

The impact of internet finance on commercial banks' risk-taking: Theoretical interpretation and empirical test^{*}

Guo Pin, Shen Yue^{**}

Through introducing internet finance's "reducing management cost" and "raising capital cost" effects into bank risk-taking model, this paper systematically investigates the dynamic and heterogeneous influence of internet finance on commercial banks' risk-taking. Using internet finance index based on "text mining" and data of 36 commercial banks from 2003 to 2013, we makes an empirical test. The results show, firstly, the impact of internet finance on commercial banks' risk-taking is a "U" trend. The initial development of internet finance can help commercial banks reduce management cost and risk-taking, but then internet finance will raise capital cost, and turn to exacerbate banks' risk-taking. Secondly, the response of commercial banks' risk-taking is heterogeneous. Large commercial banks' response is slow, while small and medium banks' response is relatively sensitive.

Keywords: internet finance, commercial bank risk-taking, system GMM estimation

1. Introduction

From simple imitation a decade ago to today's proactive innovation, China's internet finance has been demonstrating its role as the driving force, which should not be neglected. Over the past two years, in particular, internet finance has emerged as the "blue ocean" enjoying tremendous development where numerous virtual and real enterprises vied to swim into that area. On July 18th, 2015, *the Guideline on Promoting the Healthy Development of Internet Finance* (hereinafter referred to as the Guideline) was jointly issued by 10 ministries and departments including the People's Bank of China. The Guideline indicated that the deep integration of internet and finance was a prevailing trend, which would exert a profound influence on financial organization, financial products as well as financial service, but internet finance had not changed the features of financial risks such as secret, contagious, wide-spread and sudden. As

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a new type of finance business, internet finance has broken the traditional boundary, propelled the process of financial disintermediation, and brought an overall impact on commercial banking. Against this background, the ever increasing importance has been attached to the discussion on the relation between internet finance and commercial banks.

Based on the documents we grasped, scholars differed in their opinions toward the definition of internet finance. Shahrokhi (2008), Xie and Zou (2012) maintain that internet finance is a third financing model which is different from either the indirect financing of commercial bank or the direct financing in capital market. Instead, Chen (2014), Wang and Zhang (2015) point out that internet finance is an extension and upgrading of traditional financial service, and is regulatory arbitrage taking advantage of the defect of China's financial system, instead of the so-called "new finance". But the unveiling of this Guideline ends the debate. It clearly shows that internet finance is a new model of financing sector where traditional financial institutions and internet corporations conducted accommodation of funds, payment, investment and information intermediary service by way of internet technology and information communication technology.

The integration relation between internet finance and traditional finance has been highly focused. From the perspective of financial function, Syed and Nida (2013) consider that internet finance and commercial bank enjoyed their advantages respectively regarding financial functions, and both of them should be guided to compete and cooperate so as to promote the development and innovation of finance. From the perspective of financial repression, Dai and Fang (2014) stress that internet finance is produced by interest rate control, and its rapid development would facilitate the process of the marketization of interest rate and raise the financing cost, which add the risk facing commercial banks. From the perspective of financial service, Zheng (2015) indicates that internet finance exerts great impact on commercial bank including its debt, asset and intermediary service, and would create an atmosphere with commercial bank featuring rapid diversion of debt, dislocation competition among assets, as well as rivalry against internet finance in payment. In addition, viewed from the perspective of technology spill-over, Shen and Guo (2015) analyze the promotion mechanism caused by internet finance function on total factor productivity of commercial bank.

It has been another focus of spill-over effect and risk management targeting internet finance. Wu (2015) points out that internet finance reduced transaction cost and facilitated market competition, enriched the finance implication and pushed forward the financial reform. However, some risks also emerge ranging from dependence on technology, absence of trust to failure in business due to the lack of rules and regulations (Liu and Huang, 2015). Thus, it is imperative to conduct supervision and management over internet finance and adhere to the principles of "lawful, moderate, classified, coordinated and innovative supervision and management", so as to promote its sustainable development (Liu and Shi, 2015).

Undoubtedly, the above materials have made valuable contributions to the understanding of internet finance. But the discussion on internet finance and commercial banks' risk-taking is rare. Considering this, theoretical model is firstly

adopted in this article to illustrate the influence mechanism resulted by internet finance for the risk-taking of commercial bank, then the micro panel data of China's 36 commercial banks from 2003 to 2013 are used to conduct empirical test. Research shows that from the perspective of dynamic progress, internet finance has a U-shaped (downward then upward) trend impact on risk taking of commercial bank. In other words, at the beginning, internet finance benefits commercial bank because it reduces management cost and risk-taking, but then it would raise the capital cost and increase the risk-taking of commercial bank. From the angle of horizontal comparison, the risk-taking of different types of commercial banks is heterogeneous in the reaction to internet finance. Compared to small-and-medium commercial banks, large ones are slow to respond.

The contributions of this article are as follows. (1) From the micro point of view, how internet finance functions on the risk-taking of commercial banks is illustrated. The existing papers focuses more on the impact on commercial bank's business and functions exert by internet finance, lacking the discussion on the relation between internet finance and commercial bank's risk-taking. In this article, we try to offer the answer to such problem. By establishing the theoretical model including the internet finance constraint, the author manifests the dynamic and heterogeneous influence on the risk-taking of commercial bank brought by internet finance, with a view to broadening the research perspective towards internet finance and improving the theoretical framework of the risk-taking of commercial bank. (2) From the empirical point of view, the author verifies the heterogeneous response made by commercial bank's risk-taking towards internet finance. The existing research is based itself more on the empirical analysis about the complete sample of banking sector. In this article, the different influences exerted by internet finance upon large and small-and-medium size commercial banks are interpreted, and reasonable explanations of such empirical result are delivered in light of the special background of China's banking sector, thus offering advices on further deepening the reform of commercial banks. (3) From the perspective of financial function, the quantitative indicators measuring China's internet finance development level are established. Despite that some scholars in China have already selected a certain data to represent the scope of internet finance, these proxy variables merely include the payment function of the internet, in neglect of other functions of that such as building channel, distributing resource and managing risk. The author tries to make up for the deficiency in this article based on the thinking of financial function by way of "text mining" technology so as to establish internet finance indicators, enabling us to have an objective measurement of the development level of internet finance.

