The Effect of Interest Rates on Bank Risk-Taking: Evidence from Banks in China

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Abstract

There is a belief among some economists that 2008 financial crisis was caused by continuous low interest rates environment. They argue that low interest rate environment from the early to mid-2000s lead to the increase of banks' risk-taking appetite. Many empirical studies conducted in western countries have proven the negative relationship between interest rates and bank risk-taking. In this paper, we examine whether or not this connection exists within the Chinese economy. We measure bank risk-taking behaviour based on the ratio of non-performing loans to total loans, and we find its relationship with two different kinds of interest rates: legal and market interest rates. In addition, we divided control variables into internal and external variables. We analyzed more than 800 observations made on Chinese banks between 2003 and 2012. Consistent with similar studies conducted in western countries, we found that low level interest rates substantially increased bank risk-taking behaviour.

Keywords: banks in China; risk taking; interest rate;

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I. Introduction

The outbreak of the global economic crisis in 2008 impacted the world's financial system on a variety of levels. During this crisis, a large number of bank failures occurred all over the world, and since 2009, a very serious debt crisis has spread across Europe. Under the current international economic situation, academic, commercial, and political circles have renewed an emphasis on the risk-taking behaviours of banks. In order to maintain global economic stability, the Basel committee on Bank Supervision established the "Basel III", a global regulatory standard on bank capital adequacy and risk, to urge banks' managers to control risks taken by banks.

Banks are special kinds of financial institutions whose primary operation is monetary-based. A change in interest rates not only affects banks' revenue but the banks' cost of borrowing as well. Therefore, a change in interest rates also influences the banks' risk-taking behaviour in their day-to-day business operations. Between 2000 and 2007, most western countries maintained relatively low nominal interest rates. Many empirical studies of western countries suggest that a low interest rate environment influences a bank's risk preference and risk tolerance. Consequently, banks increase their risk-taking level by raising the proportion of risk assets or by other approaches.

The Chinese financial market has gradually begun to open to foreign businesses, and the national macro-control tools are gradually maturing. Thus, the interest rates environment in China will begin to vary more frequently. Research on how the level of interest rates affects the

risk-taking behaviour of banks will, therefore, have a long-term, instructive significance on the development of China's financial market.

Although many scholars have researched the relationship between the level of interest rate and the behaviours of bank risk-taking, there are few references available in regard to China. In this paper, we will discuss the relationship of interest rates and bank risk-taking behaviour, as well as define and analyze other internal and external factors that impact bank risk-taking. According to the current situation in China, we designed different regression models by simulating the methodology employed by some western scholars. In total, we conduct five regressions with two different regression equations, using different measures of interest rates and different control variables. All of the regression simulations indicate that bank risk-taking behaviour is significantly and negatively correlated with the level of interest rate. This result is consistent with the conclusion of most mainstream research produced on this topic. In addition, we found other factors, such as the return on asset ratio, size, and total capital ratio of each bank, GDP growth rate, and monetary policy, also have a great impact on the bank risk-taking behaviours.

The most important contribution of our research to existing literature is our creation of new regression models according to the real situation of China. Moreover, we used the ratio of non-performing loans to total loans to represent the level of risk-taking behaviour and observed the relationship between bank risk-taking and five different types of interest rates.

The remainder of this paper is organized into four sections and appendices. The following section discusses the previous research conducted on subjects related to bank risk-

taking and interest rates. Section III describes variables of banks' risk-taking, interest rates, internal risks and external risks we will use in our regression analyses, and lists data sources of these variables, while section IV contains an explanation of our model and empirical results. In section V, we present our conclusions and discuss some further issues on how to improve our model.

II. Theoretical Background and Literature Review

As we discussed above, bank risk-taking has greatly impacted the economic development and stability of its host country. As a result, economists and academics have produced a large number of studies on a variety of topics regarding banks' risk-taking behaviours.

On the topic of measuring a bank's risk-taking, Delis and Kouretas (2011) explained that the ratio of bank's risk assets to its total assets could be used for charting its risk-bearing level; risk assets are any and all assets excluding cash, government bonds, and inter-bank deposits. A study by Fernandez and Gonzalez (2005) agreed that the non-performing loan ratio could also be used to measure a bank's risk-taking behaviour, since loan-related business is one of a bank's key high-risk areas.

