Does FinTech Increase or Reduce Commercial Banks' Risk-taking? Evidence from China's Banking Sector

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Abstract:

Noting the rapid development of FinTech, this paper makes an in-depth analysis of its influence on commercial banks' risk-taking, using a multivariate panel regression model which we apply to annual balance panel data of 130 commercial banks in China from 2007 to 2017. Our analysis is supported by a FinTech Index that we develop using text mining technology. The results demonstrate that: (i)The impact of FinTech on the commercial banks' risk-taking shows an obvious inverted "U" shape, first rising and then falling. That is, early stage development of FinTech increases commercial bank risk-taking, but as key technologies mature, FinTech is conducive to reducing management costs and enhancing risk control ability, which in turn reduces the risk-taking level of commercial banks. (ii) The impact of FinTech varies for different types of commercial banks. Compared with small local banks, the response of large and medium-sized banks is relatively more cautious.

Keywords:

FinTech; Commercial Banks; Risk-taking; Empirical Research

1. Introduction

In recent years, FinTech has made rapid progress and makes an important contribution to the operation of the financial system. According to the FinTech Global, global investment in FinTech companies totaled $57 billion in the first half of 2018, up 49.6% from $38.1 billion in 2017.According to LingYi Data, there were 1,097 equity financing events in the global FinTech market in 2018, involving 436.09 billion CNY. Of these, 615 came from China, totaling 325.63 billion CNY, accounting for 74.7% of the global total. China's FinTech market reached 115 trillion CNY in 2018 and will exceed 157 trillion CNY in 2020. A research report published by the China Qianzhan Industry Research Institute estimates that FinTech revenue in China was 969.88 billion CNY in 2018 and will rise to nearly 2 trillion CNY in 2020.[1]. In terms of scale, China's FinTech industry has taken the initiative in the world.

In the face of a new wave of technological and industrial changes, traditional commercial banks are also strengthening the development and application of key FinTech technologies such as big data, artificial intelligence and blockchain through independent research and development, external mergers and acquisitions, and cross-border cooperation, in order to seek transformation and development. By the end of June 2019, 10 commercial banks have established FinTech subsidiaries (see table 1). At the most recent semi-annual financial report release (August 2019), Bank of Communications also announced it would set up a FinTech subsidiary and increase its annual investment in technology to more than 10 percent of total revenue.

Table 1. FinTech subsidiary of China's commercial banks

No.	Subsidiary	Bank	Founding time	Registered place	Registered capital
1	Cib FinTech	China Industrial Bank	2015.12	Shanghai	500 million CNY
2	One Connect	Ping An Insurance (Group) Company of China	2015.12	Shanghai	1.2 billion CNY
3	MB Cloud	China Merchants Bank	2016.02	Shenzhen	65 million CNY
4	All rights by Everbright Technology CO.LTD	China Everbright Group	2016.12	Beijing	100 million CNY
5	CCB FinTech co., LTD	China Construction Bank	2018.04	Shanghai	1.6 billion CNY
6	Minsheng technology co. LTD	China Minsheng Bank	2018.05	Beijing	200 million CNY
7	ICBC technology co. LTD	Industrial and Commercial Bank of China	2019.05	Xiong'an New Area	600 million CNY
8	Longying Zhida (Shen Zhen) technology co. LTD	Hua Xia Bank	2018.05	Shenzhen	21 million CNY
9	Beiyin FinTech co., LTD	Bank of Beijing	2019.05	Beijing	50 million CNY
10	Bank of China FinTech co. LTD	Bank of China	2019.06	Shanghai	600 million CNY

[1]Data source: 2019 China Financial High-tech Thematic Analysis

At present, the financial industry has fully engaged with the era of FinTech and is developing towards the networked, digital, mobile and intelligent phases. The deep integration of technology and the finance industry has led to the blurring of the financial boundary , which has brought new business forms and models as well as new risks. Emerging technologies such as cloud computing, big data, artificial intelligence and blockchain have been widely applied in the traditional financial field. The main application scenarios are shown in figure 1. FinTech is profoundly changing the financial ecology and reshaping the financial landscape. “No technology, not finance" has become an industry consensus. With the vigorous development of FinTech in China, the policy authorities also attach great importance to it and have formulated a series of policies to ensure its efficient, safe and controllable development. In May 2017, the People's Bank of China (PBC) established the FinTech Committee to strengthen related research planning and overall coordination of FinTech industry. In August 2019, the PBC issued the Chinese FinTech Development Plan (2019-2021), which clearly put forward the guiding ideology, basic principles, development goals, key tasks and safeguard measures for FinTech in the next three years, showing that FinTech has officially become a government strategy. Now the FinTech industrial ecology has formed a good development trend from government to enterprises in China.

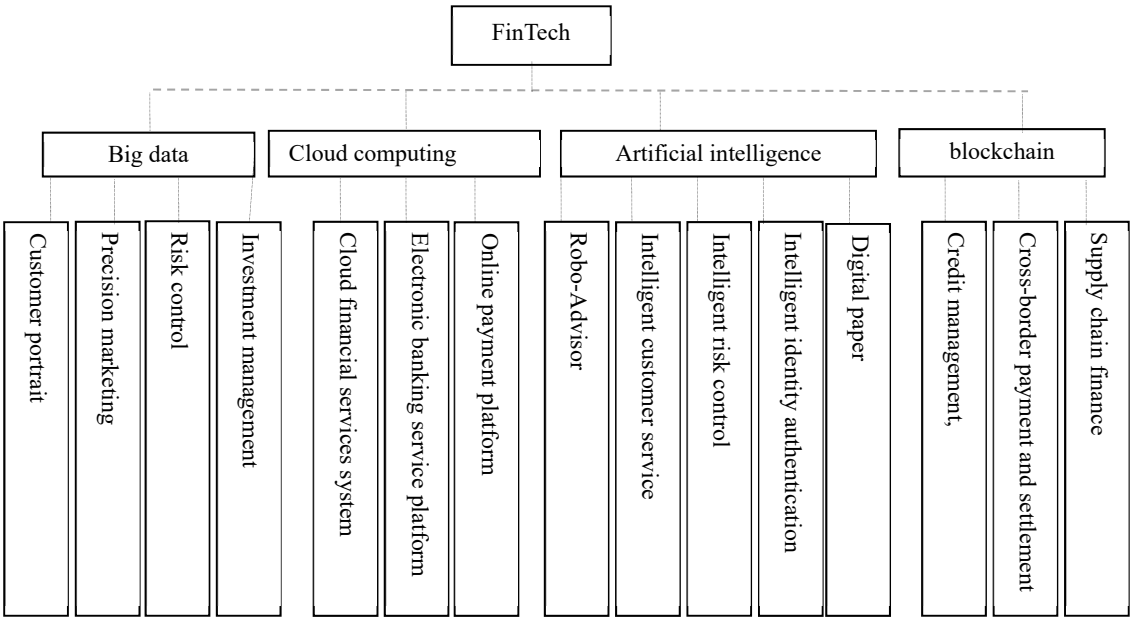

Figure 1. application scenario of FinTech in commercial banks

But it is worthy of noting that the development of science and technology is also a "double-edged sword". The history of financial innovation is full of precedents of early booms that eventually led to severe economic damage (Carney, 2017). Many scholars believe that FinTech brings new forms and models of business and promotes the transformation of the financial ecology, but also brings new risks. The FSB pointed out that as FinTech activities develop, the systemic risks arising from operational and cyber risks will increase (Board FSB, 2017). FinTech has led to fundamental changes in the financial sector, from the way institutions operate to the way capital is raised and