2. Theoretical model building

2.1. Theoretical basis

Judging from the current situation, the course of development of China's internet finance can be divided into three periods, namely, the internet extension from the

traditional financial service as the first period, booming development of internet payment as the second period, and the emergence of internet credit and internet money management as the third one. Compared with developed countries such as Britain and America, China's internet finance is still in its infancy. However, it develops and expands faster than expected, which has a bearing on the system of China's financial repression. McKinnon (1973) and Shaw (1973) point out that there always exists financial repression in countries experiencing economic transformation. Wu (1997), Wang, Johansson (2013) and Wang (2014) also hold that, for a long time, there have been a phenomenon of severe financial repression in China's banking sector—higher entry barriers block potential competitors, and severe interest rate control lower the cost of deposit which inject no impetus into commercial bank that enjoy “monopoly bonus” and “price bonus” to shift technology, reduce cost and upgrade efficiency. In this case, emerged internet finance which expands by leaps and bounds, has left a profound influence on commercial bank.

In the period of the internet extension from traditional finance service, the development of internet finance is conducive to improving the technological level of commercial bank, bringing convenience to the way of service, and decreasing the management cost. Take online bank as an example, the built-up of this platform can help commercial bank break through the limit of time and space, extend the customer chain, upgrade business process, facilitate data processing and reduce service cost, thus achieving the management of informatization and intensification with efficiency and procedure. In the prosperous period of the third party payment, internet finance does not only replace payment business of commercial bank, more crucially, it “extracts” the current deposit of bank. Take the example of Alipay, this payment model meets the various payment requirements in society through flexible method, and also distributes circulating funds into its own excess reserve account via its advantageous e-business platform, which reduces current deposit ratio and indirectly increases the cost of raising funds in bank. In the period when internet credit and money management rose, internet finance would speed up price competition, push forward the marketization of interest rate and raise capital cost of commercial bank (Dai and Fang, 2014). Take the example of Yu Ebao. Although this property management tool fails to have a huge impact on traditional finance in scale, the “catfish effect” it delivers has profoundly shaped capital pricing mechanism and the model of capital supply and demand, both of them in the charge of China's banks, having broken the revenue landscape of high interest margin enjoyed by banks and effectively driven the price marketization process (Zheng, 2014).

To sum up, internet finance influences commercial banks through the following main channels, ranging from “upgrading technology level, improving work efficiency, reducing management cost”, and “distributing current deposit, intensifying price competition and raising capital cost”. In this case, how do these two channels influence risk-taking of banks? Based on “principal-agent theory”, with management cost reduced and profit-making risen, commercial banks are less-motivated to transfer risks to depositors, thus reducing risk-taking (Hellmann, Murdock and Stiglitz, 2000; Repullo, 2004). And the “theory of competition fragility” indicates that the intense competition would lead to the decreased franchise value of bank, which would further

encourage them to take more risks (Allen and Gale, 2000). Hence, the preliminary conclusion is drawn—the effect of “reducing management cost” of internet finance would lower the level of commercial bank’s risk-taking, but the effect of “raising capital cost” would increase the level of commercial bank’s risk-taking.

Meanwhile, relationship between the profit-making level, competition in market and risk-taking are under the influence of various factors with bank such as capital scale, management strategy and the requirement of monitoring (Ariss, 2010; Jimenez, Lopez and Saurina, 2013). Instead, China’s large and small-and-medium-sized commercial banks varies sharply in terms of property right structure, target customer and policy restriction, etc (Liu, et al., 2014). Therefore, we deem that distinct commercial banks would be heterogeneous in reaction to the impact brought by internet finance. Upon the above analysis, the Figure1 is drawn to illustrate how internet finance influenced the risk-taking of commercial bank. And it serves as the basis to establish mathematical model in a bid to discuss the interrelation between the two sides.

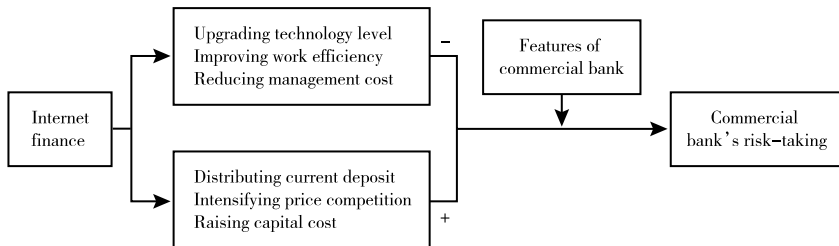


Figure 1. Influence mechanism of internet finance on commercial bank’s risk-taking

2.2. Model framework

In clarifying the effect of internet finance on commercial bank’s risk taking, the assumption of “internet finance constraint” and “commercial bank heterogeneity” is introduced into the model framework used by Kishan and Opiela (2000). The basic assumption goes as follows.

Assumption 1: Representative commercial bank accepted deposit D from household sector, raise equity capital E in capital market, and allocate these funds into business activities such as required reserve R and corporate loan L , so as to achieve the maximum profit. The identical equation of assets and liabilities could be simplified as: $R + L = D + E$. It is deemed that, without loss of generality, central bank doesn’t pay deposit reserve interests. Therefore, commercial bank only holds reserve requirements, in other words, $R = \rho D$, with ρ as reserve requirement ratio, $0 < \rho < 1$.

Assumption 2: Lending market constraint. It was until July, 2013 that China completely free its lending rate floor. However, according to the statistics from People’s Bank of China, lending rate priced by floor rate only accounts for less than 25% over the past decade.¹ So it turns out that the constraint of lending rate floor is

¹ Source: *Monetary Policy Report*, The People’s Bank of China.

ineffective in reality (He and Wang, 2012). In this situation, the higher the equilibrium lending rate r_L^* in credit market is than lending price r_L , the bigger the amount of loan commercial bank would put on, namely, $L = L_0 + L_1(r_L^* - r_L)$, $L_1 > 0$. Meanwhile, L_0 differs in different types of banks, where more L_0 existed in big commercial banks while less in small ones.¹

Assumption 3: Deposit market constraint. With long-term control of deposit rate, many scholars conduct empirical studies and conclude that in China, real interest rate is lower than equilibrium rate of interest, and it is effective to use deposit rate celling. Hence, the higher the market equilibrium interest rate r^* is than deposit benchmark interest rate, the smaller deposit commercial bank would attract, namely, $D = D_0 + D_1(r^* - \bar{r}_D)$, $D_1 < 0$.

