

Research on the Impact of Fintech on Liquidity Risk of Chinese Commercial Banks

Yiqi Wang

School of University of Southampton, Southampton, United Kingdom

Abstract: This paper investigates the liquidity impact of fintech development on commercial banks with a sample of 18 Chinese commercial banks over the time interval from 2013 to 2022. This paper constructs a basic regression model, three models with the introduction of mediating variables, and a model for heterogeneity analysis. An empirical analysis in this paper begins by analyzing the overall trend of data by conducting a descriptive statistical analysis of the selected variables; in the second step, it is determined whether the selection of the variables is reasonable through the test of multiple covariance; in the third step, regression analysis is carried out on the data to determine the relationship between the variables; in the fourth step, it is determined through the mediation effect model whether FinTech will have an impact on the liquidity of commercial banks through the selected intermediary variable impact; subsequently, a heterogeneity analysis is conducted to determine whether there are differences in the nature of ownership and regions in the impact; finally, a robust-type test is conducted to determine whether the results of the regression analysis are credible. The results show that the liquidity risk of commercial banks is significantly reduced as fintech companies strengthen their interconnection with commercial banks. In addition, the net interest margin cannot be used as a mediating variable for FinTech to affect the liquidity of commercial banks, but the results of the empirical analyses of the non-interest income share present significant, i.e., there is a mediating effect. Finally, the heterogeneity analysis shows that the liquidity of urban commercial banks and joint-stock banks is more sensitive to the development of fintech, meanwhile, the liquidity of commercial banks in the southern region is more susceptible to the development of fintech. The article concludes with some recommendations to the Chinese government and relevant commercial banks regarding the promotion of FinTech development.

Keywords: Commercial banks, FinTech, Liquidity, Liquidity risk, Net interest margin, Non-interest income share, Heterogeneity analysis.

1. Introduction

Commercial banks are a type of financial organisation instituted to meet the development of market economy and socialised mass production, and they have always played an integral role in the financial system (Levine, 1997). As the centre of finance, commercial banks play an irreplaceable role in the operation of the society, and whether the banking and financial system can operate typically depends on whether the national and even the world economy can operate normally. According to modern economics, commercial banks have the two functions of risk transfer and liquidity creation, and they provide liquidity to the society by taking deposits and granting loans (Huong Vuong et al., 2023).

After entering the 20th century, information technology has flourished, and emerging technologies represented by financial technology have gradually penetrated into various fields of the financial industry. Internet of things, big data, artificial intelligence and other technologies are widely used for the traditional financial management system, for the departments to solve a significant number of long-troubled problems, as well as for the enterprise to provide efficient services, for the people to provide a convenient operation, and more socio-economic development opportunities. The wide application of financial technology has become an important driving force for the rapid development of society [1].

Due to the convenience and efficiency of Fintech, the world's major banks have begun to layout the Fintech industry, competing for high-end Fintech talents, and launching various types of mobile terminal software to assist users in handling business in the hope of creating higher value, such

as online banking services, digital wallets, mobile payments and open banking Application Programming Interfaces (APIs). These innovations break the limitations of space and time. These innovations that break space and time constraints have significantly improved the service experience of customers and reduced the service pressure on commercial banks (PwC, 2017). Moreover, artificial intelligence and machine analysis have also increased customer stickiness by analysing customers' investment behaviour, risk tolerance, and capital status to tailor-make financial products for customers. In addition, through intelligent supervision, intelligent customer service and marketing, commercial banks have saved a substantial amount of human and material resources, improved service efficiency and changed the face of traditional banking[2].

However, there are two sides to everything, and whilst Fintech brings a fresh perspective on development for banks, it must also be accompanied by negative impacts, especially in terms of liquidity creation. The widespread use of Fintech has enabled marginalised groups such as rural areas and low-income groups to gradually access financial services. The explosion of products such as Wealth front, Betterment, Alipay, Revolut and others has lowered the threshold of investment for the general public, prompting an investment boom amongst the global population. Globally, the investment and financing of Fintech projects in 2019 was \$153.3 billion, nearly 10 times more than the total investment of \$18.9 billion in 2011. The surge in financing and the high level of Fintech market heat signals the flourishing development of Fintech enterprises, but simultaneously, commercial banks need to deal with more intense competition.

For example, due to the large amount of national capital hoarding in high-interest rate, diversified Fintech products are seriously affecting the credit business of commercial banks, this means that commercial banks are not only unable to increase their own liquidity by expanding deposit absorption and wealth management income, but will instead lose some of their customers' funds due to the high attractiveness of Fintech products, ultimately leading to a lack of liquidity[3].

If a bank is severely illiquid, it can fall into insolvency, or worse, financial risk, as China, the subject of this essay, experienced in 2013. There is a large amount of hidden debt in China's commercial banking system in the face of slowing economic growth and financial system instability. Informal financing channels, represented by 'shadow' banks, blossomed as Fintech products. As a result of the absorption of large amounts of short-term funds, the demand for credit in the financial system increased dramatically, to the point where the seven-day repo rate surged by nearly 12 percent on June 20, 2013, the highest in history (www.ceicdata.com, 2023). During the same period, the Central Bank of China was also pursuing a deflationary policy, a series of reasons that led to a liquidity crunch in China's commercial banks and an impact on the country's economy[4]

In view of the stage-by-stage impact brought by Fintech to China, and the fast-changing Fintech in today's world, this research will delve into the mechanism and extent of Fintech's impact on the liquidity of commercial banks. It will summarise how to promote the interconnection between Fintech and commercial banks, analyse how to make Fintech better serve commercial banks, and assist banks in avoiding risks and enhancing their competitiveness in accordance with the theory of liquidity creation[5].

The structure of the article is as follows. In Chapter 1, the background and significance of the selected topic is introduced. The current changes that Fintech has brought to the world and the innovations and challenges for commercial banks are presented. It also covers the relationship between Fintech and commercial bank liquidity. Chapter 2 comprises the literature review. Firstly, it will present the specific definition and development of Fintech, then introduce the knowledge related to commercial bank liquidity, and finally, examine how Fintech is affecting commercial banks today. For example, it will outline which businesses of commercial banks have been affected by Fintech, identify the benefits and challenges that Fintech has brought to the subject of this essay (China) and the necessity of combining Fintech with commercial banks, and finally propose the hypothesis. In Chapter 3, the primary data of commercial banks required for the article are collected through financial terminals and information data on the official website of commercial banks and presented using figures and tables. The reasons and rationality of selecting the explained, explanatory, and related control variables are explained. The necessary Fintech index is obtained through the Digital Finance Research Centre of Peking University. Chapter 4 presents the methodology where the appropriate model from the mixed OLS, fixed effects, and random effects models are selected through F-test, LM-test, and Hausman test. It will also outline the formulas required for mediation effects and heterogeneity analysis to prepare for subsequent analyses[6]. Chapter 5 presents the empirical analysis which will evaluate the impact of Fintech on the liquidity of Chinese commercial banks through the fixed effect model, analyse the conduction path of the impact of Fintech by using the mediation effect model, and finally

conduct heterogeneity analysis to understand the various responses of the liquidity of commercial banks of different natures and north and south regions to the development of Fintech. Chapter 6 presents the conclusion and recommendations. Through theoretical and empirical analyses, relevant conclusions are drawn, and targeted response measures are proposed [7].

This research takes into account the actual situation and analyses the impact of Fintech based on China's special internet financial development model. Since China's domestic research methods are relatively single, not based on sufficient attention to the construction of Fintech indexes, and most of China's domestic assessment of Fintech indexes are dominated by functionality and technology, with less data, this essay will use Peking University's Digital Inclusive Finance Index as the core explanatory variable to conduct an empirical study to explore the impact mechanism between Fintech and commercial bank liquidity risk. Furthermore, with the help of existing research to incorporate more considerations, the present study will improve the relevant theories in China from a more comprehensive perspective [8].

Using data from Chinese commercial banks, this research analyses the impact and transmission path of Fintech on the liquidity of commercial banks by using the fixed and mediation effect models. Heterogeneity analysis is used to understand the impact of Fintech on banks of different natures, involving comparisons between urban and rural, state-owned and joint-stock banks, as well as the different impacts of liquidity creation in southern and northern China.

2. Literature Review

2.1. Definition and development of financial technology

Fintech has gradually become a hot topic globally since the last century. The term Fintech can be traced back to the early 1990s: At the 'CARTES Forum', John Reed, Chairman of Citigroup, proposed the concept of 'Financial Technology', arguing that Fintech is not literally a simple combination of finance and technology, but actually has a much richer connotation (Ba, 2021). It actually has a richer connotation. As King (1993) indicated, economic development can be driven by both financial and technological innovations[9]

The current widely accepted definition of Fintech is proposed by Schueffel (2016). Using a literature research method, Schueffel defines Fintech as a new type of financial industry which improves financial activities through the use of information technology. In PricewaterhouseCoopers (2015) definition, Fintech combines innovative financial services with new digital technologies like crowdfunding to provide access to capital. Thomas Puschnann (2017) considered Fintech an increase in automation caused by information technology, which encompasses innovative IT-enabled financial solutions that reinvigorate the financial industry. Leong et al. (2018) defined Fintech as an interdisciplinary discipline that combines finance, technology and innovation management. Lee et al. (2018) stated in their article that Fintech is viewed by the industry as the most valuable innovation in the financial industry and it can bring innovations in the financial industry in terms of cost, and quality of service[10].

However, as Fintech continues to evolve, more authoritative organisations have expressed their insights. The Financial Stability Board (FSB) (2016) explains that Fintech

is financial innovation enabled by technology, including new business models, applications, processes or products, which can have a considerable and far-reaching impact on the financial sector.

The development of Fintech of global nature can be broadly categorised into three phases (Thakor, 2019). The first phase was in the 1967s, when Fintech focused on how to build information technology platforms and infrastructure, which was the basis for improving traditional financial interactions. In the second phase (1967 to 2008), Fintech gradually began to provide digital financial services along with the development of mobile internet technology. 2008 to the present is the third phase, in which big data, artificial intelligence, cloud computing, and blockchain technology are competing for development. Digitally-driven risk management and financial services have gradually become mainstream, and regulators have begun to guide Fintech to ensure its healthy development (PARENTI, 2020)[11].

Arner et al. (2015) argue that digital finance is more democratised as information technology is highly integrated into financial services. For China, the subject of this essay, He Jianqing (2017) argues that the current stage of Fintech in China can be referred to as the 'Internet finance' stage, signifying that the acceleration of the internet and digitalisation process has given rise to explosive growth in the Fintech sector. For China, the subject of this essay, Jingqian Tian et al. (2019) and Yang Min et al. (2020) argue that the development of Fintech in China is relatively short compared to the world, and that 2016 could be regarded as the first year of Fintech regulation in China. In the subsequent period, China's Fintech development has gradually stabilised and become more mature, and has been progressively applied to multiple scenarios such as payment, credit and wealth management. With the help of Cite Space system, Huang Jingwen and Tao Shigui (2020) collected a large amount of literature on Fintech in China, and discovered that during the period of 2016 to 2019, the discussion of Fintech in China's academia gradually increased, which confirms the rapid development of domestic Fintech in China in recent years[12].

2.2. Commercial bank liquidity analysis

In 1983, Diamond and Dybvig used the D-D model to demonstrate that due to the time lag between assets and liabilities, banks are exposed to liquidity risk although they are liquidity providers to depositors. Thadden (2004) and Coval and Thakor (2005) indicated that when the economic growth rate is positive, there is a positive correlation between financial institutions' risk-taking and liquidity creation. Liquidity creation reveals a positive correlation. Basel Committee on Banking Supervision (BCBS) (2008) stated that a bank's liquidity risk becomes apparent when it is unable to pay its debts as they fall due. Ahmed Arif and Ahmed Nauman Anees (2012) applied multivariate regression to assess the effect of the impact of liquidity risk on bank profitability. Liquidity risk was found to have a significant impact on bank profitability and liquidity gap is two factors that exacerbate liquidity risk and it is negatively related to profitability[13].