even currency itself (Magnuson, 2018). It reduces transaction costs, improves the availability of financial services, and improves the efficiency of financial markets, while increasing the complexity of financial business (Wang and Liang, 2018). It not only mutates traditional financial risks such as credit risk and liquidity risk, but also brings new risks such as data, technology and network risk, which greatly enhances the interactivity, complexity, concealment, infectivity and suddenness of risks (Zhu and Chen, 2016). The impact of FinTech on finance is very broad and deep. In a FinTech environment, financial risks occur, infect and spread more rapidly than ever before. Once the FinTech risk is triggered, it is likely to really trigger serious systemic risk. But how FinTech exactly works on commercial banks' risk-taking remains a "black box" that has yet to be opened. What are the new risks posed by FinTech? What is the effect mechanism of FinTech on the risk-taking of commercial Banks? Does the rapid development of FinTech increase or reduce the risk-taking of commercial banks? Is there heterogeneity in the response of different types of commercial banks to the impact of FinTech? The answers to these questions have important theoretical value and practical significance for promoting the integrated and coordinated development of FinTech and commercial banks, deepening the reform of financial system, maintaining financial security and stability, and ultimately avoiding the promotion of systemic risk in the banking system.

2. Literature Review

FinTech promotes innovation in financial markets to an ever-increasing extent. However, financial innovation may also blur the existing industry boundaries, subvert the existing industrial pattern, accelerate financial disintermediation, and introduce new financial risks. For example, since 2018, Lending Club, the largest P2P online Lending platform in the United States, illegally sold loans. The bitcoin exchange Bitfinex has been hacked and nearly 120,000 units of bitcoins have been lost. Many P2P companies in China misappropriate customer funds. Fake financing, illegal fund-raising and other phenomena occur frequently. How to control the potential risks of FinTech and implement effective regulation becomes increasingly urgent. Relevant institutions and scholars have also begun to discuss the risks brought by FinTech and the issues related to regulation. During the national "two sessions" in 2017, Zhou Xiaochuan, the governor of the People's Bank of China, stressed that the central bank actively encourages the development of financial technology and encourages technology enterprises to develop in the direction of inclusive finance. However, it should not only encourage progress, but also guard against risks and constantly regulate unhealthy behaviors encountered in the process of development.

The impact of risk and regulation on the development of FinTech was and is most important, perhaps as important as innovation itself (Navaretti and Pozzolo, 2017). Lakshmi Shyam-Sund, the vice President and chief risk officer of the World Bank, pointed out that there are three major risks of FinTech: the first is financial fraud by means of FinTech. The second is operational risk. Due to the lack of understanding of the complex technology of FinTech design by financial practitioners and consumers, it is easy to make operational mistakes and cause the risk of capital loss. The third

is the risk of customer privacy leakage (Zhang, 2018). Yang (2019) believes that FinTech makes the sources of risks of financial institutions more complex, aggravating the contagion and amplification effect of risks. FinTech business not only increases the convenience and availability of financial services, but also lowers the entry threshold for customers and introduces a large number of high-risk customers with uneven qualification levels (Jiang et al., 2019). In addition, there are some problems in the credit investigation system of China, such as incomplete credit data, and imperfect credit investigation supervision, which easily lead to credit risks

Li and Ye (2019) also pointed out that innovation and development of FinTech will bring about changes in risk types or risk characteristics, and various new risks and hidden dangers will appear. New risks include information technology risks (data leakage, technology out of control, technology change), operational risks, business risks and systemic risks (Yi et al., 2019). Information technology has the characteristics of cross-border operation and complex business models. While improving the quality and efficiency of financial services, it often leads to the constant renovation of the forms and connotations of financial risks, and increase the difficulty of risk identification and the speed of risk propagation (Cheng et al., 2017). FinTech not only has technology risks but also financial risks, and it may even strengthen financial risks (Zhong, 2018). From the perspective of actor network theory, Wang and Wu (2018) analyzed the influence mechanism of fintech on the systemic risk of the banking industry and empirically tested the influence degree, concluding that fintech aggravated the systemic risk of the banking industry to some extent. Yang (2017) pointed out that financial risks and challenges brought in progress of FinTech are as follows: data security and information technology risk caused by the improper application, credit risk because of the lack of information disclosure and information asymmetry, compliance risk because of the impact of financial innovation on traditional legislation, as well as cross-industry and cross-border financial fluctuations and contagion risks brought about by global connectivity. In order to realize the healthy development of FinTech, it is necessary to analyze and identify the potential risks of FinTech, and balance innovation and security (Yang, 2019).

Some scholars try to explore the root causes of fintech risks. FinTech leads to the generalization of financial risks, making the sources of financial cross-industry risks more dispersed and diversified (Zhou and Li, 2018). Zhu and Chen (2016) believes that FinTech makes financial risks more obscure, information technology risks and operational risks more prominent, and potential systematic and cyclical risks more complex. Take systemic risk as an example. First, FinTech strengthens the multi-institutional connection between data and business, increases the connection between various links in the financial industry, and increases the possibility of risk transmission. Second, FinTech has lowered the threshold for entry into the financial industry and strengthened the spread and spillover effects of risks. Third, the inclusive nature of FinTech increases the availability of financial products and the number of financial consumers, which are more likely to cause the "herd behavior" (Jin, 2019). Li (2019) also believes that the causes of systemic risk of FinTech

include being more sensitive to economic fluctuations, information asymmetry and the sharp expansion of scale of FinTech enterprises. The extensive use of FinTech in financial market also has a new type of moral hazard hidden danger. The automation, coding and invisibility of FinTech lead to the convenience and uncontrollability of adverse selection (Yuan and Deng ,2019). In order to seize market share, some FinTech companies may improve user convenience by reducing audit procedures or lowering customer threshold, bringing risks and hidden dangers of operation and violation (Cheng et al., 2017). On the whole, the potential risks of FinTech include traditional financial risks such as credit risk, liquidity risk, operational risk and legal compliance risk, systemic financial risks, as well as new risks caused by non-financial factors such as underlying information technology.

Some scholars also discussed the application of FinTech in risk management. Artificial intelligence technology can optimize asset portfolio according to compliance requirements, provide differentiated services for clients with different risk preferences, provide accurate measurement for risk management departments, and provide diversified solutions for risk identification, early warning and disposal (Li, 2018). Blockchain has the characteristics of distribution, traceability, expansibility and non-tamper, which can greatly improve the financing efficiency and control risks (Ma and Zhu, 2018). Quantitative models based on big data expand the data scope of risk management, optimize the overall process, and enrich the methods of risk data analysis (Lu and Xu, 2018). At present, AI, big data, block chain, such as cloud computing technology have been widely used in commercial banks. Fintech is playing an increasingly important role in payment and settlement, lending platform, intelligent investment and customer identity authentication (Cao, 2017). It is conducive to the internet-based transformation of traditional business, the upgrading of the original business model, the implementation of precision marketing, the rapid entry into the “long tail” blue ocean, and the expansion of non-interest income (Guo, 2017). It can help reduce the operating costs of commercial banks, improve the prevention and control level of risks, and enhance the ability to scenario-based financial services (Zhang and Jiang, 2018). Through the application of big data, cloud computing and distributed ledger technology, FinTech can provide ways for financial institutions to improve resource allocation efficiency, improve risk management ability and reduce risk concentration (Zhu and Chen, 2016). Relevant regulatory authorities use new concepts and methods such as regulatory sandbox and Regtech to optimize existing regulatory means and finally realize digital supervision (Wang et al., 2018).