Assumption 4: Capital market constraint. The higher equilibrium interest rate r_E^* of capital market than return on equity capital is, the smaller capital commercial bank would raise, namely, $E = E_0 + E_1(r_E^* - r_E)$, $E_1 < 0$. Furthermore, for a single commercial bank, r_L^* , r_E^* and r^* are exogenous, and r_L^* and r_E^* float around r^* , namely, $r_L^* = r^* + \varepsilon_L$, $r_E^* = r^* + \varepsilon_E$, with ε_L and ε_E as constant.

Assumption 5: Management cost constraint. Representative commercial banks needed to pay cost C of management and service fee. It is generally believed that the more deposit and lending were, the bigger cost C would become. So, based on scholars' common way, we set $C = (\omega/2)D^2 + (\nu/2)L^2$, $\omega > 0$ and $\nu > 0$, which indicates unit marginal management cost of deposit and loan.

Assumption 6: Internet finance constraint. As internet finance IF developed, on one hand, it could improve management efficiency and reduce unit marginal management cost ω and ν in bank, namely, $\omega = \omega(IF)$ and $\partial\omega(IF)/\partial IF < 0$, $\nu = \nu(IF)$ and $\partial\nu(IF)/\partial IF < 0$; on the other hand, it contributes to raise capital cost and correct the distortion of deposit price ($r^* - \bar{r}_D$), namely, $(r^* - \bar{r}_D) = f(IF)$ and $\partial f(IF)/\partial IF < 0$ (Nautz and Schmidt, 2009; Nautz and Scheithauer, 2011).

Accordingly, objective function and constraint conditions of representative commercial bank are supposed as follows:

$$\text{Max}\pi = r_L L - \bar{r}_D D - r_E E - C \quad (1)$$

$$S. T \begin{cases} R + L = D + E, R = \rho D, 0 < \rho < 1 \\ L = L_0 + L_1(r_L^* - r_L), L_1 > 0, r_L^* = r^* + \varepsilon_L \\ D = D_0 + D_1(r^* - \bar{r}_D), D_1 < 0 \\ E = E_0 + E_1(r_E^* - r_E), E_1 < 0, r_E^* = r^* + \varepsilon_E \\ C = (\omega/2)D^2 + (\nu/2)L^2, \partial\omega/\partial IF < 0, \partial\nu/\partial IF < 0 \\ r^* - \bar{r}_D = f(IF), \partial f(IF)/\partial IF < 0 \end{cases} \quad (2)$$

¹ According to density possibility scatter-gram of lending scale of commercial banks (this picture is omitted due to the limitation of the paper's size), the lending scale of large commercial banks is mainly seen at the right side of 80% level. Thus, it is feasible to divide the types of banks based on lending scale.

2.3. Model solution

Substituting the above constraint conditions (2) into objective function (1), then we get F.O.C of profit π depending on L :

$$r^* + \varepsilon_L - \frac{2L - L_0}{L_1} = r^* + \varepsilon_E + \frac{2(1-\rho)[D_0 + D_1 f(IF)] - 2L + E_0}{E_1} + \nu(IF)L \quad (3)$$

The left part of formula (3) indicates marginal revenue of lending by commercial bank, and the right part indicated marginal cost of loan, including capital cost and management cost. According to formula (3), with the emergence of internet finance, the capital cost of commercial bank would increase, while management cost declined. And then solve the best amount of credit supply L^* of commercial bank:

$$L^* = \frac{\Delta_1 + \Delta_2 [D_0 + D_1 f(IF)]}{\Delta_3 - \Delta_4 \nu(IF)} \quad (4)$$

In this formula, $\Delta_1 = \varepsilon_E L_1 E_1 - \varepsilon_L L_1 E_1 - L_0 E_1 + E_0 L_1 > 0$, $\Delta_2 = 2L_1(1-\rho) > 0$, $\Delta_3 = 2L_1 - 2E_1 > 0$, $\Delta_4 = L_1 E_1 < 0$. Based on formula (4), we reach the function about internet finance IF and commercial banks' risk taking.¹

$$RISK = \frac{R+L}{E} = 1 + \frac{[\Delta_3 - \Delta_4 \nu(IF)][D_0 + D_1 f(IF)]}{\Delta_1 + [\Delta_5 + \Delta_6 \nu(IF)][D_0 + D_1 f(IF)]} \quad (5)$$

In this formula, $\Delta_5 = 2E_1(1-\rho) < 0$, $\Delta_6 = L_1 E_1(1-\rho) < 0$.

First, we analyze how internet finance affected commercial bank's risk taking by "reducing management cost" and "raising capital cost" channels. And we now sought the first-order derivative of RISK via $\nu(IF)$, $f(IF)$ and reach the following result:

$$\frac{\partial RISK}{\partial \nu(IF)} \times \frac{\partial \nu(IF)}{\partial IF} = \frac{-\Delta_1 \Delta_4 [D_0 + D_1 f(IF)] - \Delta_7 [D_0 + D_1 f(IF)]^2}{[\Delta_1 + [\Delta_5 + \Delta_6 \nu(IF)][D_0 + D_1 f(IF)]]^2} \times \frac{\partial \nu(IF)}{\partial IF} < 0 \quad (6)$$

In this formula, $\Delta_7 = 2L_1^2 E_1(1-\rho) < 0$. Formula (6) indicates that internet finance reduced the risk-taking level of commercial bank. That is to say, the brand-new technology thanks to the thriving internet finance lowers the management cost of commercial bank, increases revenue level and then weaken commercial bank's willingness to take risks.

$$\frac{\partial RISK}{\partial f(IF)} \times \frac{\partial f(IF)}{\partial IF} = \frac{\Delta_1 D_1 (\Delta_3 - \Delta_4 \nu)}{[\Delta_1 + [\Delta_5 + \Delta_6 \nu(IF)][D_0 + D_1 f(IF)]]^2} \times \frac{\partial f(IF)}{\partial IF} > 0 \quad (7)$$

¹ Normally, Z-value, EDF, risk asset ratio and asset/equity ratio were adopted for measuring the risk-taking of commercial banks. Given the establishment of model, asset/equity ratio was selected as the proxy index for the risk taking behavior of banks.