Adrian C.H. Lei and Zhuoyun Song (2013) proposed the 'financial crowding out effect', stating that the amount of capital of a bank is inversely proportional to its liquidity creation. Aleksandra Žuk-Butkuvienė et al. (2014) confirmed that failure of quality control and mismatch of banks' assets and liabilities are the most important factors that affect the

profitability of banks and misalignment of banks' assets and liabilities are important causes of liquidity risk. However, David et al. (2015) also affirmed that when the macroeconomic environment changes from positive to negative and liquidity turns tight, banks' liability stability decreases, which leads to the highlighting of liquidity risk. Aisyah Abdul-Rahmana, Ahmad Azam Sulaiman (2017) empirically discovered that the increase in the share of real estate funding can in some extent lead to long-term liquidity risk. This is because the credit risk of real estate financing increases over time, which can contribute to financial stability in the short-term but induces liquidity risk when accumulated over time. Galletta and M azzù (2019) use a generalised approach with a moment two-step estimator to demonstrate that the increase in the size of a bank and diversification of its income increases liquidity risk, whilst for non-deposit funding, dependent investment banks will have a lower exposure to liquidity risk[14].

The emergence of Fintech companies has somewhat intensified the competition amongst traditional banks. How to attract high-quality customer resources and improve the efficiency of capital use has become a top priority for traditional banks. Fierce competition also affects interbank liquidity. Allen et al. (2017) stated that bank lending rates will be reduced due to the increase of competition, which will lead to the narrowing of credit spreads and the decline of profitability. Moreover, if a bank's access to cash is diverted by other banks or intercepted by Fintech companies, then its liquidity must be affected accordingly.

2.3. Impact of FinTech on Commercial Banks

Fintech has been given the reputation of being 'advanced' and 'competitive' in the financial industry (Gai, Qiu and Sun, 2018). Nowadays the impact of Fintech on commercial banks has been discussed. The emergence of any new technology has a two-sided impact on the world. From one perspective, the rise of Fintech will inject a new momentum for the traditional banking industry[15]

Lapavitsas et al.(2008) argued that with the continuous innovation of information technology, the information possessed by commercial banks will become increasingly objective and transparent, which in turn will help to conduct credit business and improve the financial performance of commercial banks, which means that information technology represented by financial technology will help to improve the business level of commercial banks.

Furthermore, along with the emergence of new technologies such as intelligent ATMs and mobile banking apps, commercial banks have undergone digital upgrading, and the resulting increase in customer satisfaction signifies an improvement in the quality of service and efficiency of the bank, which is closely related to its non-financial performance (Richard et al., 2009).

Subsequently in 2016, Odawa discovered that self-service technology has somewhat enhanced customer base, market share and customer satisfaction in Nairobi Bank. This proves that a big advantage of fintech is to enhance additional services and attract customer base. Stoica et al. (2015) suggested that the improvement of Internet technology can help the efficiency of commercial banks, because commercial banks can analyze user information more quickly and deliver messages to customers, followed by Narsalay (2016) who claimed that commercial banks have limitations in providing personalised services to their customers, whereas Fintechs are

uniquely placed, which can lead to commercial banks to innovate their services. As a result, commercial banks deeply integrated with financial technology can provide customized services for different types of customers more calmly, thus improving customer satisfaction. Nicoletti (2017) suggested that Fintech organisations have a reshaping role to play in service industries such as banking due to their ability to provide customer-centric services with a balance of speed and agility, backed by forward-looking strategies and cutting-edge business models. Nicoletti's philosophy coincides with Narsalay R's, which emphasizes the importance of commercial banking and fintech connectivity. This comes on the heels of Sannes' (2018) survey of US banks, which affirmed that more than a third of them have experienced a dramatic increase in their customer base following the introduction of Fintech technology. This shows that fintech technology can increase customer stickiness, because a good service experience will greatly retain customers, which emphasizes the necessity of the integration of commercial banks and fintech[16].

In China, banks' uptake of customers has increased dramatically after the accompanying presence of bank mobile clients in an increasing number of service windows of enterprises and business households (Guo, 2019). In the past, there were numerous consumer groups who could not have their own bank accounts because of transport and infrastructure problems, but the popularity of bank mobile phone clients in recent years has made individuals in remote areas become potential customers of banks (Albertyn, 2020). With the help of self-service functions and intelligent customer service systems, the increase in information transparency greatly reduces the perceived risks of new customers and improves the trust of basic customers in commercial banks. This not only helps commercial banks to enhance customer stickiness, broaden user channels, but also helps commercial banks to absorb a large number of deposits[17](Kaushik et al., 2022)

Through the use of blockchain, big data and other information technology, commercial banks have solved the problems of difficult to collect customer information and cumbersome procedures, improving the efficiency of banks' lending and therefore revenue (Gu & Zhang, 2018). Moreover, Fintech can help commercial banks to improve credit risk identification ability, reduce bank operational risk and increase profits by enhancing information clarity (Jakšić and Marinč, 2019). Systemic risk can also be reduced by Fintech (Fuster, Plosser, Schnabl & Vickery, 2019), as it can reduce human, capital, and time costs by using technologies such as biometrics, voice recognition, and intelligent customer service, which can both enhance the speed of information processing and prevent insider fraud[18]. Furthermore, Fintech has changed the way banks communicate with their customers and enhanced their ability to deal with unexpected risks. For example, during Covid-19, the business of banks that focus on online services has not only not stopped, but even improved the efficiency of business processing through online banking, mobile banking and other handling methods. This not only guarantees the basic rights and interests of customers, but also enhances its competitiveness through its low-cost, high-timeliness services (Gupta and Mandy, 2018).

In China, by building a research model, Mingxian Li and Yan Chen (2021) discovered that Fintech can help China to increase the level of information sharing. The advantages of

high timeliness and low cost have led to an unprecedented expansion of inclusive financial services in China. Farmers in western and northern regions and remote mountain villages are also included in the financial inclusion audience. This kind of information interconnection fundamentally grasps the income information of people in poor areas, greatly supports the implementation of China's agriculture, rural policy, and promotes the development of rural economy[19].

In contrast, the rise of Fintech will also bring alternative challenges to the traditional banking industry, that is, commercial banks may lose due profits because of the development of financial technology.

Almazari et al. (2008), after conducting an empirical study on commercial banks in Jordan, suggest that the high efficiency and low cost of e-finance can have an impact on the profits of traditional commercial banks. Because customers are more inclined to choose institutions that can provide them with efficient services due to comfortable service experience, at the same time, the low cost of fintech companies will make them have a wider profit space, so that they are more competitive than ordinary commercial banks. Whilst conducting a research study on e-finance crime investigation, Petter and Geoff (2009) affirmed that Fintech had an impact on the profitable business of commercial banks. It not only reduced the profitability of some banking businesses, but also caused some low-earning banking businesses to gradually become negative, which affected the profits of banks[20].

Srivastava (2014) also studied commercial banks in developing countries through empirical analyses and concluded that the development of the internet finance will have a certain impact on the deposit and loan business of commercial banks. This confirms Petter and Geoff's work. Joan. Margherita and Nan[21]. Stone (2015) found that Fintech had changed customers' payment concepts and thus affected the deposit and loan business of traditional banks when they studied China's mobile payment software Alipay. Because more Chinese users tend to transfer funds from banks to Alipay wealth management products with higher interest rates, this part of the funds are not only invested through third-party platforms, but also through daily consumption. Bunea et al. (2016) analysed the annual reports of US banks from which the bank's profitability has been affected, from which they learnt that some of them admitted that their own business and growth were threatened by Fintech companies after 2016[22]. Allen et al. (2017) argued that the profitability of banks is affected by inter-bank competition, namely, fierce competition leads to a weakening of the ability of banks to obtain cash, and therefore affects their liquidity, and the rise of financial technology has greatly improved the competition of commercial banks. Through the use of quantitative modelling, according to Buchak et al. (2018), Fintech lenders are among the reasons the share of traditional banks in the residential mortgage market is declining sharply, which poses a threat to bank's business. Phan (2020) concluded that the growth of financial technology (Fintech) negatively affects bank performance after conducting quantitative analyses. Maoyong Cheng and Yang Qu (2020) discovered through their study that Fintech significantly reduces credit risk and the negative impact of Fintech on credit risk is weaker in large commercial, state-owned and listed banks. Based on the stochastic frontier model constructed by the SFA method, Liu Mengfei (2020) found in his study that the improvement of the profitability of China's banking industry depends on the

development of Fintech, and the improvement of cost efficiency is hindered by the development of Fintech. Subsequently, in 2021, Liu Mengfei indicated through empirical analyses that in the context of rapid development of Fintech, commercial banks bear more systemic risks than ever before[23]. The empirical analysis conducted by Sun Qingwen and Ren Yankun (2021) indicates that Fintech analyses a large amount of customer behavior data using big data, cloud computing, and other technologies, which has significantly affected the development of commercial banks' various businesses[24].

Therefore, one can conclude that Fintech will have an impact on the profitability level of commercial banks, the development of deposit and loan business, customer accumulation, risk tolerance, innovation and development and other aspects. It is true that Fintech has brought a significant number of challenges to the smooth operation of traditional banks, however, it also pushes commercial banks out of their comfort zone and further advances towards the goals of 'serving customers' and 'improving efficiency'[25]. As such, in 2016, Románova and Kudinska analysed the trends in the banking sector and concluded that it was important for banks to work with Fintechs, especially to seek for services that they could offer in addition to their primary business. In addition, those banking sectors that are the first to co-operate with Fintech companies will be more likely to gain a comparative advantage in the fierce competition in the future. According to Temelkov (2018), the development of Fintech companies brings new challenges and opportunities to the banking sector. The form it will evolve into depends entirely on the bank's future choices. Faced with the inevitable situation of cooperation between the two parties, active banks will capture the market share and customers of passive banks in the future[26].

Therefore, based on the aforementioned literature review and China's current development situation, this paper proposes three hypotheses:

H1, The development of Fintech has influenced to reduce the liquidity of commercial banks.

H2, Fintech can affect the liquidity of commercial banks by influencing the net interest margin and proportion of non-interest income of banks.

H3, Fintech brings different impacts to commercial banks of various natures.

3. Data

3.1. Sample and data sources

Considering the degree of data availability and representativeness, this paper selects the annual data of the 18 most representative commercial banks in China over the past decade as the research sample, including five large state-owned banks, seven joint-stock banks, and six city commercial banks[27]

The sample banks satisfy the differences in ownership and geographic location for the various types of analyses conducted next. The primary sources of micro data originate from the Choice database, Prospect database, cinfo database, Sina Finance, and the annual reports of each commercial bank, whilst the macro data is derived from the website of the National Bureau of Statistics (NBS) and the People's Bank of China (PBOC) and are analysed using Stata.

The samples were selected as:

Bank of China, Industrial and Commercial Bank of China, China Construction Bank, Agricultural Bank of China, Bank of Communications, CITIC Bank, China Merchants Bank, Pudong Development Bank, Ping An Bank, Everbright Bank, Hua Xia Bank, Min sheng Bank, Bank of Beijing, Bank of Nanjing, Bank of Ningbo, Bank of Shanghai, Bank of Chongqing, and Zhengzhou Bank[28]

The sample banks are selected according to the focus of the article's analysis, as the need to understand the reflection of Chinese commercial banks' liquidity on the development of Fintech, and thus the samples are all listed banks from China. Considering the specific nature of commercial bank liquidity will have different responses to the development of Fintech, the nature of the sample banks are all different. The primary ones are banks with different ownership and geographic locations[29]

When analysing the heterogeneity of geographic location, the sample banks are all from China's (new) first-tier cities, and the cities of incorporation have similar overall strength in China (China Business Network, 2023). Moreover, joint-stock banks were similarly selected to divide the north and south regions according to their place of incorporation. The nature of ownership was used to divide the sample banks and the classification is depicted in Table 3-1[30]

Table 3-1. Sample banks

Type of bank	Bank name
State-owned bank	Bank of China, Industrial and Commercial Bank of China, China Construction Bank, Agricultural Bank of China, Bank of Communications
Joint-stock bank	CITIC Bank, China Merchants Bank, Pudong Development Bank, Ping An Bank, Everbright Bank, Hua xia Bank, Min sheng Bank
City commercial bank	Bank of Beijing, Bank of Nanjing, Bank of Ningbo, Bank of Shanghai, Bank of Chongqing, Zhengzhou Bank

The sample banks are classified by their geographic location, as presented in Figure 3-1.