The existing literature has laid a foundation for our research, but as fintech is a relatively new research field, relevant opinions and research conclusions are still controversial. Based on the above research, the existing literature has carried out studies in terms of concept definition, influence channel and risk source, and many beneficial conclusions have been obtained. Vigorously developing FinTech has increasingly become the consensus of the banking industry. But its drawbacks are also obvious. First, in terms of research content, most existing literature focuses on

experience summary and introduction, while there is less literature from a theoretical perspective exploring the mechanism whereby FinTech influences commercial banks' risk-taking. Second, in terms of research methods, most scholars have focused on normative analysis, and there were only a few relevant empirical studies. Third, in terms of research objects, most of the existing studies focus on the comprehensive research of national large commercial banks, but lack the comparative research on different types of banks.

The main contributions of this article are as follows: (1) By constructing a local equilibrium model of banks' risk-taking behavior under fintech constraints, we theoretically analyze the influence mechanism of fintech on banks' risk taking. (2) Text mining technology combined with factor analysis method is used to measure the development level of fintech in China. (3) Based on the annual balance panel dataset of 130 commercial banks in China from 2007 to 2017, this paper conducts empirical analysis on the impact of fintech on risk-taking of banking sector, and gives relevant policy suggestions.

3. Theoretical Analysis and Hypothesis Development

3.1 Theoretical Basis

According to existing studies, the impact mechanism of fintech on the risk taking of banks can be simplified into the following two directions: First, fintech forms a competitive relationship with commercial banks, crowding out the traditional deposit and loan business from banks, increasing capital cost, and finally leading to increased risk taking. For example, mobile payment has been widely used in offline consumption scenarios (Kim et al, 2015). In 2018, China ranked first in the world with the mobile payment scale of 277.4 trillion CNY. Fintech companies use new technology to tap into credit markets, expanding the range of customers, especially small and micro loan groups, and enriching the financial services that traditional commercial banks do not provide or cannot provide adequately (Gomber et al., 2018). As a result, bank deposit and loan spreads narrowed (Saunders and Schumacher, 2000).

Second, the integrated development of commercial bank and fintech improves the efficiency of financial services, improves operation management and reduces management costs, finally reducing the level of risk taking. The new consensus among fintech innovators is that future collaboration and empowerment will deliver more value than competition. The proper application of fintech will reduce the operation and management costs of commercial banks and enhance their profitability, thus leading to a weakened motivation to take risks (Hellmann et al.,2000). For example, big data can be applied to operation optimization, customer portrait, precision marketing, investment management and risk control, etc. Big data technology can quickly identify suspicious information and business violations. By integrating all information systems within a bank, cloud computing can eliminate information islands and realize centralized management of data. AI investment can help to overcome artificial subjective defects.

In addition, the risk-taking tendency of commercial banks is also influenced by bank’s individual

characteristics such as business strategy and asset size, as well as external factors such as macroeconomic environment, market structure and monetary policy (Ariss, 2010; Jimenez et al., 2013; Hou et al., 2014). In conclusion, the influence mechanism of FinTech on commercial banks' risk-taking is plotted in Figure 2.

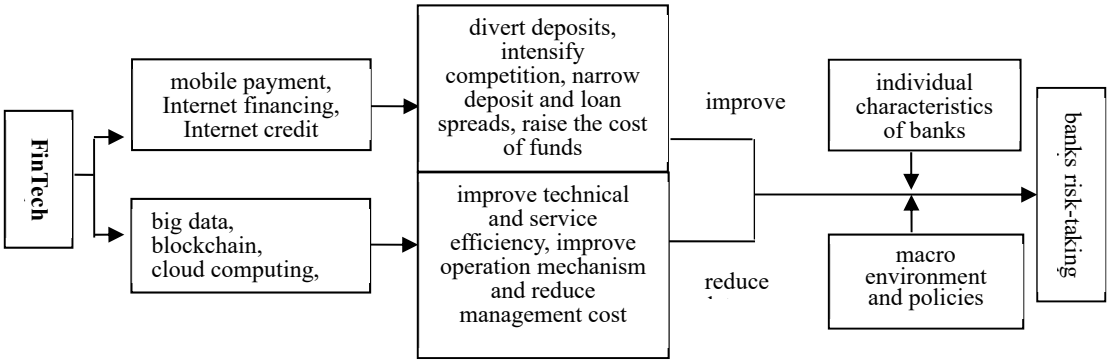

Figure 2. the influence mechanism of FinTech on commercial banks' risk-taking

3.2 Theoretical Model

Referring to Kishan and Opiela (2012), this paper adds "fintech" and "bank type" constraints to the model to explore the impact of fintech on the risk-taking of commercial banks. The basic assumptions of the model are as follows:

(i) Precondition setting: there is a representative commercial bank pursuing profit maximization, and its assets do not include other assets other than bank loans. The asset liability identity is simplified as: $R+L=D+K$ .Where, D is bank deposits; R is statutory deposit reserve, banks' excess reserves and reserve yields are zero; and $R=\rho D$, ρ is the deposit reserve ratio ($0<\rho<1$); L is bank loans; K is Bank capital.

(ii) Deposit market hypothesis: China's deposit interest rate has not been fully marketized and has been under control for a long time. The upper limit of deposit interest rate is effectively constrained, and the actual interest rate is lower than the equilibrium interest rate. Therefore, the scale of deposits taken by commercial banks is negatively correlated with the extent to which the market equilibrium interest rate r_D^* is higher than the benchmark interest rate of bank deposits r_D . There is, $D=D_0+D_1(r_D^*-r_D)$, $D_1<0$, D_0 is the size of deposits taken by the bank when r_D^* and r_D are equal. The impact of FinTech will reduce the difference between the equilibrium interest rate and the benchmark interest rate, increase the cost of capital, and narrow the spread between deposit and loan. There is, $r_D^*-r_D=d(FT)$ and $\partial d/\partial(FT)<0$.

(iii) Loan market hypothesis: China's loan interest rate has completed the process of marketization, and there is no corresponding lower bound of the loan interest rate. Therefore, the loan scale of commercial banks is positively correlated with the degree to which the equilibrium interest rate of

credit market r_L^* is higher than the bank credit pricing interest rate r_L . There is $L = L_0 + L_1(r_L^* - r_L)$, $L_1 > 0$, L_0 is the fixed loan scale. The equilibrium interest rate in the credit market r_K^* fluctuates around the equilibrium deposit interest rate r_D^* . There is, $r_K^* = r_D^* + \tau_K$,the float term τ_K is constant.

(iv) Capital market hypothesis: the financing scale of commercial banks is negatively correlated with the market equilibrium interest rate r_K^* higher than the return on capital of banks r_K . There is, $K = K_0 + K_1(r_K^* - r_K)$, $K_1 < 0$, K_0 is the amount of capital raised by the bank when r_K^* and r_K are equal. The market equilibrium interest rate r_K^* fluctuates around the equilibrium deposit interest rate r_D^* . There is, $r_K^* = r_D^* + \tau_K$, the floating term τ_K is constant.

(v) Management cost hypothesis: based on the practice of Gu and Yang (2018), it is assumed that commercial banks only have management costs related to loan business in their daily operations. And the larger the size of the loan, the higher the cost. According to the strict convexity and second-order continuous differentiability of the cost function, the management cost function is set as: $C = (\lambda / 2)L^2$, $\lambda > 0$, λ represents the marginal management cost coefficient. The development of FinTech can improve the operating efficiency of banks and reduce the marginal management cost. There is, $\lambda = \lambda(FT)$ and $\partial\lambda(FT)/\partial(FT) < 0$.