Formula (7) indicates that internet finance increased the risk taking of commercial bank through “raising capital cost”. In other words, the emergence of internet finance rationalizes the market price mechanism and bridges the gap between deposit benchmark interest rate and market equilibrium interest rate, forcing commercial bank to enhance its risk-taking level for profit maintenance.

$$\frac{\partial RISK}{\partial IF} = \frac{\partial RISK}{\partial f(IF)} \times \frac{\partial f(IF)}{\partial IF} + \frac{\partial RISK}{\partial v(IF)} \times \frac{\partial v(IF)}{\partial IF} >, =, < 0 \quad (8)$$

Formula (8) indicates that how internet finance affects commercial bank's risk-taking was co-determined by “reducing management cost” and “raising capital cost” channels. Looking at the progress of internet finance in China, “reducing management cost” plays a crucial role in the period of internet extension from traditional finance, where bank would take less risk as internet finance grew. In the period of internet payment, internet credit and internet wealth management, “raising capital cost” would be a priority, as bank would get impacted by internet finance to take even more risk. In so doing, there appears a down-and-up U curve trend demonstrating how internet finance affected commercial bank to take risk.

Second, we analyze what heterogeneous response that different commercial bank made towards internet finance. It is not hard to find that Δ_1 in both formula (6) and formula (7) includes variable L_0 which distinguishes different commercial banks. So, we take the derivative of formula (6) and formula (7) in order to interpret those responses by commercial banks:

$$\partial \left(\frac{\partial RISK}{\partial v(IF)} \times \frac{\partial v(IF)}{\partial IF} \right) / \partial L_0 = \frac{-E_1 \Delta_4 \Delta_8 D^2 - 2E_1 \Delta_7 D^3}{\Delta_9^3} \times \frac{\partial v(IF)}{\partial IF} > 0 \quad (9)$$

$$\partial \left(\frac{\partial RISK}{\partial f(IF)} \times \frac{\partial f(IF)}{\partial IF} \right) / \partial L_0 = \frac{E_1 \Delta_8 D_1 (\Delta_3 - \Delta_4 v)}{\Delta_9^3} \times \frac{\partial f(IF)}{\partial IF} < 0 \quad (10)$$

In this formula,

$$\Delta_8 = \Delta_1 - [\Delta_5 + \Delta_6 v(IF)] D > 0, \Delta_9 = \frac{E}{[\Delta_3 - \Delta_4 v(IF)]} = \Delta_1 + [\Delta_5 + \Delta_6 v(IF)] D > 0$$

Formula (9) and (10) indicate that as L_0 increases, internet finance would decreasingly affect commercial bank to take risk. In other words, big commercial banks turn out to be slow to take risk responding to the impact of internet finance, while it is not the case with small-and-medium-sized commercial banks, which showed relatively obvious reaction. There are some explanations to this end. First, nominal ownership of big commercial banks, long chain of principal-agent, implicit government guarantee as well as the expectation of “too big to fail” would weaken the restriction of budget, leading to slow reaction to market competition (Gao, Li and Liu, 2015). Second, big commercial banks are large in system, diverse in management level and various in personnel structure, so they are easily to have time-lag in signaling and tackling crisis (Mulherin and Boone, 2000). Third, big commercial banks, generally speaking, eyed for big SOEs, while small-and-medium-sized commercial

banks and internet finance always treat micro-small-and-medium-sized enterprises as their customers. Thus internet finance has an ever immediate impact on small-and-medium-sized enterprises. Fourth, big commercial banks are subject to strict policies of supervision as systematically important banks. According to the study of Beltratti and Stulz (2012), the tighter the supervision is, the more prudent risk-taking behaviors those economic subjects would make. Therefore, nominal ownership, large scale, fixed customer and special status together result that big commercial banks' risk-taking are slow in responding internet finance.

Based on the above theories and models, two propositions are proposed hereby to be further examined.

Proposition 1: Viewed from the dynamic evolution standpoint, internet finance has a "U"-shaped trend impact on the risk-taking of commercial banks, in other words, internet finance is, in its infancy, conducive to commercial banks to cut down management cost and reduce risks they shouldered, but then internet finance would raise capital cost and also the risk-taking for commercial banks.

Proposition 2: Viewed from the horizontal dimension, confronted by the impact of internet finance, different commercial banks are heterogeneous in their risk-taking' reaction: big commercial banks are slow whereas small-and-medium-sized ones were quick to make response.

3. Design of empirical study

3.1. Study sample

Ruling out some banks with a few information, 36 Chinese commercial banks are chosen as the sample, including five big commercial banks as ICBC (Industrial and Commercial Bank of China), ABC (Agricultural Bank of China), BOC (Bank of China), CBC (Construction Bank of China) and BOC (Bank of Communications), and 31 small-and-medium-sized commercial banks such as China Ever-bright Bank, Guangdong Development Bank, Industrial Bank, Bank of Dalian, Fudian Bank, as well as Bank of Nanjing. All these samples selected spans from 2003 to 2013.

3.2. Variable definition

3.2.1. Proxy variable of bank's risk-taking

The Z-Value, expected probability of default (EDF), net-lending/asset ratio, loan-loss reserves ratio and asset/equity ratio ($RISK_{A/E}$) are selected in existing papers to measure how commercial banks take risks. Yet Z-Value merely mirrors the bankruptcy risk rather than entire risks facing banks. Lagging behind in domestic credit rating explains why those EDF statistics could hardly be gained. Given this situation, hereafter this paper would adopt $RISK_{A/E}$ as the major proxy variable with respect to risk-taking, and also $RISK_{LL}$ and $RISK_{LA}$ as auxiliary proxy variables for the sake of

reliable conclusion in this study. ¹These data come from BankScope database and statements of commercial banks.

3.2.2. Proxy variable of internet finance

Internet finance is absent from coordinated, standard and comprehensive data statistics due to multi-forms and surfacing innovation in this regard. Among empirical studies, only a small number of them use the third-party payment limitation or the ratio between internet payment and online-banking transaction to reflect the development of internet finance. These kinds of indicators are worth of reference, but they only includes the payment function of internet without considering other functions such as building channels, allocating resources and managing risks. By evaluating the overall and feasible factors, therefore, this paper takes use of the indicators from “text mining” as proxy variable for internet finance from the perspective of financial function.