Figure 3-1. Geographic distribution of sample banks

The population is concentrated east of the Hu Line (black line), which comprises 93.5 percent of China's total population (Qi, Liu and Liu, 2022), 80 percent of the national gross domestic product (GDP) contribution, and the distribution of China's commercial banks is primarily concentrated in China's coastal areas (National Bureau of Statics, 2022), therefore, commercial banks are no longer considered west of the Hu Line[31]

Region A (Beijing): Everbright Bank, Hua Xia Bank, Min sheng Bank, CITIC Bank, Bank of Beijing

Region B (Shanghai): Pudong Development Bank, Bank of Shanghai

Region C (Nanjing): Bank of Nanjing

Region D (Zhengzhou): Bank of Zhengzhou

Region E (Chongqing): Bank of Chongqing

Region F (Ningbo): Bank of Ningbo

Region G (Guangzhou): Ping An Bank, China Merchants Bank

Curve: Qinling-Huaihe Line, the dividing line between the north and south regions of China

Straight line: Hu Line

3.2. Variable selection

3.2.1. Explained variable - liquidity ratio (LR)

China's liquidity supervision indicators for commercial banks were determined as early as 2006. The China Banking Regulatory Commission (CBRC) has released a set of Core Indicators for Risk Supervision of Commercial Banks for Trial Implementation, it can be observed that the liquidity risk indicators are used to measure the liquidity position of commercial banks and their volatility, including the liquidity ratio, core liability ratio and the liquidity gap ratio ((The State Council, 2019)[32]. Considering the data availability and the consistency of regulatory calibre, this paper selects the liquidity ratio (LR) as the explanatory variable for the later model construction according to the research method of Gu Haifeng and Bian Yuchen (2020). This method is also applied by Shuo Li and Xiaohui Hou (2020). Liquidity ratio is the ratio of liquid asset balance and liquid liability balance, which is required by the CBRC not to be less than 25 percent, and the liquidity risk will decrease with the increase of liquidity

ratio. Liquidity ratios indicate a bank's ability to withstand external risks, which is higher the higher the ratio (Soprano, 2015)[33].

3.2.2. Core explanatory variables - Fintech index (FI)

Fintech has developed rapidly with the innovation of information technology and has gradually penetrated people's daily life to date. However, due to the relatively short period of time since the beginning of Fintech research in China, the development process is relatively slow, and limited by the lack of standardised measurement standards, there are not many measures of the degree of Fintech development in China[34]

To date, there have been three primary sources of authoritative domestic Fintech indices in China: the first is the 'Peking University Internet Finance Development Index' from the Internet Finance Research Centre of Peking University. The index is jointly constructed by Peking University's Internet Finance Research Centre led by Guo Feng (2020), Ant Financial Services Group and Shanghai New Financial Research Institute[35]. It is a panel dataset that is extremely representative and accurate, covering 31 provinces, 337 municipalities and approximately 2,800 counties in China; followed by a Fintech index constructed using the size of P2P transactions in China. Thirdly, the text mining method (2015) published in a top Chinese journal by Guo Pin and Shen Yue was used to combine the financial functions (payment and settlement, resource allocation, risk management and information transfer) and technology paths (big data, cloud computing, artificial intelligence, blockchain, and biometrics), to construct the original financial thesaurus, and calculate the annual word frequency of relevant keywords with the help of China's mainstream search engines - Baidu, Sogou, and 360 engines. Finally, the factor analysis method constructs a national-level internet index[36]

Since the development of Fintech in China is relatively short and the time series is insufficient, the second and third methods cannot effectively reflect the development of Fintech in China in recent years, therefore, this paper chooses the 'Peking University Internet Finance Development Index' as the core explanatory variable. This variable is constructed in

collaboration with Ant Financial Services using the underlying data of Alibaba, China's largest e-commerce platform and internet finance company, which comprehensively covers the detailed data of each region in China (Institute of Digital Finance Peking University, 2020)[37] For reference, this data is unanimously recognised by Chinese domestic scholars and is one of the most authoritative Fintech data in China (Institute of Digital Finance Peking University, 2020). Currently, the Peking University Digital Inclusive Finance Index has been updated to 2021, but due to the impact of the Covid-19 and the implementation of the Universal Epidemic Prevention Policy, economic data after 2020 cannot fully and accurately reflect the development of Fintech and is thus disregarded, therefore, this paper has selected the Peking University Digital Inclusive Finance Index for the period of 2013 to 2019[38]

Using traditional inclusive finance indicators proposed by existing literature and international organizations, Peking University developed the Digital Inclusive Finance Index. In light of the innovative development of digital financial services, this index is comprehensively constructed based on the breadth of digital finance coverage, depth of use, and degree of digitisation of inclusive finance[39]

The specific dimensions and indicators are presented in Table 3-2.

Table 3-2. Digital financial inclusion index framework

Index	Dimension	Second-order index
Digital financial inclusion index	Coverage index	
	Service depth index	Payment usage index
		Money funds usage indices
		Credit usage index
		Insurance usage index
		Investment usage index
	Digitisation index	Mobility index
		Affordability index
		Credit index
		Facilitation index

In terms of construction methodology, the index is based on the connotation and characteristics of digital finance, taking into account the people and regions covered by digital finance, and combining the depth of being used and the practicality of Fintech services. Meanwhile, the construction of the index contains indicators of banking services, payments, insurance, money funds and other aspects, which more comprehensively describe the development level of Fintech (Peking University Digital Finance Research Centre, 2021).

In the existing research in China, most scholars mostly agree to use the total digital financial inclusion index to measure Fintech (Institute of Digital Finance Peking University, 2020), therefore, the test model construction in this paper will refer to this index.

3.2.3. Intermediation variables - net interest margin (NIM) and non-interest income ratio (NIR)

In addition to affecting the business model, interest income, and asset quality of commercial banks, fintech will impact their liquidity. In order to further study the transmission channel of the impact of Fintech on liquidity in commercial

banks, this paper adopts the intermediation effect model to conduct an empirical test, and introduces net interest margin (NIM) and the proportion of non-interest income ratio (NIR) as the intermediary variables[40]

Bank NIM refers to the ratio of a bank's net interest income to the bank's total interest-earning assets and it is used to measure the profitability of a bank's core business. The level of NIM implies the level of interest earned by the bank in its business such as lending and investment (CFI Team, 2020). If the NIM is excessively low, it may adversely affect the profitability.

The formula is as follows:

$$\text{Net Interest Spread} = \frac{(\text{Interest Income} - \text{Interest Expense})}{\text{Average Assets}}$$

NIR is the percentage of non-interest income of a bank or financial institution in the total income (Srivastav, 2020). In addition to interest income (for example, interest on loans and savings), banks earn income by providing other financial services, which are referred to as non-interest income. Fintech platforms have impacted the credit business of commercial banks, which have developed and innovated diversified and non-traditional businesses by restructuring their business. Not relying excessively on traditional lending and savings business means that commercial banks face lower profitability risk, and lower deposit liabilities also reduce the generation of liquidity risk to some extent. Therefore, this paper will choose the NIR, which can reflect the changes in the business structure of commercial banks, for empirical research[41].

3.2.4. Control variables

Both macro and micro levels affect the liquidity of commercial banks, therefore, drawing on existing research, the following indicators were selected as control variables:

(1) Logarithm of bank asset size (LNSIZE)

The larger the assets of a commercial bank, the stronger the siphoning effect it brings (Becker, 1999). The rise in total deposits is accompanied by an increase in the liquidity of commercial banks. The asset size of commercial banks can better represent the overall comprehensive strength of the bank, and thus can be used as one of the variables to study its impact on the liquidity risk of commercial banks.

(2) Capital adequacy ratio

Capital adequacy ratio (CAR) reflects a bank's ability to use its own funds to defend against risks, and is used to measure its capital adequacy and soundness. It represents the ability of a commercial bank to cover losses in the face of risk. Higher CARs indicate that commercial banks have less pressure to repay their debts and more liquidity when risks come. It can be assumed that CAR is positively related to liquidity[42].

(3) Non-performing loan ratio

A portion of the loans granted by commercial banks will not be recovered for some specific reasons. The non-performing loan ratio (NPL) measures the amount of non-performing loans to the total loans. A higher indicator means that more loans will not be recovered on time, which can lead to greater risk for commercial banks.

(4) Cost to income ratio

Cost to income ratio (CIR) is an important indicator to measure the operational efficiency of a business or financial institution. It is used to measure the ratio between the operating costs of a business and its revenue, namely, the proportion of costs that a business must pay for each unit of revenue earned. A lower cost-to-income ratio indicates that

the lower the operating expenses for the same amount of revenue, the better the commercial bank's operational management. For commercial banks, low cost means richer funds at their disposal at a certain level of profitability, and more flexibility in the face of capital demand[43]

(5) M2 growth rate

As the most basic part of macro monetary policy, money supply directly affects the liquidity risk of commercial banks.

(6) GDP growth rate

GDP growth rate is the growth rate of GDP, which reflects

the overall economic form of the country. Thus, the higher the GDP growth rate, the better the macroeconomic form, the rapid development of the economy; the lower the growth rate, the slower the economic growth, demonstrating a weak state. The macroeconomic situation also affects the operation of commercial banks, which in turn affects the liquidity of banks. When a country's macro-economy has an upward trend, commercial bank profits tend to rise, and vice versa. In this paper, GDP and its logarithm will be used as the control variable[44]

Table 3-3. Variable descriptions

	Variable name	Symbol	Definition
Explained Variable	Liquidity ratio	LR	Current assets/current liabilities
Core explanatory variable	Fintech index	FI	The development of financial technology
Mediated variable	Net Interest Margin	NIM	Bank net interest income / Bank total interest-bearing assets
	Non-Interest Income Ratio	NIR	Non-interest income/operating income
Control variable	Log of total assets	LNSIZE	Logarithm of the total assets of a commercial bank
	Capital adequacy ratio	CAR	Core capital/risk-weighted assets
	Non-performing Loans Ratio	NPL	Non-performing loan balance/total loan balance
	Cost-Income Ratio	CIR	Operating expenses/ Operating revenue
	Growth rate of M2	M2	$(M2 - M2_{t-1}) / M2_{t-1}$
	Growth rate of DGP	GDP	$(GDP_t - GDP_{t-1}) / GDP_{t-1}$

The indicators of all samples are shown in Appendix 1-4.