Therefore, the profit function and constraint conditions of commercial Banks are as follows:

$$max\ \Pi = r_L L - r_D D - r_K K - C \tag{1}$$

$$s.t.\begin{cases} R + L = D + K,\ R = \rho D,\ 0 < \rho < 1 \\ D = D_0 + D_1(r_D^* - r_D),\ D_1 < 0,\ r_D^* - r_D = d(FT),\ \partial d / \partial(FT) < 0 \\ L = L_0 + L_1(r_L^* - r_L),\ L_1 > 0,\ r_L^* = r_D^* + \tau_L \\ K = K_0 + K_1(r_K^* - r_K),\ K_1 < 0,\ r_K^* = r_D^* + \tau_K \\ C = (\lambda / 2)L^2,\ \lambda = \lambda(FT),\ \partial\lambda(FT)/\partial(FT) < 0 \end{cases} \tag{2}$$

3.3 Model Solution and Hypothesis

We substitute the constraint into the profit function, and arrange formula (1) as a function of Π to the loan variable L , and take the first derivative of Π with respect to L . Let's set the first derivative $F = \partial\Pi / \partial L = 0$:

$$F = r_L^* - r_K^* - \frac{2L - L_0}{L_1} + \frac{2\left[L - (1-\rho)D\right] - K_0}{K_1} - \lambda(FT)L = 0 \tag{3}$$

Then, the optimal loan demand function of representative commercial banks is:

$$\overline{L} = \frac{\Phi_1 + \Phi_2 D}{\Phi_3 - \Phi_4 \lambda(FT)} \tag{4}$$

Where, $\Phi_1 = L_1 K_0 - L_0 K_1 + (\tau_K - \tau_L) L_1 K_1 > 0$, $\Phi_2 = 2L_1(1-\rho) > 0$, $\Phi_3 = 2(L_1 - K_1) > 0$, $\Phi_4 = L_1 K_1 < 0$.

The function of RISK about FinTech (FT) is as follows[2]:

$$RISK = \frac{R+L}{K} = \frac{\Phi_1 + \Phi_2 D + \rho D\left[\Phi_3 - \Phi_4 \lambda(FT)\right]}{\Phi_1 + \Phi_2 D - (1-\rho) D\left[\Phi_3 - \Phi_4 \lambda(FT)\right]} \tag{5}$$

Next, FinTech (FT) constraint is introduced to explore the mechanism of its effect on banks' risk-taking level.

(i) FinTech and capital cost. Combined with equation (5), differentiate RISK with respect to FT via $d(FT)$, and we can get:

$$\left(\frac{\partial RISK}{\partial FT}\right)_d = \frac{\Phi_1 D_1\left[\Phi_3 - \Phi_4 \lambda(FT)\right]}{\left\{\Phi_1 + \left[\Phi_5 + \Phi_6 \lambda(FT)\right]\left[D_0 + D_1 d(FT)\right]\right\}^2} \times \frac{\partial d(FT)}{\partial FT} > 0 \tag{6}$$

In equation (6), $\Phi_5 = 2K_1(1-\rho) < 0$, $\Phi_6 = L_1 K_1 (1-\rho) < 0$. FinTech has raised the cost of capital for banks, narrowing the interest rate spread between deposits and loans. As a result, the traditional interest rate income business is hurt and the profit space shrinks, resulting in the increase of the risk-taking tendency of banks. In other words, FinTech increases banks' risk-taking through the cost of capital route.

(ii) FinTech and management costs. Combined with equation (5), differentiate RISK with respect to FT via $\lambda(FT)$, and we can get:

$$\left(\frac{\partial RISK}{\partial FT}\right)_\lambda = \frac{-\Phi_1 \Phi_4\left[D_0 + D_1 d(FT)\right] - \Phi_7\left[D_0 + D_1 d(FT)\right]^2}{\left\{\Phi_1 + \left[\Phi_5 + \Phi_6 \lambda(FT)\right]\left[D_0 + D_1 d(FT)\right]\right\}^2} \times \frac{\partial \lambda(FT)}{\partial FT} < 0 \tag{7}$$

In equation (7), $\Phi_7 = 2L_1^2 K_1 (1-\rho) < 0$. The application of FinTech in banks improves the operational efficiency and profitability of banks, reduces management costs, and thus weakens the motivation of banks to take excessive risks. In other words, FinTech mitigates banks' risk-taking

[2]Some studies have used Z-score, volatility of asset return, volatility of stock return, non-performing loan ratio, risk-weighted asset ratio and asset capital ratio as proxy variables of risk-taking. However, in order to adapt to the setting of theoretical model, we adopted asset capital ratio for mechanism analysis.

through the management cost path.

It can be seen that the influence mechanism of FinTech on the risk-taking level of banks can be summarized as the dual channels of raising capital cost and reducing management cost. The direction of its comprehensive influence depends on the relative action intensity of the two channels, that is, the symbol of $\frac{\partial RISK}{\partial FT}=\left(\frac{\partial RISK}{\partial FT}\right)_d+\left(\frac{\partial RISK}{\partial FT}\right)_\lambda$ may be greater than, less than or equal to zero.

In addition, judging from the actual development process of FinTech in China, in the early stage dominated by Internet finance, FinTech caused obvious impact on commercial banks' assets, liabilities and payment businesses through third-party payment, P2P online lending and Internet financial management. It reduces the interest income and non-interest income of the bank and squeezes its profit space, thus increasing the risk-taking of commercial banks. However, with the gradual development and maturity of FinTech, big data, cloud computing, AI, blockchain and other key FinTech technologies have been widely applied in commercial banks' daily operations and risk management. It greatly improves the service level of the bank, improves the efficiency of resource allocation, strengthens the risk management ability, and decreases management cost. At the same time, relevant regulatory authorities have used innovative ideas and tools, such as Regulatory Sandbox and RegTech, to optimize regulatory methods and reduce the potential risks of FinTech.

Take into account this, **proposition 1** of this paper is put forward: the influence of FinTech on commercial banks' risk-taking shows an inverted u-shaped trend. That is, in the primary stage, the role of FinTech is mainly to raise the cost of capital, thus increasing the risk of banks. However, with continuous integration and development of commercial banks and FinTech, FinTech will reduce management costs, which in turn will reduce Bank risk-taking.

(iii) heterogeneity of response of different types of commercial banks to FinTech.

It can be seen that Φ_1 in equations (6) and (7) both contain the bank size variable L_0. Therefore, in order to explore whether the response of different types of commercial banks to the impact of FinTech is heterogeneous, equations (6) and (7) are respectively differentiated with respect to variable L_0:

$$\frac{\left(\partial RISK/\partial FT\right)_d}{\partial L_0}=\frac{\Phi_8 K_1 D_1\left(\Phi_3-D_4\lambda(FT)\right)}{\Phi_9^3}\times\frac{\partial d(FT)}{\partial FT}<0 \tag{8}$$

$$\frac{\left(\partial RISK/\partial FT\right)_\lambda}{\partial L_0}=\frac{-\Phi_4\Phi_8 K_1 D^2-2\Phi_7 K_1 D^3}{\Phi_9^3}\times\frac{\partial \lambda(FT)}{\partial FT}>0 \tag{9}$$

Where, $\Phi_8=\Phi_1-D\left[\Phi_5+\Phi_6\lambda(FT)\right]>0, \Phi_9=\Phi_1+D\left[\Phi_5+\Phi_6\lambda(FT)\right]>0$. Equations (8) and (9) show that the influence of FinTech on the risk-taking of commercial banks decreases

with the increase of the variable of bank size L_0.That is, the response of large and medium-sized commercial banks is not so strong when facing the impact of FinTech, and the change degree of risk-taking level is lower than that of local small commercial banks.