First and foremost, the internet finance models shall be divided and original lexicons be established on the basis of financial function view. Academic circles are varied in their opinions toward the divisions of such models. The fact that internet finance plays its role by providing and perfecting the financial function allows us to comb through China’s internet finance model based on financial function view proposed by Merton and Bodie (1995), and set up the original lexicons as table 1.

Table 1

Original lexicons of internet finance based on financial function view

Financial function	Channel building	Payment clearing	Resource allocation	Financial management
Division of models	Internet channel	Internet payment	Internet credit	Internet wealth management
	Internet banking	Online payment	Online loan	Online wealth management
Original lexicons	Electronic banking	Mobile payment	Online financing	Internet wealth management
	Online banking	Third-party payment	Online investment	Internet insurance

Second, word frequency could be calculated and lexicons quantified by Baidu search engine. According to a study made by Askitas and Zimmermann (2009), the number of news released implies demand information related to netizens and supply information related to enterprise input. So in the era when internet acts as the major media of information spreading, the more numbers of online news including original lexicons in form 1, the better situation we would achieve in terms of financial development. Thus, the number of news which contain original key words from 2003

¹ In order to guarantee the consistency of the marks in empirical analysis, in designing the $RISK_{LL}$, the negative ratio between loan-loss reserves and the sum of loans is calculated. Considering that credit risk poses a major risk to commercial banks, the net lending to total assets ratio is seen as the similar figure of $RISK_{LL}$.

to 2013 in the Baidu database and the total amount of yearly news are calculated hereby, and get the yearly word frequency by comparing the above two figures so as to quantify each and every key word.¹

Finally, different kinds of internet finance indicators could be created by way of factor analysis. (1) Analyze the above 12 key words based on factor analysis and estimate the trend of the development of internet finance. First, test data. As shown in table 2, when the KMO figure is 0.79, the Bartlett figure is 202.93, which means some elements are shared among key words. Second, extract common factors. Based on principal component analysis, we extract common factors whose eigenvalue outnumbered 1. Result shows that contribution ratio of variance is registered at 86.53%, and it could reflect a majority of original information. Third, calculate factor scores. Conduct orthogonal rotation targeted at rotated component matrix in line with maximum variance principle, then get the estimated component score coefficient matrix through regression analysis. Fourth, composite index. Set factor score as the weight, and describe the common factor as the linear combination of original variables. Meanwhile, we could standardize figures as between 0 to 1 by means of the maximum and minimum principle, in order to get the index of finance (*IF*). (2) Conduct factor analysis toward key words in all dimensions, so as to measure the level of four models of internet finance. The result is shown in table 2.

Table 2
Factor analysis of the index of internet finance

Index	Index of internet finance	Index of internet channel	Index of internet payment	Index of internet credit	Index of internet wealth management
KMO figure	0.79	0.81	0.74	0.84	0.80
Bartlett statistics (figure P)	202.93*** (0.00)	16.82*** (0.00)	18.84*** (0.00)	28.34*** (0.00)	15.77*** (0.00)
Number of common factors	1	1	1	1	1
Variance contribution ratio	86.53%	93.47%	85.19%	91.77%	92.53%

Note: ***, ** and * represent significant at 1%, 5%, and 10% levels, respectively, same as the followings.

Table 2 shows how the index of internet finance develops in accordance with the technology of “text mining”. It basically matches the growth of internet finance in China. Prior to 2008, commercial banks pressed ahead with the online business, where the internet channel index held a safe lead. During 2009 to 2010, the third party payment began to spring up, when the internet payment index succeeded to overtake those figures. From 2011 to 2013, the business of online investment and internet finance swiftly expanded, and the internet credit and internet wealth management index sharply increased.

¹ Due to the lack of statistics of total number of annual news in Baidu database, the sum of news covering 10 popular Chinese three- to four-character idioms is considered as the proxy variable for yearly amount of news. The source of data derived from the *Report of Language Situation in China (2009)* is published by the Ministry of Education, P.R. China.

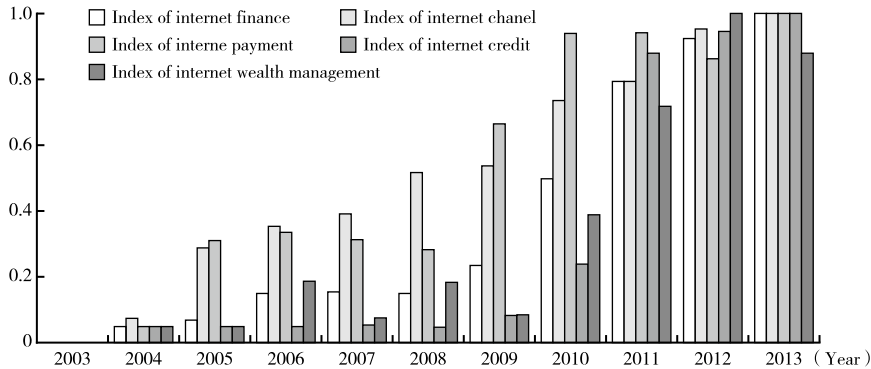


Figure 2. Development of internet finance in China between 2003 and 2013

3.2.3. Control variables

Based on the current literature, inevitably, factors such as the monetary policy change, macro-economic development, the degree of interest rate liberation, competition level in industries and micro characteristics of banks as well affect the behavior of risk-taking. To this end, the chosen control variables in this paper include: increase rate of broad money supply which indicates the tightness of monetary policy (M2), nominal GDP growth rate which reflects the level of macro-economy development (GDP), interest rate liberation index which showed the degree of interest-rate liberation (IRL), growth rate of share of asset among the top four banks which mirrored the competition level in industries (CR4), increase rate of the number of foreign-invested banks in China (FORE), and also the ratio between liquid assets and total assets which depict banks' micro characteristics (LI).¹ Among them, the index of interest rate liberation level is reached according to the study made by Wang and Peng (2014), with other data deriving from NBS website, CEINET database, China's financial statistical yearbook, BankScope database and annual statements of various commercial banks.

3.3. Research design

Proposition 1 indicates that internet finance's impact on the risk that commercial banks present a U trend. To verify Proposition 1, the following econometric model formula (11) is set up.

$$RISK_{it} = \beta_0 + \beta_1 RISK_{i,t-1} + \beta_2 RISK_{i,t-2} + \beta_3 IF_t + \beta_4 IF_t^2 + \beta_5 X_{it} + \lambda_i + \chi_t + \varepsilon_{it} \quad (11)$$

¹ Due to the size of paper, the descriptive analysis of variables is not detailed in the paper. Please contact the author if needed.

