Fintech Application and Bank Risk-Taking: Evidence from Chinese City Commercial Banks

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Abstract. Fintech is reshaping the entire financial industry, dramatically changing the operation model of traditional finance. Traditional commercial banks are confronted with challenges and opportunities as a result of fintech. The development of fintech has resulted in great uncertainty in the realm of bank security, and thus clarifying the nexus between fintech application and bank risk-taking makes sense. Using a text mining technique, this study created a comprehensive index to quantify each sample bank's specific fintech application. With relevant data, this study designed a regression model with a few variables and compared the results to the current situation in China. According to the findings, fintech application and bank credit risk-taking have an inverted U connection. The fintech application initially elevates credit risk taken by banks; but, as fintech application grows more advanced, it will have the opposite effect on bank credit risk-taking, lowering bank non-performing loan rates. Furthermore, this research demonstrates that bank size, deposit-asset rate, and ROA indicators all lessen credit risk, whereas the loan-asset rate strengthens it. The finding suggests that it is advantageous to accelerate the integration of fintech and commercial banks. Banks should exploit the chances presented by the fintech revolution and execute a digital transformation strategy.

Keywords: Fintech · City commercial banks · Bank credit risk-taking · Text mining

1 Introduction

1.1 Background

In recent years, Internet technology has developed rapidly, promoting human society from the information age into the digital age. Cloud computing, big data, and other high-end internet technology have already achieved significant breakthroughs. They have changed the way of production and human lifestyle, bringing about profound changes in the global economic pattern and competition. Relying on new transaction modes and social modes such as mobile payment and social networks, internet technology makes it possible for traditional finance to break through geographical and time limitations, simplifies the financial transaction process. Under this circumstance, fintech is born. Many fintech enterprises have come into existence, and various Internet apps targeted at online deposits and loans have been launched. These apps enable clients to withdraw

and use small amounts of funds at any time, and they can also be used as a means of payment for online shopping and online payment. Another case in point is artificial intelligence (AI). AI can not only effectively improve customer experiences of financial services, but also mange investment portfolios with minimum human labor, based on vast amounts of data. AI draws wealth portraits of a large number of customers by using more powerful computer models, and provides customized asset management plans with artificial intelligence algorithms. At present, traditional commercial banks are still the main component of China's financial market. Due to fintech, conventional commercial banks are faced with the challenges and development opportunities of macroeconomic transformation, financial market reform, complex customer demands, and increasingly intensified cross-border competition. In the digital era, traditional commercial banks are no longer simple financial service providers, but will become the creators of data value. Based on this, it is dispensable to gain an insight into the impact of fintech application on the development of commercial banks and point out the correct attitude and counter-measures of commercial banks towards fintech, to maintain sustainable development of commercial banks.

1.2 Related Research

Scholars have done a lot of research on the impact of fintech on commercial banks. Elia et al. reviewed the development of fintech in the banking industry and numerous aspects of the effect of Fintech application, updated the knowledge about technology innovation, identified essential trends in the subject, and demarcated directions for future study. Analyzing and combining useful information in recent documents, Elia et al. gave a holistic perspective of the Fintech application in the banking industry, including the emerging phenomenon of digital banking. The model of digital banking is deepened, in particular, with the six dimensions of the critical effects caused by the digital bank model delineated [1].

At the bank efficiency level, Lee et al. illustrated the function mechanism of fintech through multiple channels theoretically, constructed a new measurement index of the development level of fintech, and applied a stochastic met frontier approach to assessing relevant efficiency scores for Chinese banks under different ownership structures. The results showed that besides enhancing the technology used by banks, fintech innovations improve the cost efficiency and technology gap of commercial banks overall, whose effect is heterogeneous [2]. Wang et al. assessed what fintech had promoted in the past, considered the impact of variables on the heterogeneity of commercial banks, and used quantitative regression research methods. The focus of the research is to see if fintech can help commercial banks improve their efficiency through using big data. Fintech development has enhanced profitability and spurred innovations, according to the research. The most basic requirement for a commercial bank to accomplish extensive fintech integration and strengthen its responsiveness, professionalism, and inclusivity is to have the essential hardware and software infrastructure in place [3].

At the bank business level, Senyo and Osabutey used mobile money as a type of financial innovation, compared it with existing traditional banking services, and adopted the Prospect theory and the Unified Theory of Acceptance and Use of Technology 2 (UTAUT2) to investigate the antecedents to the actual use of mobile money services,

and contribute alternative perspectives to the debate on fintech innovation and financial inclusion. The results of the research proved that performance and effort expectancy have a significant relationship with the intention to use mobile money services. Perceived risk negatively influences mobile money service and agent trust [4]. Hodula discovered changes in traditional bank lending due to the emergence of fintech lending, and analyzed the correlation between conventional credit and automated fintech credit to see if fintech credit may replace bank credit and, if so, under what conditions. Fintech lending platforms can complement and replace traditional bank credit, according to the research, and banking sector features are expected to play a role in shaping the correlation. Banks and fintech credit platforms tend not to compete for the same clientele in less concentrated, more liquid, and more stable financial sectors, but operate as complements instead [5].