Based on this, **proposition 2** of this paper is put forward: different types of commercial banks have heterogeneous responses to the influence of FinTech. Compared with regional small commercial banks, large and medium-sized commercial banks are more cautious in risk-taking.

4. Variable Selection and Empirical Design

4.1 Samples and Data Sources

The data is mainly derived from BVD-ORBIS Bank Focus database, with the missing data on staff numbers and costs in this database manually extracted from the annual reports of each bank. Data of 130 commercial banks in China were collected for this research, including 5 large state-owned commercial banks, 12 joint-stock banks, 76 relatively large size urban commercial banks, and 37 rural commercial banks with more complete data. The sample period is from 2007 to 2017. Except for fintech index (FTI1 and FTI2) calculated in this paper, the other data not available in Bankscope are from databases such as CSMAR and CEIC. All calculations are performed using Excel, Eviews 10 and Stata15. The samples in this paper cover all types of commercial banks except foreign banks. Their total assets, deposits and loans account for more than 95% of China's banking sector, which is relatively representative.

4.2 Variable Selection

4.2.1 The Independent Variables: FinTech Index (FT)

The Financial Stability Board (FSB) and the Basel Committee on Banking Supervision (BCBS) classify FinTech activities as: payment and settlement, deposit and loan and capital raising, investment management, market facilities, etc. From the perspective of financial function, this paper adopts Text Mining Technology, principal component and factor analysis to measure the FinTech index (FTI). The advantages of this method are as follows: First, it can cover all kinds of FinTech models. Second, it can ensure the unity and stability of the data properties of all formats. Specific measurement steps are as follows:

Step one: Preprocessing of text information. Based on the view of financial function, this paper establishes the original vocabulary of FinTech, and divides the functions of FinTech into the following five aspects: payment and settlement, network financing, information channel, wealth management and risk management. The five f functions are decomposed into 15 keywords, as shown in table 2:

Table 2. Description of the Original Vocabulary

	payment and settlement	network financing	information channel	wealth management	risk management
Financial function	1. Third-party payment	4. Online lending	7. Big data finance	10. Internet financing	13. AI + finance

segmentation	2. Mobile payment	5. Crowdfunding	8. Cloud computing finance	11. Robot-adviser	14. Blockchain
	3. Digital currency	6. E-commerce small loan	9. Internet of things finance	12. Internet insurance	15. Biometrics + finance

Step two: Text Mining. With the help of Baidu search engine, we obtain the frequency of each original word between 2006 to 2017. The word frequency is used as data base for quantifying fintech index. The more information and higher frequency related to the keywords, the better development of FinTech.

Step three: Principal component and factor analysis. The above15 keywords are defined as S_1, S, S_3、 S_4, S_5, S_6, S_7, S_8, S_9, S_{10}, S_{11}, S_{12}, S_{13}, S_{14} and S_{15}. Then, software SPSS is used to conduct KMO test on these 15 variables.

Step four: Synthesize the FinTech index. The two common factors can be expressed linearly as:

$$\begin{aligned} F_1 = {} & 0.521\times S_1 + 0.592\times S_2 + 0.913\times S_3 + 0.523\times S_4 + 0.405\times S_5 + 0.861\times S_6 \\ & + 0.805\times S_7 + 0.728\times S_8 + 0.931\times S_9 + 0.842\times S_{10} + 0.256\times S_{11} \\ & + 0.729\times S_{12} + 0.386\times S_{13} + 0.337\times S_{14} + 0.913\times S_{15} \end{aligned} \quad (10)$$

$$\begin{aligned} F_2 = {} & 0.786\times S_1 + 0.742\times S_2 + 0.333\times S_3 + 0.837\times S_4 + 0.909\times S_5 + 0.321\times S_6 \\ & + 0.463\times S_7 + 0.499\times S_8 + 0.333\times S_9 + 0.521\times S_{10} + 0.969\times S_{11} \\ & + 0.629\times S_{12} + 0.902\times S_{13} + 0.902\times S_{14} + 0.333\times S_{15} \end{aligned} \quad (11)$$

Finally, we get FinTech index (FTI), which is shown in Table 4. The larger the index, the higher the level of fintech development. In order to compare, the Baidu search frequency of "FinTech" from 2007 to 2017 is selected as the reference index.

4.2.2 The Dependent Variable: Bank Risk-taking (RISK)

As for the measurement of banks' risk-taking, common methods include: weighted risk asset ratio, non-performing loan ratio, capital adequacy ratio (Gu and Zhang, 2018), loan loss preparation rate, capital asset ratio (Yao et al., 2011), equity-to-liability ratio, Z-score, expected default probability (Niu and Qiu, 2013), stock market volatility and stock price volatility, etc. The data of weighted risk assets and capital adequacy ratio are missing. The calculation of expected default probability and stock market volatility requires stock trading data, and most of China's banks are not listed yet. Z-score only represents bankruptcy risk rather than risk-taking. In addition, China's government has implicit guarantee for commercial banks, so bank's bankruptcy risk is small. Therefore, in order to adapt to the setting of the theoretical model in this paper, the asset-capital ratio is adopted as the risk-taking variable. The higher the asset-capital ratio, the more obvious the risk-taking tendency. At the same time, in order to ensure the robustness of our conclusion, equity-to-liability ratio and non-performing loan ratio were selected as alternative dependent variables. The higher the equity-to-liability ratio, the lower the bank risk-taking. And the higher the non-performing loan ratio, the higher the risk of commercial banks. In order to ensure consistency of empirical analysis symbols, the negative equity-liability ratio is adopted in regression.

4.2.3 Control Variables

Based on the analysis of the existing literature, this paper selects control variables from three aspects: micro, industrial and macro economy. At micro level, the factors that affect banks' risk-taking mainly include: (1) Operating efficiency. We select cost-income ratio of banks as the proxy variable. Generally speaking, the higher the operating efficiency is, the lower the risk-taking level of the bank will be. (2) Liquidity levels. We select loan-deposit ratio as the proxy variable. At industrial level, considering the main change of China's banking industry in recent years is that its external competitive environment has changed greatly due to the market opening to foreign institutions. Therefore, the concentration of the banking industry (the proportion of total assets of the top four banks) and the openness degree of the banking industry (the proportion of the employees of foreign banks accounting the whole industry) were selected as proxy variables. Control variables in macro level include:(1) Macroeconomic development. We select the real GDP growth rate. (2) Financial correlation ratio. The ratio of money supply (M2) to GDP is selected. (3) Monetary policy. M2 growth rate is chosen as the proxy variable. Definition and descriptive statistics of the above variables are reported in table 3 and table 4.