In this formula, $RISK_{it}$ is bank i 's risk-taking level in the year of t , IF_t is internet finance index in the year t , X_{it} is a series of control variables, λ_i is individual fixed effect, χ_t is time fixed effect, and ε_{it} the stochastic error term. As studied by Delis and Kouretas (2011), relationship lending and fierce competition would trigger consistent risks. Therefore, the first and second lagged variables as regards commercial banks' risk-taking were introduced here in this paper. According to theoretical analysis, the coefficient regression of β_3 was expected to be significantly negative, with the expected result of β_4 significantly being positive.

Proposition 2 showed that internet finance played a heterogeneous role in affecting risk-taking behavior of different types of commercial banks. In order to verify proposition 2, interaction items of internet finance index and dummy variable of bank kinds were introduced into formula (11). The empirical equation was set below:

$$RISK_{it} = \beta_0 + \beta_1 RISK_{i,t-1} + \beta_2 RISK_{i,t-2} + \beta_3 IF_t + \beta_4 IF_t \times K_i + \beta_5 IF_t^2 + \beta_6 IF_t^2 \times K_i + \beta_7 X_{it} + \lambda_i + \chi_t + \varepsilon_{it} \quad (12)$$

Here in this equation, K_i referred to the kind of bank i . When the sample bank was large-scaled commercial bank, then we assume K as 1, and in other situations as 0. After the above analysis, we expected that β_4 was significantly positive and β_6 significantly negative.

Since dependent variable lagged items serve as the explanatory variables in formula (11) and (12), the cross section dependency and endogenous problems are easy to occur in empirical equations. In this situation, the adoption of traditional data estimation method would lead to deviation including mixed-effect model, fixed-effect model as well as random-effect one, hence the explanation viewed from economics done was bound to be far from scientific. In comparison, SYSGMM method used by Blundell and Bond (1998), Arellano and Bond (2004) do not only allow the existence of serial correlation and heteroscedasticity in data, but also helped the endogenous problem-solving by way of proper instrument, thus significantly reducing the biasedness of estimated coefficient. In so doing, the SYSGMM method is chosen so as to interpret the relation between variables.

4. Empirical result study

4.1. Stability test of variables

The precondition of estimating dynamic panel model is the stability of data. To this end, the Hadri test, LLC test and IPS test at bank level are taken. Table 3 demonstrates that proxy variables of risk-taking and liquidity level of commercial banks are all stable series at the significant level of 1 %, excluding the possibility of "fake regression" model.

Table 3
Variable unit root test

variables	Hadri test	LLC test	IPS test
	statistics (figure P)	statistics (figure P)	statistics (figure P)
$RISK_{AE}$	2.327*** (0.010)	-8.883*** (0.000)	-4.229*** (0.000)
$RISK_{LL}$	7.787*** (0.000)	-30.396*** (0.000)	-7.206*** (0.000)
$RISK_{LA}$	8.636*** (0.000)	-7.139*** (0.000)	-3.522*** (0.000)
LI	8.000*** (0.000)	-6.152*** (0.000)	-1.764** (0.039)

Note: The original assumption of three types of unit roots test is the non-existence of unit root of variables.

4.2. Empirical study about internet finance's dynamic impact on commercial bank's risk-taking behavior

Table 4 reports the regression result of proposition 1. Model (1) and (2) are the benchmark regression results taking $RISK_{AE}$ as bank's risk-taking proxy variables. According to table 4, among these two models, the regression coefficients of the first and second lagged items of dependent variable are significantly positive, demonstrating that the risk-taking behavior is indeed of sustainability. The figure P of AR(2) test and Sargan test are both above 0.1, indicating that the second-order autocorrelation in the difference of disturbing terms, and over—recognition in instrumental variables did not exist. Hence, the dynamic empirical model in this paper is both necessary and reasonable.

First, model (1) merely considers the relation between internet finance and commercial bank's risk-taking behavior. The monomial coefficient (IF) and quadratic coefficient (IF^2) of internet finance are respectively negative and positive, both of them having passed the significance test at the level of 1%. This result is in line with the expectation of proposition 1, and has tested the U-type relation between internet finance and risk-taking behavior of commercial banks, which shows that the initial development of internet finance could lessen the burden of commercial bank's risks, while the further progress of internet finance could aggravate the risks.

Next, control variables are added into model (2), with the result showing that the regression marks and significance level of monomial coefficient and quadratic coefficient of internet finance remain unchanged. It again proves that the proposition 1 does come into existence. Based on the estimated result of model (2), the inflection point of the quadratic function is 0.9164, slightly lower than the internet finance index in 2012. Fact shows that the parabola of model (2) is upward, so the preliminary prediction is drawn that from 2003 to 2011, the internet finance development is conducive for banks to decrease risks they shouldered, whereas in 2012 to 2013, the impact deriving from such development would further intensify the relevant risks. According to figure 2 where the growth of internet finance is illustrated, prior to 2010, China's internet channel index is far higher than internet credit index and internet wealth management index. Therefore, in this period, internet finance lowers the management cost of bank by improving technological level and work efficiency, hence

dampening the willingness of commercial banks to take the risks. Following 2011, booming internet credit and internet wealth management index overtake the internet channel index. It explains why the capital cost in bank is uplifted and commercial banks forced to resist more risks to maintain profit, due to the fact that current deposit is distributed and distorted interest rate corrected. And as manifested by theory and empirical analysis, from the perspective of dynamic evolution, internet finance's impact on risk-taking of banks is not a simple linear relation, but a U-type trend upward after downward.

