sichel, "Can financial innovation help to explain the reduced volatility of economic activity?," *Journal of Monetary Economics*, vol. 53, no. 1, pp. 123–150, 2006.
- [31] N. Prakash, S. Singh, and S. Sharma, "Contemporaneous or causal? Evaluating the triumvirate of insolvency risk, capitalization and efficiency in Indian commercial banking," *Managerial Finance*, vol. 48, no. 1, pp. 136–157, 2021.
- [32] B. Casu and C. Girardone, "Testing the relationship between competition and efficiency in banking: a panel data analysis," *Economics Letters*, vol. 105, no. 1, pp. 134–137, 2009.
- [33] A. Kasman and S. Kasman, "Bank size, competition and risk in the Turkish banking industry," *Empirica*, vol. 43, no. 3, pp. 607–631, 2016.
- [34] M. Mercan, "Determinant factors influence bank risk-taking: evidence from commercial bank of Georgia," *Globalization and Business*, vol. 11, pp. 59–65, 2021.
- [35] M. R. Goetz, L. Laeven, and R. Levine, "Identifying the valuation effects and agency costs of corporate diversification: evidence from the geographic diversification of U.S. banks," *Review of Financial Studies*, vol. 26, no. 7, pp. 1787–1823, 2013.
- [36] M. S. Khan, H. Scheule, and E. Wu, "Funding liquidity and bank risk taking," *Journal of Banking & Finance*, vol. 82, pp. 203–216, 2017.
- [37] R. Rokhim and I. Min, "Funding liquidity and risk taking behavior in southeast Asian banks," *Emerging Markets Finance and Trade*, vol. 56, no. 2, pp. 305–313, 2020.
- [38] F. Abbas, S. Ali, I. Yousaf, and W. K. Wong, "Dynamics of funding liquidity and risk-taking: evidence from commercial banks," *Journal of Risk and Financial Management*, vol. 14, no. 6, p. 281, 2021.
- [39] M. Lucchetta, "What do data say about monetary policy, bank liquidity and bank risk taking?," *Economic Notes*, vol. 36, no. 2, pp. 189–203, 2007.
- [40] A. M. Dahir, F. B. Mahat, and N. A. B. Ali, "Funding liquidity risk and bank risk-taking in BRICS countries," *International Journal of Emerging Markets*, vol. 13, no. 1, pp. 231–248, 2018.
- [41] M. Mostak Ahamed, "Asset quality, non-interest income, and bank profitability: Evidence from Indian banks," *Economic Modelling*, vol. 63, p. 114, 2017.
- [42] A. I. Hunjra, M. Hanif, R. Mehmood, and L. V. Nguyen, "Diversification, corporate governance, regulation and bank risk-taking," *Journal of Financial Reporting and Accounting*, vol. 19, no. 1, pp. 92–108, 2020.
- [43] K. Zhou, "The effect of income diversification on bank risk: evidence from China," *Emerging Markets Finance and Trade*, vol. 50, Supplement 3, pp. 201–213, 2014.
- [44] S. Claessens, S. Ghosh, and R. Mihet, "Macro-prudential policies to mitigate financial system vulnerabilities," *IMF Working Papers*, vol. 14, no. 155, p. 1, 2014.
- [45] S. Zhou and D. D. Tewari, "Shadow banking, risk-taking and monetary policy in emerging economies: a panel cointegration approach," *Cogent Economics & Finance*, vol. 7, no. 1, p. 1636508, 2019.
- [46] T. Muganyi, L. Yan, Y. Yin, H. Sun, X. Gong, and F. Taghizadeh-Hesary, "Fintech, regtech, and financial development: evidence from China," *Financial Innovations*, vol. 8, no. 1, pp. 1–20, 2022.
- [47] The People's Bank of China (PBOC) 2019, *Released the financial technology development plan for 2019-2021. The plan includes the guidelines, development goals, and principles to enhance the application of fintech products and services (Bu, Li & Wu)*, 2021.
- [48] Y. Bu, H. Li, and X. Wu, "Effective regulations of FinTech innovations: the case of China," *Economics of Innovation and New Technology*, vol. 31, no. 8, pp. 751–769, 2021.
- [49] N. K. Bhasin and A. Rajesh, "Impact of E-collaboration between Indian banks and Fintech companies for digital banking and new emerging technologies," *International Journal of e-Collaboration*, vol. 17, no. 1, pp. 15–35, 2021.
- [50] S. Kumail Abbas Rizvi, B. Naqvi, and F. Tanveer, "Is Pakistan ready to embrace Fintech innovation?," *The Lahore Journal of Economics*, vol. 23, no. 2, pp. 151–182, 2018.
- [51] B. Rehman, O. Ahmed, and S. Shakil, "Fintech in Bangladesh: ecosystem, opportunities and challenges," *International Journal of Business and Technopreneurship*, vol. 11, no. 1, pp. 73–90, 2021.
- [52] R. Wang and Y. Sui, "Political institutions and foreign banks' risk-taking in emerging markets," *Journal of Multinational Financial Management*, vol. 51, pp. 45–60, 2019.
- [53] E. Cubillas and F. González, "Financial liberalization and bank risk-taking: International evidence," *Journal of Financial Stability*, vol. 11, pp. 32–48, 2014.
- [54] H. Hong, J. Huang, and D. Wu, "The information content of Basel III liquidity risk measures," *Journal of Financial Stability*, vol. 15, pp. 91–111, 2014.