The relationship between interest rates and bank risk-taking has also aroused concern among academics. Related studies show that interest rates affect a bank's risk bearing level through three mechanisms: the profit-seeking mechanism (Rajan, 2005), the valuation mechanism (Borio & Zhu, 2008), and the insurance mechanism (Gambacorta, 2009). According to their analyses, the banks' earnings derived from loan-related business will decline in a low interest rate environment. In order to seek higher profits, banks must be more willing to gain profits through high-risk business. In addition, banks tend to have better expectations for their assets valuation and cash flows in a low interest rate environment than they do when interest rates are high, which will then stimulate them to bear more risks. Moreover, low interest rates reflect a loose monetary policy, which indicates that the government is trying to create policies

that will stimulate economic development; a stable economic environment provides insurance on a bank's risky investments.

In addition to studying the interest rate environment, scholars have also researched other factors affecting bank risk-taking behaviour. These studies mainly focus on the following two aspects:

1) *Bank-level factors*. The financial conditions of a bank greatly impact its risk-taking decisions. A bank's balance sheets can also reflect its preferences on risky investments. Haldane (2009), Kishan and Opiela (2000) examined the relationship between the size of a bank and its risk-taking, concluding that bigger banks tend to increase risky investments because they are skilled in reducing risks through diversification. Denicolo et al. (2010) discovered that the liquidity of a bank can also influence its risk-taking: banks with high liquidity have a greater ability to take risks. Furthermore, Delis and Kouretas (2011) proved that banks with a higher leverage ratio are more willing to take risks.

2) *Macroeconomic factors*. Studies conducted by Jimenez, Ongena, Peydro and Saurina (2008), Ioannidou et al. (2009), and Atnanasoglou, Brissimis and Delis (2009) examined whether or not monetary policy influences a bank's risk-taking decisions; independently of one another, they found that an expanding monetary policy will lead banks to bear more risks. Moreover, Lopez et al. (2007) found that the economic growth rate will affect a bank's risk-taking behaviour: in healthy economic times, with high GDP growth rates, banks are more optimistic and willing to take a greater number of risks.

The rest of this paper focuses on the relationship between the level of interest rates and banks' risk-taking behaviour, specifically in China. It will also analyze the effects of macroeconomic situations and a bank's specific financial conditions in relation to its risk-taking behaviours.

III. Sample and Variables

3.1 Data Sources

In order to conduct our study on the relationship between risk-taking behaviours and interest rates in banks, we created a large panel data set and used the regression function in Excel. We observed nearly all the listed banks in China, including commercial, cooperate, and savings banks, between 2003 and 2012. Interest rate data and other macroeconomic data was collected from the websites of the People's Bank of China and the National Database of China (National Bureau Statistics of China); annual data for banks was taken from the Bankscope database. Our Sample includes a total of 808 observations. In order to minimize the impact of extreme observations on the estimation outcomes, we manually deleted around 20 outliers using the sorting function in Excel.

3.2 Bank Risk-Taking

We used the ratio of non-performing loans to total loans (denoted as NPLR) to stand for bank risk-taking behaviours. This ratio was obtained from Bankscope and is presented in Table 1, Summary statistics (Appendix A). The reason we used the non-performing loans ratio is that it reflects the quality of bank assets: high non-performing loans ratios usually indicate that banks are more willing to provide loans to pursue high returns even though these loans have low ratings and high risks, while low non-performing loans ratios indicate that banks are more concerned with qualities of their loans and tend to bear less risks. In addition, this ratio can also represent a bank's credit risks, which means the higher the non-performing loans ratio, the higher the bank's credit risk. The average value of the non-performing loans ratio in our sample

equals 2.706; the highest average value was reported in 2003, at 9.27%, and relatively low values in 2008, 2011, and 2012, which all equalled around 1%.

3.3 Interest Rate

Most previous studies on the topic that we selected have focused on the relationship between the general level of interest rates and the behaviour of bank risk-taking. In this paper, however, we divide the various interest rates into legal benchmark interest rates and market interest rates. Legal benchmark interest rates include short-term borrowing (STBoR), long-term borrowing (LTBoR), short-term lending (STLeR) and long-term lending interest rates (LTLeR). In particular, we used the one-year legal benchmark borrowing interest rates as STBoR, five-year legal benchmark borrowing interest rates as LTBoR, six months to one year legal benchmark lending interest rates as STLeR, and more than five-year legal benchmark lending interest rates as LTLeR. This data was all collected from the People's Bank of China website.