At the bank security level, Wang and Wang firstly reviewed the general theories and technologies of big data in safety management, then summarized the typical applications of big data in safety management, and finally discussed the challenges of big data in safety management and its future development directions, aiming to provide a reference for the further development of big data in the field of safety science [6]. Nguyen et al. examined the relationship between fintech credit, bank rules, and bank performance using an aggregate dataset of 73 countries from 2013 to 2018 to assess the possibility of fintech credit influencing bank performance, with the consideration of moderating impact of bank regulations. The results showed that fintech loans diminish bank profitability, while enhancing risk-related performance. Fintech competes with banks and takes a portion of their revenues as it grows, but it also benefits banks in terms of stability. Second, stronger restrictions help to maintain bank stability. Nguyen et al. found that when more stringent banking regulation is present, fintech credit would have a more favorable impact on bank stability [7]. Du et al. mentioned that an Internet credit risk early warning model and risk level evaluation system are constructed using big data technology and integrating of the BP neural network and GA algorithm with the introduction of the "3σ" rule. Because the data fitting effect of the BP neural network training is good, but the accuracy rate needs to be improved, Du et al. chose GA to optimize the neural network. In this approach, the big data-based early warning model can successfully predict and analyze Internet credit risk. Furthermore, by improving the neural networks through the GA algorithm, constraints in the assessment process may be avoided, making the warning outcomes more objective and credible [8]. Banna et al. discussed the existing limitations of connections between fintech-based financial inclusion (FFI) and bank risk-taking. Through an analysis of banks from several OIC countries, Banna et al. revealed that FFI not only increases the economic mobility among the OIC countries, but also shows a negative association with the levels of bank risk-taking, indicating a higher degree of FFI controls banks' risk-taking behavior more effectively [9].

This study has arrived at two hypotheses based on the above discussions. These are stated below:

H_1: A higher degree of fintech application helps reduce credit risk-taking of commercial banks.

H_2: Fintech application first increases and then decreases the credit risk-taking of commercial banks.

1.3 Objective

Previous literature is mainly restricted to text descriptions about the influences of fintech on commercial banks' capability as a whole. This study fills the gap and pays attention to how fintech application influences bank credit risk-taking and how such effect alters, thus making several contributions to the literature. This study developed an index to measure the specific fintech application of each sample bank by using the text-mining approach. Given the availability of relevant data, this study included a few variables in a regression model and compared the findings with the current situation in china. As a result, this study is timely in presenting fintech as a solution and highlighting the importance of fintech applications for credit risk reduction of city commercial banks. Such findings provide a theoretical basis for city commercial banks of enhancing their ability to apply science and technology and realizing deep integration and coordinated development of finance and technology, for the sake of better overall development of commercial banks.

The remainder of this research is structured as follows. Section 2 outlines the sample banks and estimation models, provides variable definitions, and presents descriptive statistics. Section 3 lays out empirical results and discussions. The final section offers the main conclusions and implications of this study.

2 Methods

2.1 Explained Variable

Z-score, weighted risk assets proportion, non-performing loan rate, and expected default rate are often employed to evaluate commercial banks' risk-taking. Credit risk is the core focus of this research, so the non-performing loan rate serves as the dependent variable. The higher non-performing loan rate, the more risk bank is taking.

2.2 Explanatory Variable

IN the existing literature, there are two commonly used methods for constructing an index to measure fintech application: single index evaluation and comprehensive index evaluation. This study used the text-mining method to calculate banks' fintech index. Firstly combining the credit business practice of commercial banks and the function of fintech, the original lexicon is constructed from two aspects of core technology and application scene (Table 1) [10]. Secondly, this study searched the news that each city commercial bank and each keyword appear together from Baidu search index, and calculated every term's annual frequency, quantifying the original lexicon. The last, factor analysis and Principal Component Analysis (PCA) were deployed to build weight coefficient. The minimum-maximum normalization technique was used to calculate factor sore and synthesize a comprehensive fintech index (Table 2).