Table 3. Variable Definitions

	The variable name	Variable symbol	Variable definitions
Explained variable	asset-capital ratio	*ACra*	Total assets/total owners' equity
	equity-to-liability ratio	*ETD*	Bank equity to liabilities ratio (%)
	non-performing loan ratio	*NPLra*	Year-end non-performing loan ratio (%)
Core explanatory variable	FinTech index 1	*FTI1*	It is synthesized by text mining method
	FinTech index 2	*FTI2*	Calculated by arithmetic average method
Control variables	Operational efficiency	*CRra*	Bank cost-income ratio = operating income/operating expenses
	Liquidity level	*LDR*	Bank loan-to-deposit ratio = total deposits/total loans
	Industry concentration	*CR4*	the proportion of the assets of the top four banks
	Degree of banking openness	*OPEN*	the proportion of the number of employees of foreign banks in the whole industry *100
	Level of macroeconomic development	*GDP*	The natural logarithm of last year's GDP (1 billion CNY)
	Financial correlation ratio	*FIR*	Money supply (M2)/GDP
	Monetary policy	*M2*	M2 growth rate (sequential)

Note: In order to avoid the problem that the estimation coefficient is too large or too small, in the regression process, the asset capital-ratio variable ACra is reduced by 10 times and the operating efficiency variable CRra is enlarged by 10 times.

Table 4. Descriptive Statistics of Variables

Variable	mean	maximum	minimum	standard deviation	Probability	Number of observations

ACra	15.212	45.370	4.251	4.044	0.000	1042
FTI1	0.083	0.146	0.000	0.058	0.000	1042
FTI2	0.115	0.223	0.000	0.092	0.000	1042
CRra	2.398	97.024	1.011	3.517	0.000	1042
LDR	1.614	4.755	0.399	0.385	0.000	1042
CR4	0.413	0.505	0.352	0.049	0.000	1042
OPEN	1.208	1.325	1.023	0.089	0.000	1042
GDP	10.948	11.315	10.204	0.295	0.000	1042
FIR	1.885	2.095	1.488	0.167	0.000	1042
M2	0.144	0.284	0.090	0.046	0.000	1042
NPLra	1.464	12.130	0.000	1.048	0.000	1042
ETD	0.076	0.308	0.023	0.024	0.000	1042

Note: the period of all variables is from 2007 to 2017, in which the variables of total bank assets and GDP related to prices are adjusted according to CPI based on 2007.

4.3 Econometric Models

Considering the lagged impact of fintech on commercial Banks' risk-taking, the first-phase lag term of the risk-taking variable was added into the empirical model. Finally, this paper establishes a set of multivariate panel regression models based on non-balanced panel data as follows:

$$\text{Model (1)}: ACra_{i,t} = \beta_0 + \beta_1 ACra_{i,t-1} + \beta_2 FTI_t + \beta_3 FTI_t^2 + \sum_{j=1}^{7} \gamma_j Control_{j,it} + u_i + \varepsilon_{it}$$

$$\text{Model (2)}: ETD_{i,t} = \beta_0 + \beta_1 ETD_{i,t-1} + \beta_2 FTI_t + \beta_3 FTI_t^2 + \sum_{j=1}^{7} \gamma_j Control_{j,it} + u_i + \varepsilon_{it}$$

$$\text{Model (3)}: NPLra_{i,t} = \beta_0 + \beta_1 NPLra_{i,t-1} + \beta_2 FTI_t + \beta_3 FTI_t^2 + \sum_{j=1}^{7} \gamma_j Control_{j,it} + u_i + \varepsilon_{it}$$

Where ACra, ETD and NPLra in model (1), model (2) and model (3) are risk-raking variables. *FTI* is the core explanatory variable of FinTech development index, and FTI_t^2 is used to describe the non-linear relationship between FinTech and banks' risk-taking. β and γ are regression coefficients vector, *Control* is a set of Control variables considered in this paper, u_i is the bank's fixed effect, and ε_{it} is the robust standard errors.

5. Model Estimation Results and Analysis

5.1 Method Selection of Estimation

In order to avoid possible multicollinearity problems, the correlation test of the control variables was performed before regression. The results show that the correlation coefficients between variables are small, which means that there is no serious multicollinearity problem. Furthermore, in order to prevent the problem of "false regression", the panel model requires the data

to be stable. In this paper, Hadri LM, IPS and HT test methods are adopted to conduct a panel unit root test for bank-level variables, such as ACra, ETD, NPLra and CRra. The results demonstrate that none of the five variables have unit roots. Therefore, there will be no false regression in regression analysis. Due to space reasons, the test results are not repeated.

In addition, for the static panel, there are a variety of Estimation methods such as mixed regression (POOL) and fixed effect (FE) and random effect (RE) regression. Firstly, F test is performed on the model to determine whether to use a mixed regression model or individual fixed effect model. The test result shows that the p-value of f-test for model 1, model 2 and model 3 is 0.000, so the null hypothesis is rejected. That is, the individual fixed effect model is obviously superior to mixed regression. Secondly, Hausman test is carried out, and the test results showed that the P value corresponding to the null hypothesis that "individual effect is independent of regression variables" is 0.000. Therefore, individual fixed effects (FE) model should be used instead of individual random effects (RE) model.

Table 5. Model Selection Test Results

test method	statistic	Mode1		Mode2		Mode3	
		FTI1	FTI2	FTI1	FTI2	FTI1	FTI2
F test	F statistic	2.22 (0.000)	2.22 (0.000)	3.55 (0.000)	3.54 (0.000)	2.76 (0.000)	2.80 (0.000)
Hausman test	chi2	174.44 (0.000)	174.62 (0.000)	141.98 (0.000)	142.37 (0.000)	104.95 (0.000)	104.79 (0.000)

Note :() is P value

5.2 Regression Result Analysis

Based on the above analysis, table 7 reports the fixed effects (FE) estimate results for models (1), (2), and (3).

Table 6. Regression Results of Panel Data

Variable symbol	model（1）		model（2）		model（3）	
	FTI1	FTI2	FTI1	FTI2	FTI1	FTI2
Acra(-1)	0.377*** (0.03) 14.32	0.376*** (0.03) 14.29				
ETD(-1)			0.362*** (0.02) 18.17	0.362*** (0.02) 18.10		
NPLra(-1)					0.526*** (0.02) 25.06	0.526*** (0.02) 25.28
FTI1	5.88** (2.43) 2.42	1.532* (0.88) 1.75	0.377*** (0.14) 2.79	0.067 (0.05) 1.37	11.227** (4.69) 2.39	6.578*** (1.67) 3.93
FTI11	-43.176*** (16.97) -	-11.997** (5.63) -2.13	-2.828*** (0.94) -3.00	-0.599* (0.31) -1.92	-81.016*** (32.69) -2.48	-45.788*** (10.73) -4.27

	2.54					
CRra	-0.166	-0.165	-0.012	-0.012	0.163	0.154
	（0.23）-0.74	（0.23）-0.73	（0.01）-0.97	（0.01）-0.96	（0.43）0.38	（0.43）0.36
LDR	0.110***	0.107***	0.004**	0.004**	0.162***	0.148***
	（0.03）3.63	（0.03）3.53	（0.00）2.21	（0.00）2.13	（0.06）2.70	（0.06）2.49
CR4	2.734	-1.512	0.268	-0.044	35.331***	31.738***
	（3.14）0.87	（2.16）-0.70	（0.17）1.54	（0.12）-0.37	（6.02）5.87	（4.08）7.77
OPEN	-1.110***	-0.782***	-0.072***	-0.042**	-2.541***	-3.082***
	（0.40）-2.75	（0.32）-2.47	（0.02）-3.23	（0.02）-2.39	（0.78）-3.26	（0.61）-5.08
GDP	0.549	0.123	0.043	0.004	4.997***	5.564***
	（0.52）1.06	（0.42）0.29	（0.03）1.49	（0.02）0.18	（1.00）5.02	（0.81）6.90
FIR	0.023	-0.083	0.015	0.010	0.982*	0.590
	（0.29）0.08	（0.29）-0.28	（0.02）0.92	（0.02）0.60	（0.56）1.76	（0.56）1.06
M2	1.748***	1.623**	0.064*	0.046	0.165	1.126
	（0.68）2.55	（0.69）2.37	（0.04）1.69	（0.04）1.22	（1.32）0.13	（1.30）0.86
cons	-5.389	0.990	-0.587	-0.050	-69.154***	-72.271***
	（6.52）-0.83	（5.00）0.20	（0.36）-1.62	（0.28）-0.18	（12.51）-5.53	（9.50）-7.61