Table 4

Empirical analysis of internet finance's dynamic impact on commercial banks' risk-taking behavior

Variable	Model(1)	Model(2)	Model(3)	Model(4)	Model(5)	Model(6)
<i>L1.RISK</i>	0.2164*** (0.0025)	0.2101*** (0.0106)	0.7195*** (0.0106)	0.8478*** (0.0099)	0.5135*** (0.0200)	0.4362*** (0.0195)
<i>L2.RISK</i>	0.1047*** (0.0036)	0.0939*** (0.0049)	0.1654*** (0.0022)	0.1692*** (0.0033)	0.0742*** (0.0134)	0.0557*** (0.0076)
<i>IF</i>	-0.2223*** (0.0185)	-30.1231*** (2.3049)	-0.0035*** (0.0007)	-0.0366*** (0.0040)	-0.0850*** (0.0164)	-7.3493** (3.1677)
<i>IF</i> ²	0.1569*** (0.0136)	32.8704*** (2.4995)	0.0031*** (0.0007)	0.0513*** (0.0059)	0.0255* (0.0146)	7.9062** (3.4574)
<i>M2</i>		78.8531*** (5.9788)		0.1627*** (0.0176)		18.8744** (8.3045)
<i>GDP</i>		69.1355*** (5.2319)		0.1392*** (0.0180)		16.2992** (7.2208)
<i>IRL</i>		1.3581*** (0.1395)		0.0060** (0.0021)		0.3046*** (0.0186)
<i>CR4</i>		-0.2378*** (0.0248)		0.0022*** (0.0004)		-0.0892*** (0.0278)
<i>FORE</i>		-28.3608*** (2.2229)		-0.0290*** (0.0033)		-7.2150** (2.9662)
<i>LI</i>		-0.0427*** (0.0147)		-0.0131*** (0.0016)		-0.2629*** (0.0290)
Individual fixed effect	control	control	control	control	control	control
Time fixed effect	control	control	control	control	control	control
AR2 test	-0.7297 (0.4656)	-1.0136 (0.3110)	-0.9811 (0.3266)	-0.6236 (0.5329)	0.1376 (0.8906)	-0.8907 (0.3731)
Sargan test	27.8502 (0.3659)	27.2150 (0.3981)	36.3178 (0.1906)	26.7258 (0.5332)	31.2279 (0.2199)	32.5433 (0.1758)

Note: Under the regression coefficient sit the standard error within bracket; beneath the model test is figure P; constant term is omitted in the regression result; same case is seen as the followings.

Besides, the regression result of control variables is basically corresponding with the existing studies. The coefficient of monetary supply increase rate (M_2) is significantly positive at the level of 1%, symbolizing that China's monetary policy is not neutral and too proactive policy would level up commercial bank's risk tolerance scale. Plus, the regression coefficient of macro-economic growth rate (GDP) is significantly positive. According to the research of López, Tenjo and Zárate

(2011), upward economic tendency would boost the optimism of commercial banks and encourage them to undertake excessive risks. And the coefficient of *IRL* level is positive which also pass the significance test at 1% level, same as the study of Wang and Jin (2014). The cancellation of interest rate control tightened the interest margin between deposits and loans, and further raises the credit risk among banks. Furthermore, the significant negative results of the concentration ratio of industry (*CR4*) and industrial openness (*FORE*) reflect more intense competition in industries always companied with lower risks confronting commercial banks. For one thing, the management efficiency would be improved and exposure of risks decreased as market competition intensified (Berger, Klapper and Turk, 2009). For another, foreign-invested banks involvement would increase the risk-control skills for domestic banks and stabilize the healthy operation (Yao, Jiang and Feng, 2011). Also, the coefficient of liquidity level (*LI*) is negative and highly significant in statistics. As mentioned by Mussa (2010), as liquidity risk is one of the major risks in banks, the more abundant the liquidity is the lower risk-taking level the commercial banks have to face.

In order to ensure the robustness of study result, firstly, loan loss reserve rate (*RISK_{LL}*) and risk asset ratio (*RISK_{LA}*) are considered as alternative variables to banks risk-taking, with result been listed in model (3) and model (6) in table 4. Secondly, processed Winsor sample under 5% would be regressed. Study showed that the estimated monomial coefficient of internet finance (*IF*) is significantly negative, while quadratic term (*IF²*) significantly positive, with the result of control variables unchanged.¹ The robust test again verifies proposition 1, indicating that the study conclusion would not alter due to changes of risk-taking variables in banks.

4.3. Empirical analysis of internet finance's heterogeneous impact on commercial banks' risk-taking behavior

Table 5 lists the regression result of proposition 2. Model (7) is a benchmark analysis where the ratio between asset and equity is used as explanatory variables. And AR (2) test and Sargan test both reveal the rationality of the empirical equation. Among them, interaction term *IF*×*K*'s regression coefficient proves significantly positive, and the coefficient of *IF²*×*K* significantly negative. This result is in accord with the expectation of proposition 2, which explains that in the face of the internet finance's impact, different kinds of commercial banks' risk-taking would respond distinctly. In respect of large commercial banks, their responses are a little bit slow due to the dysfunctional ownership, large scale, fixed customer base and the stringent surveillance. While the small and medium sized banks are comparatively sensitive. In the meanwhile, the monomial coefficient of internet finance proved significantly negative and quadratic one significantly positive, further backing the proposition 1. It

¹ What need to be noticed is that the turning point of model (4) and (6) was 0.7135 and 0.9296, one year gap between itself and the turning point of benchmark analysis. But it dose not affect the U-type relation between internet finance and commercial banks' risk taking. Due to the size of this paper, the regression result following Winsor processing is not listed in detail. Please contact the author if needed.

is needless to say that the regression mark and significance level of control variables are basically same as the result of equation (11).

Table 5

Empirical analysis of internet finance's heterogeneous impact on commercial banks' risk-taking behavior