Table 1. Fintech original lexicon

Aspects	Representative words
Core technology	cloud computing
	big data
	artificial intelligence
	internet of things
	blockchain
	mobile payment
	5G
Application scene	electronic banking
	online loan
	online lending
	internet financing
	network insurance

Table 2. Data Description

Variables	Obs	Mean	Std. Dev	Min	Max	Median
NLR	126	1.172937	0.468786	-1.26	2.47	1.185
FINTECH	126	-0.000159	1.000441	-1.3	3.46	-0.235
BS	126	2.084023	2.25052	0.226853	15.799	1.304565
DA	126	93.35773	1.173539	88.3892	95.5676	93.64008
LA	126	0.66204	0.098886	0.4837	0.8947	0.640836
ROA	126	1.027436	0.256021	0.57987	1.779992	1.00317

2.3   Control Variable

Considering all sample banks are in China, macroeconomic dimensions were dismissed, and only microeconomic measurements were taken into account. This research had four control variables: bank size, deposit-asset ratio, loan-asset ratio, and return on assets.

Bank size (BS): sufficient assets lay a solid foundation for commercial banks to carry out business and withstand losses. However, the increase of asset scale may cause commercial banks to expand their risk exposure, leading to the increase of potential risks and non-performing ratio. The quantity unit of bank size in this study is billion.

Deposit-asset ratio (DA): The increase of deposit-asset ratio shows that the bank has good development potential and strong credit capability to carry out business. However, excessive deposit-asset ratio will increase the interest burden of banks.

Loan-asset ratio (LA): A higher proportion of loans indicates that the bank's loan business is developing smoothly and banks can obtain more interest income from the

loan business. The bank's overall efficiency momentum is good. However, the increase of this index is largely accompanied by the increase of the non-performing loan ratio of banks, affecting profitability and loss of bank capital.

Return on assets (ROA): displays the bank's profit strength. Usually a bank with a higher return on equity means a stronger profitability, thus reducing the generation of non-performing loans.

2.4 Data and Resource

Chinese fintech entered the beginning of rapid development in 2012. Many traditional financial institutions built online business platforms, revolved around conventional financial channels, and further realized the interaction and integration between technology and finance. Based on this, the period from 2012 to 2018 was chosen as the time in the research. This research collected 18 on-listed city commercial banks' relatively financial data from Bankscope and Choice database, and a few missing figures were made up by looking into the annual report. The following table demonstrates the data description.

2.5 Model

To verify hypothesis 1, which means fintech has negative effects on non-performing loan rates in Chinese city commercial banks, the chosen model is below.M1:

$$NLR_{it} = \alpha + \beta_1 Fintech_{it} + \beta_2 BS_{it} + \beta_3 DA_{it} + \beta_4 LA_{it} + \beta_5 ROA_{it} + \varepsilon_{it} \qquad (1)$$

where the indices i and t respectively stand for bank and time. In the above models, the explained variable NLR_{it} indicates the non-performing loan rate of bank i in year t; $Fintech_{it}$ is the explanatory variable, indicating the comprehensive fintech index of bank i in year t. The remaining variables are control variables: BS_{it} = fixed assets, which is adopted from the financial statement, DA_{it} = total deposits/total assets, LA_{it} = loans/total assets, and ROA_{it} = return on assets. α represents the intercept term, β serves as the coefficient of the variables, and ε_{it} measures the accidental error term, including unknown influencing factors, variables' inherent randomness and so on.

M1 illustrates that the risk-taking of a commercial bank is affected by fintech application, the asset end's quality, the liability end's quality and its profitability. The direction of the impact of fintech on the commercial banks' risk-taking does not change over time with the development of fintech.

To verify hypothesis 2, which means fintech has an inverted U relationship with non-performing loan rate, M1 was adjusted to M2:

$$NLR_{it} = \alpha + \beta_1 Fintech_{it} + \beta_2 Fintech_{it}^2 + \beta_3 BS_{it} + \beta_4 DA_{it} + \beta_5 LA_{it} + \beta_6 ROA_{it} + \varepsilon_{it} \tag{2}$$

M2 adds the quadratic term of fintech on the basis of M1, indicating that fintech will show two opposite directions of impact on commercial banks' risk-taking with its growing development. The inverted U relation is the most classical and common nonlinear relation in economics. The famous Laffer curve shows that there is a classic

inverted U-shaped relationship between tax rate and tax revenue. Williamson's inverted U-shaped hypothesis shows that with economic development, the urban-rural income gap increases at the beginning, but tends to narrow over time. In M2, if $\beta 1$ is significantly positive while β_2 is significantly negative, there exists an inverted U relationship.

3   Results and Discussions

3.1   F Test

Since this panel data is short, unit root statistic has no practical guiding sense. In terms of individual influence, panel data models can be classified into three catalogues: pooled regression model (without individual influence or structural change on the cross-section members), individual-mean corrected regression model (with no structural change other than individual influence), and unrestricted model (with both individual influence and structural change). F test was used to assess individual influence. The calculated value of F in the research was smaller than the critical value at 5% significance level, and thus pooled regression model was chosen.