Note：regression coefficients in parentheses is the standard error；the value of T is outside the parentheses；***, ** and * indicate significance at the level of 1%, 5% and 10% respectively

The regression results in table 6 show that the estimated coefficients of primary item FTI and squared item FTI11 of the FinTech index in model (1), model (2) and model (3) are highly consistent. The coefficient of FTI was positive and significant in all three models, while the coefficient of FTI11 was negative and significant, indicating that the influence of FinTech on commercial banks' risk-taking presented an inverted "U" type relationship. This shows that in early stage, the development of FinTech improves risk-taking level of commercial banks, but with the progress of FinTech, the risk-taking level of commercial banks is reduced in the later stage. In the early stages, when Internet finance dominated, due to the influence of third-party payment, P2P online lending and other aspects, fintech has caused a great negative impact on commercial Banks, narrowing the deposit and loan spreads, raising the cost of capital, reducing bank interest income and non-interest income, and finally increasing the risk of commercial banks. However, with development and maturity of FinTech, a number of Internet enterprises have gradually transformed into FinTech companies to provide technology solutions for financial institutions. At the same time, commercial banks began to increase FinTech to a strategic level, actively absorb information technology and upgrade their business models and service levels with the help of emerging technologies. The industrial ecology gradually changed from competition to cooperation. Key FinTech technologies such as big data, cloud computing, artificial intelligence and blockchain have been widely applied in commercial banks' daily operations and risk management, greatly improving the operational efficiency of traditional commercial banks, optimizing resource allocation, reducing management costs and enhancing risk control capabilities. Relevant regulatory authorities have also started to use new ideas and methods, such as sandbox regulation and regtech to optimize existing regulatory

means and reduce the potential risks of FinTech. Finally, the overall impact of FinTech on commercial banks is to reduce their risk-taking level. Proposition 1 of this paper is preliminarily confirmed.

5.3 Other Robustness Tests

The robustness test was conducted by rebuilding panel data from two aspects. One is shortening sample time and the other is applying risk-taking variable lagged by 2 periods. The results of fixed effect (FE) estimation based on the Hausman test are reported in table 7:

Table 7. Robustness Test Results

	Risk-taking variables lag by 2 periods			2009-2017		
Variable symbol	panel（4）	panel（5）	panel（6）	panel（7）	panel（8）	panel（9）
Acra(-1)	0.375***			0.299***		
	（0.03）10.80			（0.03）10.10		
Acra(-2)	-0.056**					
	（0.03）-1.95					
ETD(-1)		0.357***			0.337***	
		（0.03）10.48			（0.02）15.50	
ETD(-2)		-0.080***				
		（0.02）-3.55				
NPLra(-1)			0.566***			0.521***
			（0.04）15.70			（0.02）22.95
NPLra(-2)			0.008			
			（0.03）0.29			
FTI1	7.487**	0.370**	15.817**	6.323*	0.610***	3.910
	（3.37）2.22	（0.18）2.02	（6.54）2.42	（3.56）1.78	（0.21）2.86	（6.53）0.60
FTI11	-55.644**	-2.935**	-117.972***	-45.648*	-4.718***	-65.898
	（24.42）-2.28	（1.33）-2.21	（47.31）-2.49	（27.80）-1.64	（1.67）-2.83	（50.99）-1.29
CRra	-0.164	-0.013	0.225	-0.227	-0.014	-0.161
	（0.22）-0.76	（0.01）-1.07	（0.41）0.55	（0.21）-1.08	（0.01）-1.14	（0.38）-0.42
LDR	0.095***	0.004**	0.140**	0.090***	0.003*	0.173***
	（0.03）2.88	（0.00）2.15	（0.07）2.09	（0.03）3.11	（0.00）1.79	（0.06）3.14
CR4	3.892	0.445	38.510**	3.203	1.392	79.529***
	（9.22）0.42	（0.50）0.89	（17.76）2.17	（14.97）0.21	（0.90）1.55	（27.42）2.90
OPEN	-1.368***	-0.072***	-3.435***	-1.287***	-0.100***	-1.559*
	（0.51）-2.71	（0.03）-2.61	（0.98）-3.50	（0.49）-2.64	（0.03）-3.42	（0.90）-1.74
GDP	0.856	0.081	5.789**	0.677	0.192*	8.757***
	（1.33）0.64	（0.07）1.12	（2.57）2.26	（1.94）0.35	（0.12）1.65	（3.55）2.47
FIR	-0.079	0.026	0.775	-0.095	0.141	13.925***
	（0.92）-0.09	（0.05）0.52	（1.77）0.44	（1.80）-0.05	（0.11）1.31	（3.29）4.23
M2	2.304***	0.112**	0.874	2.278*	0.064	9.413***
	（0.88）2.61	（0.05）2.34	（1.70）0.51	（1.29）1.77	（0.08）0.84	（2.37）3.97
cons	-8.684	-1.113	-77.664**	-6.478	-2.890	-154.654***

	（19.50-0.45	（1.06）-1.05	（37.61）-2.07	（30.17）-0.21	（1.81）-1.60	（55.24）-2.80		

Note: regression coefficient is standard error within () and T value outside (). ***, ** and * indicate significance at the level of 1%, 5% and 10% respectively.

As can be seen from table 7, both under the case that the risk-taking variable lagged 2 years and study period is changed to 2009-2017, the key explanatory variable estimated by all three models, the FinTech development index coefficient, is of the same size, the same direction and basically the same significance. Although the significance of estimated coefficients in model 3 decreased, but the sign direction of the coefficients did not change at all. The coefficient symbols of other control variables also remain unchanged and the significance is basically the same. Overall, the estimation results of this paper are robust and reliable.

5.4 Heterogeneity Test of the Impact of FinTech on Banks' Risk-taking

To test the heterogeneous impact of FinTech on banks; risk-taking, we refer to the practice of Guo and Shen (2015) , a dummy variable TY representing the commercial bank type, is introduced into the model, with a value of "1" assigned to large and medium-sized banks and "0" to small banks. Based on model (1), an interaction term for FinTech index and bank type FTI*TY is introduced to establish the nonlinear multiple regression model as shown in equation (10).

$$ACra_{i,t} = \beta_0 + \beta_1 ACra_{i,t-1} + \beta_2 FTI_t + \beta_3 FTI_t \times TY_i + \beta_4 FTI_t^2 + \beta_5 FTI_t^2 \times TY_i + \sum_{j=1}^{8} \gamma_j \text{Control}_{jit} + u_i + \varepsilon_{it} \quad (10)$$

As for the classification standard of banks, previous literatures are usually according to bank's assets sizes (Zhang and Wang, 2013), or defined joint-stock banks as medium-sized banks, and the urban commercial and rural commercial banks as small banks (Ma, 2019). Based on the practice of Zhang and Wang (2013), this paper classified the sample banks according to their asset size. Given that the median of total assets of the sample banks at the end of 2017 was 193.769 billion CNY, the banks with total assets over 200 billion CNY at the end of 2017 were defined as large and medium-sized banks. There are altogether 64 large and medium-sized banks including 5 large state-owned banks and 12 joint-stock banks. The other 66 banks with total assets under 200 billion CNY were defined as small banks, including 36 urban commercial banks and 30 rural commercial banks. Table 8 reports the regression results of panel (10) based on FTI1 and the results of panel (11) based on FTI2.