4. Methodology

4.1. Analysis of descriptive statistical indicators

This article constructs and analyses the panel data of 18 commercial banks from 2013 to 2022 as a sample. The

explanatory variable of the article is liquidity ratio (LR), and the core explanatory variable is Fintech index (FI); the two mediating variables are net interest margin (NIM) and non-interest margin ratio (NIR); and the six control variables are the logarithm of banks' asset sizes (LNSIZE), capital adequacy ratio (CAR), non-performing loan ratio (NPL), cost-to-income ratio (CIR), M2 growth rate (M2), and GDP growth rate (GDP). The results are presented in Table 4-1[45]

Table 4-1. Descriptive statistics

Variables	Mean	SD	Min	Max
LR	52.87	13.02	28.43	121
FI	252.83	67.48	155.35	341.22
NIM	2.2	0.38	1.25	3.5
NIR	26.28	7.75	3.58	51.09
LNSIZE	19.8	1.33	16.52	22.1
CAR	13.46	1.82	9.88	19.26
NPL	1.35	0.38	0.39	2.47
CIR	28.49	4.16	18.93	40.77
M2	10.63	1.98	8.1	13.6
GDP	6.24	1.92	2.24	7.77

As depicted in Table 4-1, during the period of 2013 to 2022, the average value of LR of the sample banks is 52.87, the minimum value is 28.43, and the maximum value is 121. The LR indicator of each bank reaches the minimum supervisory standard of 'the liquidity ratio of commercial banks should not be less than 25%' of the China Banking and Insurance Regulatory Commission (CBIRC), which can theoretically respond to a certain degree of liquidity risk with more flexibility. The standard deviation of the LR indicator is 13.02,

which indicates that the liquidity risk faced by banks varies greatly according to their own circumstances. The difference between the lowest and highest values reveals the different financial health and operational management efficiency of each company. The FI index rose from a low of 155.35 to 341.22, indicating that China's Fintech has developed rapidly in recent year and the overall industry is in a more active and rapid growth[46].

The variance of the NIM index is 0.38, indicating that the

profitability of the overall core business does not differ significantly amongst banks, and the small difference between the maximum and minimum values also reflects this conclusion adequately. The NIR index has a large fluctuation, indicating that the degree of development of non-traditional business varies amongst banks, for instance, there are differences in the business portfolio and performance in terms of noninterest income, which reflects the banks' different business strategies, product innovation, market positioning and customer segments. The mean value of 26.28 also indicates that most banks have continued to rely on interest income as their primary source of income [in recent years, with non-interest income as a supplement [47].

The overall variance of bank assets is not large after implementing the logarithm, which can reduce the right skewness of the indicator to a certain extent. The small standard deviation of the CAR indicator implies that the overall risk level of the banking system remains relatively stable, and the vulnerability of the banking sector is reduced in the face of external shocks, with lower systematic risk, which helps maintain financial stability. The NPL indicator is maintained within 3 percent, which indicates that banks have a certain degree of resilience in the face of loan default risk, helping to maintain financial stability resilience, which helps maintain financial system stability and protects the interests of depositors and financial markets. The standard deviation of 0.38 suggests that banks are not substantially different from each other, with a balanced performance in risk control and loan quality management, and the overall loan portfolio is relatively robust. The maximum value of the CIR indicator is 40.77, whilst the minimum value is 18.93, which may imply that there is a fluctuation in the operational efficiency of different banks, with some banks controlling their costs more efficiently, whilst others may face higher operational costs [48]. The M2 and GDP growth rates are at a constant 3 percent, which indicates that banks have a certain degree of resilience when facing loan default risk, helping to maintain the stability of the financial system and protect the interests of depositors and financial markets costs; M2 and GDP growth rates are both within a reasonable range, suggesting that China's economic development will be stable over the 2013 to 2022 period, and that the favourable market environment will give Fintech more stable socio-economic conditions, which to some extent corroborates the development of Fintech.

4.2. Model selection

The data in this paper originates from multiple individuals under various points in time and is panel data. The analysis of panel data should first start with determining the model. For the selected data, this paper will determine the model through F-test, LM-test, and Hausman-test, and then select the most suitable model from the mixed OLS, fixed effects and random effects models[49].

The fixed effects model is suitable for panel data analysis methodology and is used to control for inter-individual heterogeneity (Kumar, 2021). In panel data, data from multiple individuals at various points in time may differ due to individual characteristics, and this inter-individual variation is referred to as heterogeneity. The core idea of the fixed effects model is to control for inter-individual heterogeneity by introducing individual dummy variables. These dummy variables represent the fixed characteristics of individuals, and by introducing these dummy variables, the model can capture the fixed differences between individuals,

allowing researchers to study the effects of other variables more accurately on the dependent variable.

The random effects model is also applicable to panel data analysis and aims to explore the relationship between variables whilst also accounting for heterogeneity and random variation between individuals (Kumar, 2021). The model assumes that an individual's utility consists of fixed utility (individual-specific characteristic preferences) and random utility (indicating a component of randomness associated with unobservable factors), and at the heart of the model is the allowance for the inter-individual random effects to be stochastic, namely, the variables are independent of the other explanatory variables[50]

The mixed OLS model has the advantage of balancing fixed and random effects. As such, it is suitable for situations where there are fixed differences between individuals as well as for situations where there is random variation. The model not only estimates the relationship between variables more accurately, but also considers variation in the time dimension.

The exact analytical model to which the panel data is applicable requires relevant tests. The first test for individual effects, which is primarily to observe the effect of individual specificity on the dependent variable, is the F-test with the original hypothesis that a mixed OLS model is used. The results of the test reveal that the F-value is 19.14 and the p-value is $0.0000 < 0.05$, therefore, the original hypothesis should be rejected, indicating that the individual effect is significant, and it is better to choose a fixed effects model. This is because fixed differences between individuals have a significant effect on the dependent variable and the differences are constant over time, which is consistent with the basic assumption of the model of fixed effects, namely, the fixed effects model is better at capturing differences between individuals[51].

The LM test was then conducted with the original hypothesis that a mixed OLS model was used. The test result is $\chi^2(01) = 94.67$, and the corresponding p-value is $0.0000 < 0.05$, thus, the original hypothesis is rejected. The results indicated that the random effect was significant, and the mixed OLS model failed to capture the random differences between individuals, therefore, the random effect model was superior to the OLS model.

Finally, Hausman's test was conducted on the data and the original hypothesis was that the random effects are not correlated with the explanatory variables and the random utility model should be used. The result of the test is $\chi^2(7) = (b - B)'[(V_b - V_B)^{-1}](b - B) = 6.46$, $\text{Prob} > \chi^2 = 0.487$, which proves that the original hypothesis should be accepted and that the random-effects model is superior to the fixed-effects model[52].

However, since the results of Hausman test are affected by serial correlation and heteroscedasticity of the model, serial correlation and heteroscedasticity tests need to be performed in. The reasons are that when there is serial correlation in the panel data, the random error term is correlated in time, which may make the random effect and the explanatory variables correlated, thus violating the assumption that the random effect and the explanatory variables are uncorrelated, leading to inaccurate Hausman test results. Secondly, heteroscedasticity may cause the variance of the random error term not to be constant across individuals or time periods, which may also undermine the assumption that 'the random effects are not correlated with the explanatory variables', thus affecting the reliability of the Hausman test.

The results in Table 4-2 demonstrate that the presence of serial correlation and heteroskedasticity can affect the results of the Hausman test.

Table 4-2. Sequence correlation and heteroscedasticity tests

	F-number and significance	Result
Sequence correlation	F(1,17)=31.972 Prob>F=0.000	Rejecting null hypothesis, sequence correlation exists
heteroscedasticity	chi2(01)=94.67 Prob > chibar2 = 0.0000	Reject null hypothesis, heteroscedasticity exists

The presence of serial correlation and heteroskedasticity interferes with the results of the classical Hausman test, whereas the use of the robust Hausman test removes the effect of serial correlation and heteroskedasticity on the data as it is an improvement on the Hausman test by considering the variance-covariance matrix of the parameter estimates which in turn reduces the reliance on the model assumptions. The results of the robust Hausman test are as follows; F (17,155)=7.52, Prob>F=0.0000, the original hypothesis is rejected and therefore the fixed effects model can be used[53].

4.3. Model construction

1. To study the impact of Fintech development on the liquidity of commercial banks, this paper constructs the following econometric model 4-1 according to the hypothesis:

$$LR_{it} = \alpha_0 + \alpha_1 FI_t + \alpha_2 Lnsiz_{it} + \alpha_3 CAR_{it} + \alpha_4 NPL_{it} + \alpha_5 CIR_{it} + \alpha_6 M2_t + \alpha_7 GDP_t + \varepsilon_{it} \quad (4-1)$$

In Equation 4-1, liquidity ratio (LR) is the explanatory variable and Fintech Index (FI) is the core explanatory variable. The logarithm of total bank assets (Lnsiz), capital adequacy ratio (CAR), non-performing loan ratio (NPL), cost-to-income ratio (CIR), M2 growth rate and GDP growth rate are control variables. α_0 is the fundamental constant term, ε_{it} is the random error term, α_i ($i=1,2,3\dots$) represents the regression coefficients corresponding to the respective variables, LR_{it} can be interpreted as the regression coefficient of bank i in year t , and the others are the same[54]

2. Fintech may affect commercial banks through different channels. According to the aforementioned Hypothesis 2, this paper needs to take the intermediation effect model for testing, introducing NIM and NIR as intermediary variables for empirical testing[55]

The mediation effect was first proposed by Donald T. Campbell in 1960. Its primary role is to help experimentalists understand how the effect of the independent variable on the dependent variable is transmitted through the mediating variable [56]. More specifically, the causes and course of action of a phenomenon can be understood by tapping into the mechanisms behind the variables. This means that mediated effects modelling can be used to develop interventions and ameliorate particular problems or situations. There is a wealth of empirical analyses around the world that use mediated effects models to explore the mechanisms by which the independent variable acts on the dependent variable, with Baron and Kenny's (1986) stepwise analysis approach being

the most dominant. The specific modelling of mediating effects is designed as follows:

$$Y = cX + e_1 \quad (4-2)$$

$$M = aX + e_2 \quad (4-3)$$

$$Y = c'X + bM + e_3 \quad (4-4)$$

Figure 4-1 provides a clear picture of the relationship between the aforementioned variables.

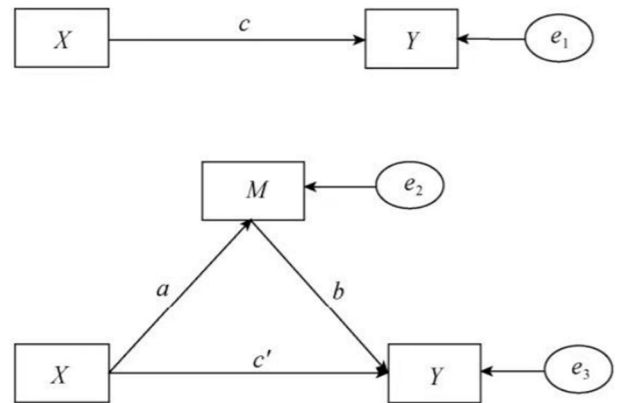


Figure 4-1. Relationship between variables

In Figure 4-1, path a denotes the effect of independent variable X on mediating variable M , path b denotes the effect of mediating variable M on dependent variable Y , path c' denotes the total effect of independent variable X on dependent variable Y , path c denotes the direct effect of independent variable X on dependent variable Y , and e_i denotes the residual term. The more common tests are stepwise analysis, Sobel and Bootstrap tests. The significance test of the coefficient c can determine whether the mediation effect is established, and if the coefficient c is significant, it can be presumed that the mediation effect is established[57]

According to the test steps, one can construct a mediation effect test model:

$$LR_{it} = \alpha_0 + \alpha_1 FI_t + \alpha_2 Lnsiz_{it} + \alpha_3 CAR_{it} + \alpha_4 NPL_{it} + \alpha_5 CIR_{it} + \alpha_6 M2_t + \alpha_7 GDP_t + \varepsilon_{it} \quad (4-1)$$

$$MED_{it} = \beta_0 + \beta_1 FI_t + \beta_2 Lnsiz_{it} + \beta_3 CAR_{it} + \beta_4 NPL_{it} + \beta_5 CIR_{it} + \beta_6 M2_t + \beta_7 GDP_t + \varepsilon_{it} \quad (4-5)$$

$$LR_{it} = \gamma_0 + \gamma_1 FI_t + \gamma_2 MED_{it} + \gamma_3 Lnsiz_{it} + \gamma_4 CAR_{it} + \gamma_5 NPL_{it} + \gamma_6 CIR_{it} + \gamma_7 M2_t + \gamma_8 GDP_t + \varepsilon_{it} \quad (4-6)$$

Equation 4-1 can be derived based on Hypothesis 1. Equation (4-5) primarily tests the response of intermediary variables to the development of Fintech, where MED is the intermediary variables NIM and NIR, and β_i represents the coefficient of Fintech's impact on intermediary variables. Equation (4-6) reveals the impact of Fintech on commercial bank liquidity after the addition of intermediary variables, and γ_i represents the coefficient of the impact of the respective variables on liquidity[58]

3. Hypothesis 3 in the article needs to be explored regarding the response of commercial bank liquidity of different natures to the development of Fintech, namely,

exploring heterogeneity. Thus, the construction of the model needs to include a dummy variable for the nature of the bank, and an interaction term between the Fintech index and the bank dummy variable[59]. Since the heterogeneity explored in the article includes bank ownership, North-South region, the model is set as:

(1) Based on ownership differences:

$$LR_{it} = \alpha_0 + \alpha_1 FI_t + \alpha_2 NATURE_i + \alpha_3 Lnsize_{it} + \alpha_4 CAR_{it} + \alpha_5 NPL_{it} + \alpha_6 CIR_{it} + \alpha_7 M2_t + \alpha_8 GDP_t + \varepsilon_{it} \quad (4-7)$$

Where nature1 and nature2 denote state-owned banks and joint-stock banks, respectively. If the bank is a state-owned bank, nature1 is 1, otherwise 0. If the bank is a joint-stock bank, nature2 is 1, otherwise 0.