3.2   Baseline Regression

Table 3 shows the results of benchmark baseline regressions. At first, this study conducted an empirical test of Hypothesis 1 using M1. From the regression result of M1, the coefficient of variable Fintech is significantly positive, up to 0.047. The fintech index increases by 100 units, and the non-performing loan rate will increase by 4.7%, which means the deeper fintech has developed, the higher non-performing loan rate is estimated to be. It contradicts Hypothesis 1, which implies fintech application plays a role in decreasing the non-performing loan rate of commercial banks.

Due to that, this research conducted another empirical test to evaluate Hypothesis 2, using M2. In this regression, the coefficient of variable Fintech is significantly positive, while that of variable Fintech^2 is significantly negative. Such a result illustrates there is a significant inverted U relationship between non-performing loan rate of city commercial banks in China and fintech application. H2 proved to be correct.

A possible explanation is as follows: In the early stage of fintech development, banks were exposed to such a new concept. They slowly explored the complementarity of finance and technology. They dedicated a lot of human resources, materials and finances to build fintech service platforms, innovated financial products, and improved financial services. It greatly increased banks' costs and forced them to elevate risk-taking to maintain profits. However, along with the advancement of fintech, the advantages will outweigh the disadvantages. Fintech will boost the work efficiency of commercial banks and is capable of risk controlling and timely warning. Besides, the application of fintech can help banks get a more thorough understanding of customers' different needs and risk preferences, introducing accurately customized products.

From the results of M1 and M2, the plus or minus characteristics of the coefficients of variables remained stable. The increase in loan-asset rate is expected to have a positive influence on the non-performing loan rate. On the contrary, the growth in other three remaining variables: bank size, deposit-asset rate, and return on asset, is expected to lower the non-performing loan rate.

Table 3. Short cut keys for the template

Indicator	M1	M2
Fintech	0.047*	0.081***
Fintech^2	–	–0.027*
BS	–0.031**	–0.018
DA	–0.053***	–0.056***
LA	1.008***	1.092***
ROA	–0.978***	–0.963***

Note: *, **, *** represent the significance level of 10%, 5%, and 1%, respectively

3.3 Discussions

Fintech in China has been proliferating these years rapidly, and many fabulous achievements have been achieved already. Fintech has enabled the market to burst out a tremendous vitality and rise wildly. It is worth mentioning that six of the top 20 enterprises which owned the most fintech invention patent applications in the world in 2018 are in China, and the patent applications of these six enterprises accounted for 42%, almost half of the total. Intellectual property is a typical transformation of science and technology innovation achievements. Such an increase in fintech patents not only means the promotion of China's science and technology strength, but also highlights the autonomy of China's fintech development. China is taking the leading position in the international fintech market.

More and more Chinese financial institutions are willing to invest massive capital into the fintech field. The total technical capital input has reached 403.47 billion (Fig. 1). Banks have relatively complete IT construction and technological solid autonomy. In addition to state-owned large banks and other leading banks, city commercial banks are also deploying cutting-edge technologies such as face recognition and blockchain supply. The frontier technical input of head insurance companies increases year by year. The main focus of the middle and tail insurance company is an information system, mainly external procurement. Only a few enterprises in the securities and fund industry have invested in fintech solutions. The security industry is also making continuous attempts at financial business innovation. It can be predicted that in the future, Chinese enterprises and financial institutions will further increase investment in fintech, enhancing their market competitiveness.
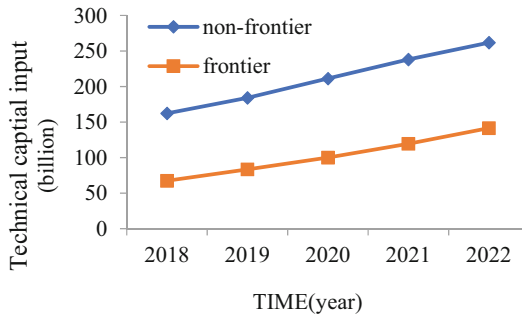
Fig. 1. Non-frontier and frontier technical capital input of Chinese financial institutions. Photo credit: original.

4   Conclusion

This research has examined the relationship between fintech application and credit risk-taking of Chinese on-listed city commercial banks during the period between 2012 and 2018 by establishing baseline regression models. The finding demonstrates that fintech application and bank credit risk-taking have an inverted U relationship. Fintech application increases credit risk undertaken by banks initially. Still, as fintech application becomes more advanced, it will have an inverse effect on bank credit risk-taking, reducing the non-performing loan rate of banks. The results of this study point out the future development direction of fintech in commercial banks: it is favorable to accelerate the integrated development of fintech and commercial banks. Banks should seize the opportunities brought by the development tide of fintech, and actively implement digital transformation strategy. However, unfettered growth of fintech will cause frequent crises in fintech security, such as excessive issuance of credit and disclosure of personal privacy. Therefore, national financial supervision and risk management system of commercial banks should be enhanced, and specific risks of Internet finance should be warned and monitored in a timely and effective manner.

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