Table 8. Heterogeneity Test Results of the Model

	panel model（10）：FTI1				panel model（11）：FTI2			
	Random effects		Fixed effects		Random effects		Fixed effects	
Variable symbol	coefficient	T value	coefficient	T value	coefficient	T value	coefficient	T value
Acra(-1)	0.625***	31.70	0.372***	14.10	0.636***	32.27	0.372***	14.12

	（0.02）		（0.03）		（0.02）		（0.03）	
FTI	3.541	1.33	4.302*	1.66	1.029	1.02	1.325	1.38
	（2.67）		（2.60）		（1.01）		（0.96）	
FTI*TY	5.220***	4.31	2.974**	1.87	1.122**	2.16	0.257	0.46
	（1.21）		（1.59）		（0.52）		（0.56）	
FTI^2	-25.315	-1.35	-29.258*	-1.62	-10.087*	-1.61	-9.757*	-1.66
	（18.71）		（18.04）		（6.28）		（5.87）	
FTI^2*TY	-36.635***	-3.96	-25.514**	-2.37	-33.234**	-1.70	-28.336	-1.49
	（9.26）		（10.78）		（19.59）		（18.98）	
CRra	-0.301	-1.46	-0.153	-0.68	-0.288	-1.38	-0.142	-0.63
	（0.21）		（0.22）		（0.21）		（0.22）	
LDR	0.095***	4.91	0.111***	3.70	0.094***	4.78	0.108***	3.58
	（0.02）		（0.03）		（0.02）		（0.03）	
CR4	0.770	0.23	2.597	0.83	-3.260	-1.41	-1.220	-0.57
	（3.33）		（3.12）		（2.31）		（2.16）	
OPEN	-0.901**	-2.10	-1.086***	-2.70	-0.630*	-1.85	-0.814***	-2.58
	（0.43）		（0.40）		（0.32）		（0.32）	
GDP	0.328	0.60	0.507	0.98	0.041	0.09	0.209	0.49
	（0.55）		（0.52）		（0.46）		（0.42）	
FIR	-0.036	-0.12	0.037	0.13	-0.213	-0.68	-0.101	-0.35
	（0.31）		（0.29）		（0.31）		（0.29）	
M2	2.056***	2.83	1.712***	2.52	2.061***	2.80	1.660**	2.43
	（0.73）		（0.68）		（0.74）		（0.68）	
cons	-2.715	-0.39	-4.918	-0.76	2.230	0.41	0.003	0.00
	（6.92）		（6.49）		（5.38）		（5.00）	

Note: the regression coefficients in brackets are standard errors. ***, ** and * indicate significance at the levels of 1%, 5% and 10%, respectively.

Table 8 shows that the multiply items FTI*TY, except for the fixed effect (FE) of panel (11), all passed the significance test. Among them, the regression coefficient of multiply items FTI*TY was significantly positive, and the coefficient of FTI2*TY was significantly negative. This result is consistent with the expectation of proposition 2, indicating that different types of banks' risk-taking have significantly different responses to the impact of FinTech. In the early stages of fintech dominated by Internet finance with high-risk characteristics, because of its relatively fixed client base, huge size and more stringent regulation, large and medium-sized banks reacted more cautiously to the new business model. But in the late stage when the development of key fintech technologies such as cloud computing, big data, artificial intelligence and blockchain is maturing, with its advantages in capital strength, profitability and skilled employees, it is easier for large and medium-sized banks to actively integrate fintech through independent research and development, external mergers and acquisitions or cross-border cooperation to make full use of the new development opportunities brought by fintech. Finally, large and medium-sized banks have generally been more cautious in their response to fintech than regional smaller banks.

Obviously, after introducing the dummy variable of bank type, the basic conclusion of the model did not change. The square term FTI^2 are still significantly negative in all regression results, and the primary term FTI was still positive. This shows that, on the whole, the influence of FinTech on the risk-taking of commercial banks still presents an inverted u-shaped relationship. In the early stage, FinTech increase banks' risk-taking, but reduce banks' risk-taking in the later stage, which further verified proposition 1.

6. Conclusion

This paper, we collected an unbalanced panel dataset of 130 commercial banks in China between 2007 and 2017. First, by constructing a local equilibrium model of banks' risk-taking behavior under fintech constraints, we theoretically analyze the influence mechanism of fintech on banks' risk taking. Then text mining technology combined with factor analysis method is used to measure fintech development index. Finally, a multi-panel regression model is constructed to empirically analyze the overall and heterogeneous impact of fintech on banking risk taking.

The results show that: (i) On the whole. The influence of FinTech on the risk-taking of commercial banks shows an obvious inverted "U" shape. That is, in the early stage, the development of FinTech increase the risk-taking level of commercial banks. but reduced the risk-taking level of commercial Banks in the later stage as the key technology of fintech gradually matured. (ii) In terms of other control variables, factors such as liquidity level, industry openness and monetary policy, also have important influence on the risk-taking behavior of commercial banks to different degrees. (iii)The heterogeneous test results show that, in the face of the impact of FinTech, the responses of different types of commercial banks are obviously different. Compared with local small commercial banks, the responses of large and medium-sized banks are relatively more cautious.

The above conclusion shows that with the gradual maturity of FinTech related technologies and the increasing expansion of the industrial scale, the continuous deep integration of technology and finance industry leads to the gradual blurring of the financial boundary. It brings new development opportunities as well as challenges to commercial Banks. Commercial banks, especially small local banks, need to adjust their thinking, accelerate technological innovation, actively integrate finance and technology, and seek transformation and development to cope with the reform of the financial system. In this regard, this paper puts forward the following Suggestions: first, commercial Banks should actively promote the transformation and innovation of credit business, rely on the market and customer demand for innovative products, establish a comprehensive network credit service platform, use big data, cloud computing, block chain, artificial intelligence, Internet of things and other key technologies, and achieve networked management. Combining the advantages of physical bank outlets with those of Internet virtual outlets, gradually transform to "digital", "intelligent" and "asset-light" mode, and finally improve profitability. Second, commercial banks should actively seek in-depth cooperation with Internet financial enterprises, use its business scale advantage to strengthen the innovation and channel construction of Internet payment and settlement, financial

management, sales and other businesses, expand its business to the field of e-commerce, integrate resources, improve synergy, build a professional and comprehensive financial industry ecosystem, diversify our business, increase the diversity of profit sources, reduce the unilateral impact of narrow interest margins, and gain new profit growth points. Third, accelerate the construction of FinTech talent team, strengthen independent research and development of key technologies, actively integrate into the trend of FinTech application development through joint innovation, or the establishment of FinTech subsidiaries, so as to reduce the cost of FinTech innovation and improve the level of management and performance. Fourth, give full play to the application advantages of emerging technologies such as big data, cloud computing, blockchain and artificial intelligence in risk control and strengthen risk management capabilities. Fifth, policy authorities should accelerate the improvement of the regulatory system and mechanism reform, optimize regulatory tools, and provide a benign institutional environment for the integrated and symbiotic development of FinTech and traditional commercial banks.

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