(2) Based on North-South regional differences

$$LR_{it} = \alpha_0 + \alpha_1 FI_t + \alpha_2 LOACTION_i + \alpha_3 Lnsize_{it} + \alpha_4 CAR_{it} + \alpha_5 NPL_{it} + \alpha_6 CIR_{it} + \alpha_7 M2_t + \alpha_8 GDP_t + \varepsilon_{it} \quad (4-8)$$

Where loaction1 indicates the geographic location of the bank in China to which the bank belongs in the north and south. If the bank is registered in the north, the location is 1, otherwise it is 0.

5. Results

5.1. Correlation test

In order to prevent serious problems of multicollinearity amongst the selected variables, the variables need to be tested by the variance inflation factor analysis (VIFA) method[60]. The multicollinearity test is judged by the variance inflation factor (VIF) of the independent variables being less than 10 and the tolerance (1/VIF) being greater than 0.1. The VIF measures the linear relationship between the explanatory variables and the other explanatory quantities, for example, the greater the VIF, the stronger the covariance between the independent variables[61].

Strong multicollinearity between independent variables may lead to unstable parameter estimation, wrong direction of coefficients, unclear interpretation of coefficients and other problems. Therefore, the test of multicollinearity between variables can judge whether the choice of variables is reasonable or not. The results are presented in Table 5-1[62]

Table 5-1. Multiple collinearity test

Variable	VIF	1/VIF
FI	3.69	0.270989
CAR	2.54	0.393761
M2	2.23	0.448759
Lnsize	2.06	0.486604
GDP	1.90	0.525710
NPL	1.62	0.615844
CIR	1.12	0.889928
Mean VIF	2.17	

As evident from Table 5-1, the VIF values of the

independent variables selected in the article are all less than 10, and the 1/VIF values are all greater than 0.1, which indicates that there is no obvious multicollinearity relationship between the explanatory variables[63]. Therefore, it is apparent that the model construction of the article does not have the problem of multicollinearity, and the subsequent step of regression analysis can be conducted.

5.2. Regression analysis

Based on the data that has been collected, the results of the regression analyses are presented in Table 5-2 below.

Table 5-2. Empirical results of the impact of Fintech on the liquidity of Chinese commercial banks

	Coefficient	t	P> t
FI	0.133*** (4.068)	4.07	0.000
M2	0.849* (1.901)	1.90	0.059
GDP	0.206 (0.492)	0.49	0.624
Lnsize	3.842 (0.654)	0.65	0.514
CAR	-2.483*** (-3.136)	-3.14	0.002
CIR	-0.029 (-0.107)	-0.11	0.915
NPL	3.600 (1.439)	1.44	0.152
_cons	-40.836 (-0.368)	-0.37	0.714
N	180	180	180

Note: The t value in parentheses, ***, ** and * are significant at the level of 1, 5 and 10 percent, respectively.

From the regression results in Table 5-2, it can be concluded that the coefficient of the impact of Fintech on commercial bank liquidity is 0.133 and is significant at the 1 percent confidence level, which indicates that the development of Fintech is positively correlated with the proportion of commercial bank liquidity[64]. This is due to the fact that in 2021, the People's Bank of China, the CBRC, the CSRC, the Foreign Exchange Bureau and other financial management authorities interviewed more than a dozen Chinese Fintech company giants, including Ant Financial Services, Tencent, and Baidu, and the overhaul of the third-party Fintech investment platforms swept across China (Wan, 2021), thus leading to the fact that Fintech had to take the initiative to weaken their own fund-raising function and seek to cooperate with the commercial banks. This has led to a significant strengthening of commercial banks' deposit-taking capacity[65]

Moreover, the 'China Banker Survey Report 2021' reveals that China's banking industry has set the promotion of digital transformation as a top priority for the high-quality development of the banking industry since 2021. More than 70 percent of commercial banks have invested more than 2 percent of their revenue in developing big data, blockchain and cloud computing, and integrating them into business marketing, risk control and back-office management (China Banker Survey Report 2021, 2022). Subsequently, along with the popularisation of Fintech technology, commercial banks have actively deepened supply-side structural reforms and enhanced their services to the real economy, which has also

led to an increase in their absorption of a wider range of industrial capital (PricewaterhouseCoopers, 2022)[66]. This set of reasons has contributed to the increase in the attractiveness of commercial bank deposits, as well as reducing costs, creating more business models, and increasing the liquidity ratio[67].

With regards to the control variables, the coefficient of M2 growth rate and liquidity risk is positive and significant at the 10 percent level. This is because an increase in the amount of money in circulation is to some extent accompanied by more funds being deposited into the banking system, which both subjectively increases the liquidity of commercial banks and objectively requires them to enhance their own liquidity to meet the payment needs of their customers[68]. However, simultaneously, CAR reveals a negative correlation with the commercial bank liquidity ratio and is significant at the 1 percent confidence level. This is because the impact of the pandemic, commercial banks in China have strengthened their financial support to individuals, enterprises, and local governments according to the government's requirements to ensure the normal social order (China Banking and Insurance Regulatory Commission General Office, 2022). As a result, commercial banks reduced their holdings of risky but more liquid assets, such as short-term bonds and highly liquid securities, to ensure capital adequacy (China Banking and Insurance Regulatory Commission General Office, 2022)[69]

The impact coefficients of non-performing loan ratio (NPL), cost-to-income ratio (CIR), and GDP growth rate do not pass the significance test, which may be due to the impact of the pandemic. During the pandemic period, 'the Notice on Further Strengthening Financial Support to Prevent and Control the Pneumonia Epidemic of Novel Coronavirus Infection' (Xinmeng Fan, 2020) issued by the State Council of China was introduced, in which the government required commercial banks to fully implement differentiated and preferential financial services, providing flexible housing mortgages, personal credits, and priority claims for individuals; and deferring repayments, reasonably renewing loans, and increasing credits for enterprises. This policy, which continues to this day (China Banking and Insurance Regulatory Commission General Office, 2022), has greatly revitalised China's economy, but has simultaneously had a serious impact on the profitability and operational efficiency of commercial banks (KPMG China, 2020). A series of objective reasons lead to the fact that the data from 19 years to the present cannot fully and accurately reflect the brief operating situation of commercial banks, and thus some of the data may not accurately reflect the impact in the regression model. Therefore, Hypothesis 1 holds[70]

5.3. Intermediary analysis

Based on the research hypotheses presented in the literature review of this paper, the following verifies whether Fintech affects commercial bank liquidity through NIM and NIR, respectively[71]

5.3.1. NIM

Fintech has spawned third-party payment platforms in China, primarily WeChat and Alipay. Due to the advantages of high interest rates and convenience of their financial products, they have absorbed a large number of deposits from

residents(Tai, 2020). Influenced by such third-party platforms, commercial banks have had to raise deposit rates to attract deposit[72]. This means that the net interest income of banks will fall, and the NIM will fall as well. The reduction in profitability will reduce commercial bank liquidity, and thus this paper chooses NIM as the mediating variable to test the impact of Fintech on commercial bank liquidity. The results are presented in Table 5-3[73].

Table 5-3. Empirical results of the mediation effect test for NIM

	Model 4-1 LR	Model 4-5 NIM	Model4-6 LR
FI	0.133*** (4.068)	-0.002*** (0.343)	0.133*** (4.057)
M2	0.849* (1.901)	0.048*** (4.445)	0.865* (1.820)
GDP	0.206 (0.492)	0.007 (0.727)	0.208 (0.495)
Lnsiz	3.842 (0.654)	-0.437*** (-3.082)	3.692 (0.608)
CAR	-2.483*** (-3.136)	-0.008 (-0.444)	-2.486*** (-3.128)
CIR	-0.029 (-0.107)	-0.035*** (-5.381)	-0.041 (-0.139)
NPL	3.600 (1.439)	-0.304*** (-5.029)	3.496 (1.291)
NIM			-0.343 (-0.103)
_cons	-40.836 (-0.368)	11.761*** (4.388)	-36.799 (-0.311)
N	180	180	180

Model 4-5 reveals the regression results of net interest spread and Fintech index, and Model 4-6 shows the regression results of Fintech's impact on commercial banks' liquidity after bringing in net interest spread as a mediating variable. According to Table 5-3, it can be observed that Fintech has a significant feature on NIM in 1 percent confidence interval with a coefficient of -0.002. This indicates that the development of Fintech reduces NIM to some extent. Meanwhile, in Model 4-6 it can be clearly observed that the NIM and commercial bank liquidity ratio is negatively correlated. The coefficient is -0.343, but the results are not significant. This means that along with the increase of banks' return on interest-earning assets, the liquidity of commercial banks moves in the opposite direction. However, the level of financial technology is positively related to the level of commercial bank liquidity with a coefficient of 0.133, which is significant at the 1 percent level, indicating that the higher the level of financial technology in the market, the higher the liquidity of commercial banks[74]

Since the result of the effect of NIM on liquidity of commercial banks is demonstrated to be insignificant, the bootstrap method is conducted to test it. Bootstrap test is a statistical method used to test the mediation effect. The purpose is to determine whether the mediating variable produces a significant mediation effect between the independent and dependent variable. The results are depicted in Table 5-4[75]

Table 5-4. Bootstrap Inspection results

	Observed coefficient	Bootstrap std. err.	z	P> z	Normal-based [95% conf. interval]	
_bs_1	.0039364	.0049602	0.79	0.427	-.0057854	.0136583
_bs_2	.1315159	.0216442	6.08	0.000	.089094	.1739379

As observed from Table 5-4, the confidence interval for *_bs_1* includes 0, indicating that the indirect effect is insignificant at the chosen confidence level, namely, the parameter estimates are insignificant, and thus the mediating effect does not hold. Moreover, the confidence interval of *_bs_2* does not include 0, thus proving that the direct effect exists, namely, NIM is a partially mediating variable. This implies that the core explanatory variable FI can affect LR both directly and indirectly through NIM. Therefore, one can conclude that NIM cannot be regarded as a channel through which Fintech affects the liquidity of commercial banks[76].

5.3.2. Non-interest income share (NIR)

In terms of income structure, Fintech can be analyzed as a factor affecting commercial banks' profitability. The mediation effect of the share of non-interest income is tested as presented in Table 5-5.