Variable	Model(7)	Model(8)	Model(9)	Model(10)	Model(11)	Model(12)
<i>L1.RISK</i>	0.2042*** (0.0180)	0.8134*** (0.0129)	0.4123*** (0.0241)	0.1925*** (0.0212)	0.7914*** (0.0117)	0.4244*** (0.0206)
<i>L2.RISK</i>	0.0937*** (0.0071)	0.1409*** (0.0146)	0.0480*** (0.0122)	0.1416*** (0.0076)	0.1555*** (0.0199)	0.0754*** (0.0123)
<i>IF</i>	-29.5753*** (3.1639)	-1.9488*** (0.2472)	-8.6732*** (3.2313)	-37.9363*** (1.8582)	-2.3629*** (0.2915)	-11.7531*** (3.0525)
<i>IF</i> ²	32.2653*** (3.4387)	2.1361*** (0.2693)	9.3516*** (3.5244)	41.4076*** (2.0135)	2.5910*** (0.3174)	12.7041*** (3.3185)
<i>IF</i> × <i>K</i>	0.0503*** (0.0041)	0.0113** (0.0045)	0.1667*** (0.0446)			
<i>IF</i> ² × <i>K</i>	-0.0661* (0.0352)	-0.0019*** (0.0033)	-0.0833** (0.0344)			
<i>M2</i>	77.4084*** (8.2261)	5.1755*** (0.6457)	22.3141*** (8.4614)	99.4639*** (4.8040)	6.2661*** (0.7626)	30.3136*** (7.9617)
<i>GDP</i>	67.8745*** (7.1875)	4.4807*** (0.5627)	19.2978*** (7.3569)	87.2799*** (4.2009)	5.4303*** (0.6626)	26.2671*** (6.9081)
<i>IRL</i>	1.3712*** (0.1567)	0.0766*** (0.0134)	0.3056** (0.1289)	1.8193*** (0.1269)	0.0852*** (0.0137)	0.4283*** (0.1607)
<i>CR4</i>	-0.2353*** (0.0309)	-0.0155*** (0.0024)	-0.0936*** (0.0295)	-0.3051*** (0.0205)	-0.0177*** (0.0028)	-0.1203*** (0.0320)
<i>FORE</i>	-27.8407*** (3.0072)	-1.8230*** (0.2367)	-8.3868*** (3.0313)	-35.7035*** (1.7970)	-2.2065*** (0.2747)	-11.3062*** (2.9053)
<i>LI</i>	-0.0242** (0.0027)	-0.0143*** (0.0028)	-0.2443*** (0.0338)	-0.0228** (0.0016)	-0.0180*** (0.0030)	-0.2530*** (0.0308)
Individual fixed effect	control	control	control	control	control	control
Time fixed effect	control	control	control	control	control	control
AR2 test	-1.2650 (0.2059)	-0.0583 (0.9535)	-0.2554 (0.7984)	-1.2698 (0.2057)	0.0837 (0.9333)	-1.0268 (0.3045)
Sargan test	27.0726 (0.4055)	20.5812 (0.7632)	25.9352 (0.4667)	23.3621 (0.6124)	18.0236 (0.8749)	22.3627 (0.6687)

In order to guarantee the reliability of the conclusion, the robustness test is conducted from the following three aspects. First, the $RISK_{LL}$ and $RISK_{L/A}$ are treated as the alternative-indicator in terms of banks' risk-taking behavior, with result shown in model (8) and (9). We find that the coefficient of interaction item $IF \times K$ in the regression result is still significantly positive, while the coefficient of $IF^2 \times K$ significantly negative. Second, with 31 small and medium sized commercial banks as sample, $RISK_{A/E}$, $RISK_{LL}$ and $RISK_{L/A}$ constituted of explained variables to estimate equation (11), results being seen from model (10) to (12). It was not uneasy to discern that compared with the regression result of the complete sample (second, fourth and

sixth row in Table 4), the monomial (IF) and quadratic coefficient (IF^2) of internet finance are significantly increased in absolute term and highly significant in speaking of statistics, further supporting proposition 2. Third, system GMM technique is used for estimating equation (12) based on the sample of processed Winsor fewer than 5% level, and no marked changes are noticed among regression coefficients of all variables.¹ Such robustness test results echo the benchmark study, which illustrates that from the dimension of horizontal comparison, different types of commercial banks differed in risk-taking in responding to internet finance.

5. Conclusion and political implications

At an unprecedented scale, the internet has been bringing about a profound revolution worldwide. Finance, as the origin of all industries, would inevitably be involved this time. Besides, the “uncultivated” growth of China’s internet finance in recent years put itself under the spotlight of the entire society. Explosive development of internet finance rapidly shapes the original financial ecology, having a great impact on the traditional businesses of commercial banks which are forced to make changes. These banks try to radicalize their business behaviors and shift risk-control strategies of to maintain profits. Under this background, it carries both theoretical and realistic value to study the relation between internet finance and commercial banks’ risk-taking behavior.

Considering this, in this paper, the internet finance restraint and heterogeneity assumption are introduced into the theoretical model of Kishan and Opiela (2000) to analyze the dynamic and heterogeneous influence on commercial banks for bearing risks from internet finance. On this basis, 36 commercial banks from 2003 to 2013 are selected as sample for empirical analysis, with internet finance index setting up by “text mining method” as explanatory variable and SYSGMM as methodology. The conclusions are as follows: (1) through the lens of dynamic evolution, the downward-to-upward U trend is found in regard to the impact of commercial banks’ risk-taking delivered by internet finance. In other words, internet finance is, in its infancy, helpful for commercial banks to cut down management cost and reduce risk-taking, but then internet finance would raise capital cost and also the risk-taking for commercial banks. (2) Viewed from the perspective of horizontal comparison, different types of commercial banks are heterogeneously responding to internet finance. Some large commercial banks are slow while small and medium sized ones comparatively sensitive.

The conclusions show the complexity of the implication mechanism and functional process of how internet finance affected commercial banks’ risk-taking. Some differences could be seen apart from those similarities regarding the responses made by various kinds of commercial banks to internet finance during different periods of time. And the hidden political implications remain as follows. First, supervision

¹ Due to the size of this paper, the regression result following Winsor processing is not listed in detail. Please contact the author if needed.

department should grasp the rules of internet finance development and spill-over risks, in a bid to ward off disadvantages through comprehensive management. During the initial stage of internet finance, we should give more support and tolerance in the principle of encouraging financial development and innovation and preventing excessive intervention. In the mid-to-late-period, we should put in place early warning and surveillance over the typical risks carried by internet finance itself and the spill-over risks confronting traditional finance, securing the bottom-line from any systematic risks. Second, we should adopt differed management strategies tailored to those characteristics of different commercial banks. Also, we need to accelerate the equity restructuring of large commercial banks and cut down monopoly, in an effort to improve efficiency for better embracing the challenges posed by internet finance, strengthen the risk-management capacity of small and medium sized commercial banks, giving play to such banks to solve capital-raising difficulties of small and medium sized enterprises and, at the same time, prevent the outbreak of regional financial crisis. Third, we should steadily promote institution reform of finance, gradually complete the interest rate liberation and encourage the advantage complementing between internet and traditional finance, allowing financial sector better serve the real economy so that China's economy could again take off with the booming development of "internet+" industry.

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