Table 5-5. Empirical results of the mediation effect test for NIR

	Model 4-1 LR	Model 4-5 NIR	Model 4-6 LR
FI	0.133*** (4.068)	-0.086*** (-4.716)	0.145*** (4.157)
M2	0.849* (1.901)	-1.078*** (-4.312)	1.003** (2.123)
GDP	0.206 (0.492)	0.091 (0.386)	0.193 (0.460)
Lnsiz	3.842 (0.654)	23.603*** (7.172)	0.469 (0.069)
CAR	-2.483*** (-3.136)	0.351 (0.791)	-2.533*** (-3.193)
CIR	-0.029 (-0.107)	0.508*** (3.316)	-0.102 (-0.360)
NPL	3.600 (1.439)	6.000*** (4.281)	2.743 (1.037)
NIR			0.143* (0.996)
_cons	-40.836 (-0.368)	-434.102*** (-6.976)	21.192 (0.166)
N	180	180	180

Similarly, Model 4-5 shows the regression results of the impact of Fintech index on the share of non-interest income, and Model 4-6 shows the regression results of the impact of Fintech and the share of non-interest income on the liquidity of commercial banks. From Table 5-5, it can be learnt that the coefficient of the impact of Fintech on the proportion of non-interest income is -0.086, which passes the significance test at the 1 percent significance level, indicating that Fintech has a certain negative impact on non-interest income. This is because along with the development of Fintech, the investment enthusiasm of Chinese residents has been gradually ignited, and a considerable amount of capital has been shifted from the property and consumer market to the third-party investment platform represented by Ant Financial

Services (add reference, p.). However, a series of financial regulators such as the People's Bank of China and the CBIRC issued new regulations to curb the uncontrolled expansion of third-party platforms, making third-party payment platforms uncooperative with traditional commercial banks. Coupled with the continued downturn in China's stock market, residents' investment funds were gradually transferred out, and banks absorbed a large amount of deposits, thus reducing the proportion of non-interest income (add reference, p.). Meanwhile, Model 4-6 reveals that the non-interest income share of commercial bank liquidity impact on the individual coefficient of 0.143, which is significant at 10 percent of the condition, indicating that the non-interest income share of commercial bank liquidity will be enhanced. As such, it can be concluded that the development of Fintech can affect the commercial bank liquidity through the non-interest income share. Therefore, Hypothesis 2 does not hold[77]

5.4. Heterogeneity analysis

The following analysis is conducted for the heterogeneity of banks based on the questions posed in Hypothesis 3 of the article. Firstly, the heterogeneity is analysed according to the different ownership of commercial banks. Where (1) is a state-owned bank, (2) is a joint-stock bank, and (3) is a city commercial bank. The regression results are presented in Table 5-6 and the formula used is (4-7).

Table 5-6. Heterogeneity analysis test results (Nature of ownership)

	(1) LR	(2) LR	(3) LR
FI	0.072 (0.918)	0.154** (2.467)	0.258*** (4.097)
M2	-0.472 (-0.835)	0.528 (0.694)	2.227** (2.560)
GDP	-0.345 (-0.730)	0.321 (0.501)	0.161 (0.192)
Lnsiz	11.164 (0.556)	-9.445 (-0.634)	-14.956 (-1.449)
CAR	-2.181* (-1.731)	-2.700** (-2.196)	0.769 (0.475)
CIR	-0.171 (-0.339)	-0.164 (-0.387)	-0.069 (-0.138)
NPL	-6.940** (-2.304)	5.389 (1.299)	5.064 (1.053)
_cons	-152.582 (-0.379)	220.426 (0.769)	222.248 (1.268)
N	50	70	60

As presented in Table 5-6, Fintech has an impact on the liquidity of commercial banks of different natures. Amongst them, the impact of Fintech on the liquidity of state-owned banks is the smallest and not significant. This is because the size of state-owned banks is extremely large, far more than other commercial banks, whether from the underlying

architecture of Fintech construction or integration with the business is very difficult. Thus, the impact of Fintech on them has not been fully highlighted. The degree of impact of Fintech on the liquidity of joint-stock banks and urban commercial banks is more obvious, respectively, significant at the 5 and 1 percent confidence interval, the coefficient is 0.154 and 0.258. This is due to the fact that the size of the two smaller, the development of the two compared to the former has a larger space, and thus joint-stock banks and urban commercial banks pay more attention to the use of new technologies to attract customers, which to a certain extent mitigates the negative impact of the competitive benefits of Fintech. In summary, this paper concludes that the impact of Fintech on liquidity is heterogeneous amongst banks of different natures[78].

Subsequently, the heterogeneity is analysed according to the differences between the northern and southern regions of commercial banks. Where (1) represents northern commercial banks and (2) represents southern commercial banks. The regression results are shown in Table 5-7 and the formula used is (4-8).

Table 5-7. Heterogeneity analysis test results (Region)

	(1) LR	(2) LR
FI	0.092** (2.054)	0.122* (1.790)
M2	0.391 (0.581)	1.906** (2.132)
GDP	-0.195 (-0.312)	0.250 (0.306)
Lnsize	6.211 (0.630)	9.280 (0.835)
CAR	2.172 (1.641)	-3.380** (-2.353)
CIR	0.122 (0.291)	0.383 (0.801)
NPL	-0.060 (-0.015)	12.936** (2.281)
_cons	-127.037 (-0.704)	-158.840 (-0.777)
N	60	70

As observed from Table 5-7, the coefficient of the impact of Fintech on northern commercial banks is 0.092 and passes the test at the 5 percent level of significance, indicating that Fintech does have a significant positive impact on the liquidity ratio of northern commercial banks. Similarly, the impact coefficient of Fintech on southern commercial banks also passes the test at a significant level of 10 percent, and the coefficient is even higher than that of the north, at 0.122. This suggests that Fintech has a more pronounced impact on the liquidity of southern commercial banks.

This is due to the fact that the South is a more economically developed region in China, close to Hong Kong and Macao, and also Shanghai is the open door and financial centre of China, which makes the development and use of Fintech more important than in the North. As they are exposed to overseas markets and emerging technologies before the north, commercial banks in the south have absorbed Fintech more thoroughly and with better technology. In summary, this paper concludes that the impact of Fintech on liquidity is heterogeneous amongst banks with different regional natures, and Hypothesis 3 holds.

5.5. Robustness check

5.5.1. Winsorization

When conducting data collection and descriptive analysis, it can be observed that there are some extreme values, for example, the GDP growth rate in 2022 is only 3 percent affected by the pandemic, and the non-interest income share of Zhengzhou Bank was only in single digits in 2013 and 2014, which are extreme values due to special circumstances, such as the pandemic and government policies (add reference, p.). Therefore, this paper shrinks the continuous sample data at its 1 and 99 percent distribution positions to ensure that the interference of extreme values on the empirical results is eliminated. The regression results are presented in Table 5-8 for Model (2), and the original regression result is (1).

Table 5-8. Empirical results of winsorization

	(1) LR	(2) LR
FI	0.133*** (4.068)	0.133*** (4.424)
M2	0.849* (1.901)	0.445 (1.072)
GDP	0.206 (0.492)	0.398 (1.077)
Lnsize	3.842 (0.654)	-0.867 (-0.150)
CAR	-2.483*** (-3.136)	-2.529*** (-3.365)
CIR	-0.029 (-0.107)	-0.329 (-1.146)
NPL	3.600 (1.439)	1.343 (0.486)
_cons	-40.836 (-0.368)	67.393 (0.608)
N	180	155

As observed from the chart, the coefficient of the impact of Fintech on the liquidity of commercial banks has not changed and is still 0.133, which indicates that the integration of Fintech and commercial banks has indeed brought about an improvement in liquidity for commercial banks. Meanwhile, M2 is no longer significant after winsorization, which may be due to the impact of the pandemic caused by the adjustment of the national monetary policy impressed the data results. The winsorization eliminates the effect of extreme values, and all other results are the same as the first regression results.

5.5.2. Replacement of explained variables

Liquidity ratio, as one of the liquidity regulatory indicators, does not fully represent the liquidity level of commercial banks. Considering the publicly disclosed data, as well as data availability, the article selects the loan-to-deposit ratio (LDR) as a proxy variable for the liquidity ratio (LR), thus eliminating the one-sidedness of a single indicator.

A bank's loan-to-deposit ratio can provide some information about the relationship between a bank's loans and deposits, and to a certain extent, it can reflect a bank's liquidity position, thus indirectly reflecting the liquidity risk that a bank may face. When the loan-to-deposit ratio is low, namely, when total loans are higher than total deposits, it usually means that the bank has more liquid funds. This may make banks more able to meet the withdrawal needs of their customers and thus more favourably placed in times of liquidity stress. Lower loan-to-deposit ratios may indicate

that banks are more conservative and focused on maintaining adequate liquidity.

The results after replacing the indicators are depicted in Table 5-9, where (1) is the original regression result and (2) is the regression result after replacement.

Table 5-9. Regression results after changing the explained variables

	(1) LR	(2) LDR
FI	0.133*** (4.068)	0.174*** (6.848)
M2	0.849* (1.901)	0.127 (0.366)
GDP	0.206 (0.492)	0.275 (0.847)
Lnsize	3.842 (0.654)	-8.440* (-1.849)
CAR	-2.483*** (-3.136)	-1.133* (-1.842)
CIR	-0.029 (-0.107)	-0.049 (-0.230)
NPL	3.600 (1.439)	2.385 (1.227)
_cons	-40.836 (-0.368)	208.970** (2.421)
N	180	180

As presented in Table 5-9, the coefficient of the impact of Fintech on commercial bank liquidity changes from 0.133 to 0.174, both of which are significant within the 1 percent confidence interval. This indicates that Fintech indicators still have a significant impact on commercial bank liquidity creation and bank competition and are in the same direction as the benchmark regression results. Therefore, the estimation of the aforementioned model is robust.

6. Conclusion

Since Fintech came into the limelight in the last century, it has begun to develop rapidly with the innovation of information technology and led the change of traditional banks. Facing the new round of technological innovation, Chinese commercial banks are actively exploring and creating new financial products and business modules to enhance their competitiveness with the help of Fintech. However, whilst Fintech injects new vigour into commercial banks, one should also be alert to the risks it brings to commercial banks' liquidity. In order to prevent the liquidity risk of commercial banks, Using the current trend of Fintech as a point of departure, this paper discussed the relationship between Fintech development and liquidity of Chinese commercial banks.

Based on the aforementioned background and research content, this paper selected the data of the 18 most matched listed bank companies in China from 2013 to 2022 as the basis to study the liquidity of commercial banks. Through empirical analysis of the collected data, the following conclusions were drawn:

(1) In China, the support of national macro-policies has led to the integration of Fintech with commercial banks, creating a positive guiding relationship on the liquidity of Chinese commercial banks.

(2) In China, non-interest income will serve as one of the ways for Fintech to influence commercial bank liquidity. NIM,

in contrast, cannot perfectly act as a pathway of influence.

(3) In China, the technological advantages of Fintech have not yet been fully manifested in state-owned banks, but joint-stock banks and urban commercial banks have already tended to use Fintech to improve their comprehensive strength. However, the use of Fintech in the southern region is better than that in the northern region, whilst the technological dividend is also more inclined to the south.

In summary, under the strong competitive pressure of Fintech, Chinese commercial banks, with the help of policy support and their own advantages, have combined Fintech for innovation and development, which has greatly improved the quality of financial services, whilst reducing their own liquidity risk, and gradually converted to a stable and healthy development mode.

Therefore, this paper proposed the following suggestions to provide reference for the prevention of liquidity risk in commercial banks.

1. China needs to promote financial technology and strengthen regulations to maintain financial stability.

Today's era is the age of information technology, and as the leader of the innovation of the times, science and technology is always an important initiative for the benefit of mankind. Accompanied by the explosion of artificial intelligence, big data, and blockchain technology in recent years, all industries have seized considerable resources from internet technology. Although China has been ranked as the second largest economy in the world, the problem of unbalanced economic development is extremely prominent; the South is strong and the North is weak, and the East is strong and the West is weak all the time. The wealth and strength of a country is not based on the abundance of a small number of people, but the abundance of all the people.

The country should use financial technology as the primary way to optimise the distribution of resources, strengthen the drop of resources to backward areas, and use financial technology to implement scale and centralised mobilisation. This will not only show the way for commercial banks in terms of policy, but also strengthen the interconnection between commercial banks and Fintech in practice in order to enhance their comprehensive strength.

Moreover, along with Fintech sweeping through China, an increasing number of commercial banks in the country have begun to warm up with tech companies, and the lack of regulation has led to a significant financial crisis in China caused by the financial model represented by shadow banking. Meanwhile, the Fintech companies represented by Ant Gold and Jingdong Baijiao gradually tend to be 'financialised', engaging in the business of some traditional banks and cross-border marketing, such as issuing loans, but they do not comply with the corresponding laws and regulations, touching the bottom line of the national supervision and forming cross-border arbitrage. Finally, large companies are expanding in an uncontrolled manner with their capital advantages, eating into the profit margins of small and medium-sized enterprises (SMEs), and leading to excessive competition and a waste of resources.

Therefore, in 2020, China's regulators began to conduct large-scale interviews with Fintech companies, and Fintech ushered in the first year of strong regulation, with the government emphasising that Fintech companies should strengthen integration with commercial banks, weaken their own capital-raising ability, focus on weighing the balance between profitability and regulation, and operate in

compliance. It also emphasises the protection of consumers' legitimate rights and interests as a core objective of financial regulation in order to effectively use Fintech to promote the stability of the financial sector.

2. Adjust the structure of assets and liabilities to provide liquidity support

The theory of comprehensive asset-liability management states that the singularity of asset-liability management cannot achieve effective control of liquidity. Thus, a sound and flexible asset-liability structure is an effective way to enhance liquidity.

Commercial banks can make use of big data from financial technology companies to dynamically analyse customers in a wide area and comprehensively contemplate their deposits and loans in order to make the bank's assets and liabilities match better. Moreover, commercial banks need to be guided by the protocols of the regulatory authorities, reasonably control the scale and maturity of assets and liabilities, always monitor the movement of funds, use big data to analyse the capital behaviour of loan users, attempt to reduce the rate of non-performing loans, and strive to minimise credit risk and ensure liquidity. In addition, commercial banks should take their own operating conditions as the actual starting point, avoiding excessive pursuit of indicators and ignoring potential liquidity crisis. Furthermore, commercial banks can develop digital banking and online deposit channels to attract more deposit customers. They can provide convenient mobile applications and online deposit features to encourage customers to bank their funds, and introduce innovative deposit products such as high-interest savings accounts, special rates for short-term deposits, and savings bonds to attract customers and provide additional liquidity when needed.

3. Accelerate the absorption of advanced technology and build a complete liquidity management system.

In the process of aligning with Fintech, commercial banks should consolidate their own advantages and simultaneously actively absorb the mind-set and technical advantages of Fintech to promote their own digital transformation, and strive to make the technological spill over effect of Fintech stronger than the competitive effect at an early date in order to bring more obvious progress for the banks. Banks should continue to deepen the application of artificial intelligence, big data, blockchain, cloud computing and other technologies in the business process to ensure that all types of technologies can be utilised in the banking sector. The use of artificial intelligence in marketing, customer service, asset allocation and other scenarios can improve efficiency and user experience. The use of blockchain technology can play an invaluable role in solving information asymmetry and scientifically establishing a credit mechanism, as well as enhancing data security; and the use of big data can be used to delve into the information and value behind the data and gain insights into the habits of users in order to make the positioning of the users of the bank's products more accurate and cater to the tastes of the users. Through various types of technology, they can build up a high fortress, fully absorb the spill over effect of technology, and enhance the hard power of banks. Commercial banks should keep abreast of the times and adopt more comprehensive regulatory indicators to monitor their liquidity levels. Whilst managing liquidity, they should also take into account their overall scale, business model, profitability and other factors, strictly control the movements of various assets and liabilities, and make timely

adjustments to prevent liquidity risks from occurring if they are not reasonable. Stress tests on liquidity should also be adjusted in accordance with their own operating conditions, and stress test scenarios for liquidity risk should be set up scientifically, with the breadth and frequency of the tests being constantly changed.

4. Adhere to the strategy of cooperation and sharing to achieve a win-win situation for many parties

With the advent of the era of fintech, traditional commercial banks and fintech companies are competing with each other with their unique advantages and trying to grow their strength.

But even though their respective strengths can absorb a large number of target customers for them, they also have shortcomings in their own development. As fintech penetrates into all corners of the globe, no company or business can move forward steadily without the other, nor can they gain the sustained attention of consumers. The only way for both financial institutions and fintech companies to survive is for them to co-exist in a mutually beneficial way. Therefore, both traditional financial institutions and fintech companies should be aware of this and take the initiative to seek co-operation with each other to complement each other's strengths and win-win co-operation, in order to enable themselves to move forward steadily in this society full of variables and competition.

First of all, for banks, they need to systematically upgrade the information technology they have already established and check for gaps. Banks should have a clear understanding of themselves, understand their own shortcomings, and strive to establish a cooperative relationship with high-tech financial technology enterprises, so that they can better complete the collection of internal information and systematic risk analysis with the help of the information processing technology of financial technology companies. At the same time, with the help of big data to study the habits and needs of users, to carry out research and development, testing and sales of different types of financial products, so as to make the products more in line with the needs of consumers, and improve customer stickiness.

Secondly, commercial banks should take the initiative to seek cooperation with open Internet enterprises, such as Alipay, WeChat and Jingdong, which are deeply involved in the lives of the public and play an important role in social production and life all the time. Such enterprises are often able to establish more direct contact with customers, the customer base has great stickiness, and at the same time, along with the gradual increase in the investment needs of Chinese nationals, the people began to have a higher pursuit of financial services, and thus the commercial banks (especially small and medium-sized banks) need to seize the opportunity to use third-party service platforms to expand their own influence, and lay a good user base for the future of the fierce competition.

Finally, fintech companies should take the initiative to cater for the development direction of commercial banks. Along with the frequent occurrence of illegal fund-raising by domestic fintech companies in China, the government's regulation of fintech has gradually deepened, i.e., the development of fintech companies has been subject to more and more control and their authority has been restricted. The government requires FinTech companies to increase cooperation with commercial banks and give them maximum support in capital collection and basic information collection,

not only to protect the stable operation of traditional commercial banks, but also to ensure the stability of the financial system. Therefore, fintech companies should endeavour to cooperate with commercial banks, clarify their own positioning, and operate steadily in compliance with national laws and regulations in order to seek longer-term development.

Word Count: 14,694 words

References

- [1] Albertyn, N. (2020). No branch? No problem. Technology brings banking to rural businesses. [online] Finastra. Available at: <https://www.finastra.com/viewpoints/articles/no-branch-no-problem-technology-brings-banking-rural-businesses>.
- [2] Aleksandra Žuk-Butkuvienė, Dalia Vaitulevičienė and Julija Staroselskaja (2014) "Capital Adequacy (solvency) and Liquidity Risk Management: Analysis, Evaluation, and Possibilities for Improvement," 93(2). doi: 10.15388/Ekon.2014.2.3546.
- [3] Almazari, A. A. K., & Siam, A. Z. (2008). E-Banking: An empirical study on the Jordanian commercial banks. *Economics and Administration*, 22(2).
- [4] Arif, A. and Nauman Anees, A. (2012), "Liquidity risk and performance of banking system", *Journal of Financial Regulation and Compliance*, Vol. 20 No. 2, pp. 182-195. <https://doi.org/10.1108/13581981211218342>
- [5] Askitas, N., & Zimmermann, K.F. (2009). Google Econometrics and Unemployment Forecasting. *Discussion Papers of DIW Berlin*, 55(2), 107-120.
- [6] Ba, S. (2021). Financial structure improvement and real economy growth in the context of fintech. [online] www.aisixiang.com. Available at: <https://www.aisixiang.com/data/124417.html> [Accessed 9 Sep. 2023].
- [7] Becker, M., & Collins, M. (1999). "Financial Crisis and Structural Changes in British Commercial Bank Assets from 1860 to 1913." *Economic History Exploration*, 36(4). doi: 10.1006/exeh.1999.0727.
- [8] Berger, A. N., & Bouwman, C. (2017). Bank liquidity creation, monetary policy, and financial crises. *Journal of Financial Stability*, 30, 139-155.
- [9] Buchak, G., Matvos, G., Piskorski, T., et al. (2018). Fintech, regulatory arbitrage, and the rise of shadow banks. *Journal of Financial Economics*, 130(3), 453-483.
- [10] Bunea, S., Kogan, B., & Stolin, D. (2016). Banks vs fintech: At last, it's official. *Journal of Financial Transformation*, 44, 122-131
- [11] CFI Team (2020). Net Interest Margin. [online] Corporate Finance Institute. Available at: <https://corporatefinanceinstitute.com/resources/accounting/net-interest-margin/>.
- [12] Cheng, M., & Qu, Y. (2020). Does bank FinTech reduce credit risk? Evidence from China. *Pacific-Basin Finance Journal*, 63, 101398
- [13] China Banking and Insurance Regulatory Commission General Office (2022). Notice of the General Office of the China Banking and Insurance Regulatory Commission on Further improving financial services for enterprises in difficult industries affected by the epidemic. [online] www.gov.cn. Available at: https://www.gov.cn/zhengce/zhengceku/2022-06/03/content_5693848.htm [Accessed 25 Aug. 2023].
- [14] China Business Network (2023). 2023 New first-tier city list official announcement: Kunming returned, Qingdao rose, northern cities accounted for only four seats. [online] news.cctv.com. Available at: <https://news.cctv.com/2023/05/30/ARTI5kyAHUzgByGH081UpEQ4230530.shtml> [Accessed 6 Aug. 2023].
- [15] Diamond, D. W., & Dybvig, P. H. (1983). Bank runs, deposit insurance, and liquidity. *Journal of Political Economy*, 91(3), 401-419.
- [16] FSB. (2016). "Describing the Landscape and a Framework for Analysis." 23-51
- [17] Gai, K., Qiu, M. and Sun, X. (2018). A survey on FinTech. *Journal of Network and Computer Applications*, 103(1), pp.262–273. doi:<https://doi.org/10.1016/j.jnca.2017.10.011>.
- [18] Galletta, S. and Mazzù, S. (2019). Liquidity Risk Drivers and Bank Business Models. *Risks*, 7(3), p.89. doi:<https://doi.org/10.3390/risks7030089>.
- [19] Gottschalk, P., & Dean, G. (2009). A review of organised crime in electronic finance. *International Journal of Electronic Finance*, 3(1), 46
- [20] Gu, H. F., & Zhang, Y. N. (2018). Financial innovation, credit environment and bank risk-taking-evidence from China's banking industry from 2006 to 2016. *International Finance Research*, 377(09), 68–77
- [21] Gu, H., & Bian, Y. (2020). Cross-Border Capital Flows, Asset Prices, and Bank Liquidity Risk: The Moderating Role of Monetary Policy Uncertainty and Banking Competition. *Financial Science*, 393(12), 13-27
- [22] Guo, F., Wang, J. Y., Wang, F., Kong, T., Zhang, X., & Cheng, Z. Y. 2020, "Measuring the Development of Digital Inclusive Finance in China: Index Construction and Spatial Characteristics," *Economic Quarterly*, vol. 19, no. 4
- [23] Guo, Q., (2019). China Merchants Bank App8.0 Releases Open Ecology to Create New Wealth Life. *Tech Web*. <http://www.techweb.com.cn/it/2019-11-18/2764590.shtml>
- [24] Gupta, P. and Tham, T. M. (2018) *Fintech : the new dna of financial services*. Boston: De Press, 2018. doi: 10.1515/9781547400904.
- [25] Gupta, P.T., Mandy, T., (2018). Fintech: the new DNA of financial services. *J. Serv Mark.*20 (2), 125–135.
- [26] He, J. (2017). Fintech: Development, Impacts, and Regulation. *Financial Development Research*, 6, 54-56
- [27] Huong Vuong, G.T., Thanh Phan, P.T., Nguyen, C.X., Nguyen, D.M. and Duong, K.D. (2023). Liquidity creation and bank risk-taking: Evidence from a transition market. *Heliyon*, [online] p.e19141. doi:<https://doi.org/10.1016/j.heliyon.2023.e19141>.
- [28] Institute of Digital Finance Peking University (2020). Center for Digital Finance Research, Peking University. [online] idf.pku.edu.cn. Available at: <https://idf.pku.edu.cn/zxgk/zxgkn/index.htm> [Accessed 9 Sep. 2023].
- [29] Jak`si`c, M., Marin`c, M., (2019). Relationship banking and information technology: the role of artificial intelligence and FinTech. *Risk Manage.* 21, 1-18.
- [30] Joan, M. (2014). Opportunities and Challenges Facing Foreigners in Online Shopping in China: A Case of Foreign Students Shopping in Taobao [Doctoral dissertation]. Wuhan: Central China Normal University
- [31] Joshua D. Coval, Anjan V. Thakor. (2005). Financial intermediation as a beliefs-bridge between optimists and pessimists[J]. *Journal of Financial Economics*, 75(3):535-569
- [32] Kaushik, A.K., Kaushik, A.K., Mohan, G., Kumar, V., (2020). Examining the antecedents and consequences of customers' trust toward mobile retail apps in India. *J. Internet Commerce* 19 (1), 1–31

- [33] King, R.G., & Levine, R. (1993). Finance and growth: Schumpeter might be right. *The Quarterly Journal of Economics*, 108(3), 717-737
- [34] KPMG China (2020). How do commercial banks respond to the epidemic. [online] KPMG. Available at: <https://kpmg.com/cn/zh/home/insights/2020/05/how-commercial-banks-respond-to-epidemic.html> [Accessed 25 Aug. 2023].
- [35] Kumar, A. (2021). Fixed vs Random vs Mixed Effects Models – Examples. [online] Data Analytics. Available at: <https://vitalflux.com/fixed-vs-random-vs-mixed-effects-models-examples/>.
- [36] Lee, I., & Shin, Y.J. (2018). "Fintech: Ecosystem, business models, investment decisions, and challenges." *Business Horizons*, 61(1), 35-46
- [37] Lei A C H , Song Z . (2013).Liquidity creation and bank capital structure in China[J]. *Journal of International Financial Markets Institutions & Money*, 24(3):188-202.
- [38] Leong, K., & Sung, A. (2018). "FinTech (Financial Technology): What Is It and How To Use Technologies to Create Business Value in Fintech Way?" *International Journal of Innovation, Management and technology* 2018.
- [39] Levine, R. (1997). Financial Development and Economic Growth: Views and Agenda. *Journal of Economic Literature*, 35(2), pp.688–726.
- [40] Li, S., & Hou, X. (2020). Liquidity Risk, Credit Risk, and Commercial Bank Liquidity Creation. *Economic Geography*, 37(04), 168-176.
- [41] Liu, M. (2020). The Impact of Internet Finance on Commercial Banks' Profit Efficiency: An Empirical Study Based on SFA Method. *Dalian University of Technology Journal (Social Sciences Edition)*, 1-15
- [42] Liu, M. (2021). Fintech and Systemic Risk in Commercial Banks: An Empirical Study Based on Listed Banks in China. *Journal of Wuhan University (Philosophy & Social Sciences)*, 74(02), 119-134.
- [43] Merton, R. C., & Bodie, Z. (1995). *A Conceptual Framework for Analyzing the Financial Environment*. Cambridge: Harvard Business School Press.
- [44] Narsalay R. (2016).Thriving with Fintechs: Strategies for Large Indian Banks[J]. *Vinimaya*, 37(1): 5-15
- [45] National Bureau of Statistics (2022). National Bureau of Statistics. [online] [Stats.gov.cn](http://www.stats.gov.cn/). Available at: <http://www.stats.gov.cn/>.
- [46] Nicoletti, B. (2017). *The Future of FinTech*. Cham: Springer International Publishing. doi:<https://doi.org/10.1007/978-3-319-51415-4>.
- [47] Odawa, C.A., (2016). *Technology Enabled Banking Self Services And Performance Of Commercial Banks Listed In The Nairobi Securities Exchange* (Doctoral dissertation,University of Nairobi).
- [48] PARENTI, R. (2020). Regulatory Sandboxes and Innovation Hubs for FinTech Impact on innovation, financial stability and supervisory convergence. [online] Available at: [https://www.europarl.europa.eu/RegData/etudes/STUD/2020/652752/IPOL_STU\(2020\)652752_EN.pdf](https://www.europarl.europa.eu/RegData/etudes/STUD/2020/652752/IPOL_STU(2020)652752_EN.pdf).
- [49] Peking University Digital Finance Research Center (2021). *Peking University Digital Financial Inclusion Index (2011-2020)*. [online] www.idf.pku.edu.cn. Available at: <https://www.idf.pku.edu.cn/yjcg/zsbg/513800.htm>.
- [50] Phan, D.H.B., Narayan, P.K., Rahman, R.E., & Hutabarat, A.R. (2020). "Do Financial Technology Firms Influence Bank Performance?" *Pacific-Basin Finance Journal*
- [51] PricewaterhouseCoopers (2022). *China Banker Survey Report (2022) Condensed edition*. [online] PwC. Available at: <https://www.pwccn.com/zh/industries/financial-services/banking-and-capital-markets/publications/survey-chinese-bankers-2022.html> [Accessed 24 Aug. 2023].
- [52] PricewaterhouseCoopers (PwC). (2015). *States of Guernsey A strategic vision for FinTech*. [online] Available at: <http://www.gov.gg/CHttpHandler.ashx?id=96797&p=0> [Accessed 10 Jul. 2023].
- [53] Puschmann, T. (2017). *Fintech. Business & Information Systems Engineering*, [online] 59(1), pp.69–76. doi:<https://doi.org/10.1007/s12599-017-0464-6>.
- [54] PwC (2017). *Customers in the spotlight: How FinTech is reshaping banking*. [online] PwC. Available at: <https://www.pwc.com/gx/en/industries/financial-services/publications/fintech-is-reshaping-banking.html>.
- [55] Qi, W., Liu, S. and Liu, Z. (2022). The novel pattern and driving factors of population spatial distribution on both sides of the ‘Hu Line’ based on seventh census in China - CNKI. [online] kns.cnki.net. Available at: <https://kns.cnki.net/kcms/detail/detail.aspx?FileName=DLXB202212006&DbName=DKFX2022> [Accessed 8 Aug. 2023].
- [56] Research Group of Peking University Internet Finance Research Center. (2015). "Internet Finance Development Index of Peking University [EB/OL]." Retrieved December 20, 2015, from <http://iif.pku.edu.cn>
- [57] Románova, I., & Kudinska, M. (2016). Banking and Fintech: A challenge or opportunity? In *Contemporary issues in finance: Current challenges from across Europe* . Emerald Group Publishing Limited
- [58] Schueffel, P. (2017). Taming the beast: a scientific definition of fintech. *Journal of Innovation Management*, 4(4), 32
- [59] Schumaker, R. P., & Chen, H. (2009). Textual analysis of stock market prediction using breaking financial news: the AZFinText system. *ACM Transactions on Information Systems (TOIS)*, 27(2), 1-19
- [60] Shen, Y., & Guo, P. (2015). Internet Finance, Technology Spillover, and Total Factor Productivity of Commercial Banks. *Financial Research*, (03), 160-175.
- [61] Shen, Y., & Guo, P. (2015). Internet Finance, Technology Spillover, and Total Factor Productivity of Commercial Banks. *Financial Research*, (03), 160-175.
- [62] Soprano, A. (2015) *Liquidity management : a funding risk handbook*. Hoboken: Wiley.
- Srivastav, A.K. (2020). Non-Interest Income of Banks (Definition) | Examples and List. [online] [WallStreetMojo](https://www.wallstreetmojo.com/non-interest-income/). Available at: <https://www.wallstreetmojo.com/non-interest-income/>.
- [63] Stoica, O., Mehdian, S., & Sargu, A. (2015). The impact of Internet banking on the performance of Romanian banks: DEA and PCA approach. *Procedia Economics and Finance*, 20, 610-622
- [64] Sun, Q., & Ren, Y. (2021). Reflections on the Strategic Models of Commercial Banks in the Fintech Era. *Modern Marketing (Management Edition)*, (01), 102-103
- [65] Tai, L. (2020). Burst! Alipay removed this kind of deposit service, what happened? Ant Group responds. [online] news.stcn.com. Available at: https://news.stcn.com/sd/202012/t20201218_2641223.html [Accessed 9 Sep. 2023].
- [66] Temelkov, Z. (2018). Fintech firms: Opportunity or threat for banks? *International Journal of Information, Business and Management*, 10(1), 137-143

- [67] Thakor, A. V. (2014) Incentives to innovate and financial crises. SSRN. doi: 10.2139/ssrn.1786855.
- [68] The State Council (2019). The State Council of the People's Republic of China. [online] Wwww.gov.cn. Available at: <http://english.www.gov.cn/>.
- [69] The University of Bath (2021). How fintech is changing the future of traditional banking. [online] The University of Bath. Available at: <https://online.bath.ac.uk/articles/impact-of-fintech-on-banking>.
- [70] Tian, J., & Liu, X. (2019). Social Network Attention in Fintech: Theoretical Model and Empirical Analysis. *Financial Forum*, 24(1), 67-80.
- [71] Tian, J., & Liu, X. (2019). Social Network Attention of Fintech: Theoretical Model and Empirical Analysis. *Financial Forum*, 24(1), 67-80.
- [72] Wan, M. (2021). The end of the Internet cannot be lending, the central bank and other financial authorities interviewed 13 online platforms. [online] www.eeo.com.cn. Available at: <http://www.eeo.com.cn/2021/0430/486702.shtml> [Accessed 24 Aug. 2023].
- [73] Wang, J. (2020). The Impact of Financial Technology on the Profitability of Commercial Banks' Retail Business. *Hubei Social Sciences*, 406(10), 81-88
- [74] www.ceicdata.com. (2023). China Reverse Repurchase Rate: Central Bank: 7 Day . [online] Available at: <https://www.ceicdata.com/zh-hans/china/open-market-operation-daily/cn-reverse-repurchase-rate-central-bank-7-day> [Accessed 9 Sep. 2023].
- [75] Ximeng Fan (2020). Notice on Further Strengthening Financial Support for prevention and control of the novel coronavirus pneumonia epidemic. [online] www.gov.cn. Available at: https://www.gov.cn/zhengce/zhengceku/2020-02/01/content_5473639.htm [Accessed 25 Aug. 2023].
- [76] Yang, M., & Wu, S. (2020). Technological Innovation and Banking Industry Development: Evolutionary Process and Prospects. *Xinjinrong* , 383(12), 33-37
- [77] Zero One Finance and Central China New Financial Research Institute. (2017). "Global Financial Technology Investment and Financing Index Report [EB/OL]." Retrieved January 21, 2017, from <http://www.01caijing.com/article/13550.htm>.
- [78] Zhang, Z., Yin, Z., Gao, S., et al. 2021, "Analysis of Factors Affecting the Estimation Accuracy of Different Industries' GDP Based on Nighttime Light Remote Sensing Data: A Case Study of 16 Coastal Cities in China," *Remote Sensing Information*, vol. 36, no. 4, pp. 28-37