For market interest rates, we used bank level interest rates from each bank, which equals the total interest income divided by total loans. According to our observation period, 2003 to 2012, the average value of these rates was lowest in 2003 and remained low until 2006; the highest interest rates occurred in 2007 and 2008, and fluctuated thereafter. We have reported the correlation coefficients between each variable in Table 2 below (Appendix C). We found that the ratios of non-performing loans are negative in relation to all recorded interest rates between 2003 and 2012. The negative correlation coefficients and Figure 1 below (Appendix B), which presents a simple, non-parametric regression between non-performing

loan ratios and bank level lending rates, both provide us with evidence that a low interest rate environment is related to higher risk-taking behaviours of banks.

3.4 Control Variables

In our regression equations, we set the non-performing loan ratio as dependent variables and various interest rates as independent variables. Since there are many other elements that may be associated with bank risk-taking, we also controlled some other factors in order to observe the "real" relationship between NPLR and various interest rates. We divided the control variables into internal and external variables. Internal variables (namely bank-level variables) include return on average assets (denoted as ROAA), size (measured as the natural logarithm of total assets), and total capital ratio (denoted as ToCapR); external variables (like some macroeconomic variables) include GDP growth rate (denoted as GDPG) and money supply growth rate (denoted as M2G). We used different combinations of control variables in each regression equation according to our analyses and tests. The summary statistics of the control variables are presented in Table 1 (Appendix A).

3.5 General Empirical Model

The general empirical regression equation we estimated is as follows:

$$Risk_{it} = \alpha + IR_t + \sum IV_{it} \, (+\sum EV_t) + \varepsilon_{it}$$

In the equation above, subscript "i" represents a certain bank and subscript "t" stands for a certain year. Therefore, dependent variables and internal control variables are a panel data set, while other variables are time series data sets. Risk represents the level of bank risk-

taking, which is itself measured by non-performing loan ratios (NPLR). IR represents various interest rates, including four kinds of legal benchmark interest rates and one type of market level interest rates. IV stands for internal variables and EV is the notation for external variables.

IV. Empirical Model and Results Analysis

In order to find the relationship between interest rates and a bank's risk-taking behaviour in China, we designed two empirical regression equations according to our analysis about the current situation in China and many test-models.

$$Risk_{it} = \alpha + IR_t + \sum IV_{it} + \sum EV_t + \varepsilon_{it} \quad (1)$$

We used the simple equation (1) to regress a bank's non-performing loan ratio on China's four legal benchmark lending rates (IR_t) seperately. These rates include short-term borrowing, short-term lending, long-term borrowing, and long-term lending rates, respectively. Here IV_{it} denotes a bank's internal variables: ROAAs, total capital ratios and sizes; EV_t denotes China's macroeconomic variables: GDP growth rates and money supply growth rates.

The regression results from equation (1) are presented in Table 3 (Appendix D). In this table, column I and column III are the regression results when using short-term and long-term borrowing rates as the interest rate variable. Negative coefficients -2.8213 and -2.5808 indicate that increasing short-term or long-term borrowing rates will decrease a bank's risky investments. The reason for this negative relationship may be that in a low interest rate environment, a decreased interest rate might result in a decline in banks' costs on interest payments, which will force banks to allocate more funds to risky investments. Column II and column IV present the results when short-term and long-term lending rates are the determinants of bank risk. These two lending rates have similar coefficients to the borrowing rates, which are also negative and significant (-3.0591 and -3.3904, respectively). The reason for this negative correlation may be that when the level of legal benchmark lending rates is low, a

bank's income from interests on loans will decline. Therefore, banks are required and incentivized to increase risky investments in order to pursue higher profits and achieve their profit targets. According to these results, bank risk-taking behaviours have negative relationships with interest rates, irrespective of the type of interest rates variables.

Regardless of the interest rate variables, the effects of other control variables to bank risk-taking are similar no matter which type of interest rates is used. In terms of bank-level internal variables, ROAA has a negative and significant relationship with a bank's risk-taking behaviour (-1.9130, -2.09203, -1.680 and -2.0158, respectively), which means that a bank's profitability is negatively correlated with bank risk-taking. This outcome opposes our original hypothesis according to the rule of 'higher risk, higher profit.' However, we did not use only one variable in our regression model. Therefore, the final negative relationship between RROA and bank risk-taking is the result of the interaction of various factors in our regression equation. Moreover, coefficients on total capital ratio and size are both negative, although not always significantly, indicating that large banks or those with higher total capital ratios tend to have less risky investments and are exposed to less credit risk.

When it comes to macroeconomic variables, our regression results indicate that banks are more likely to increase their risky investments in an economic environment with a high GDP growth rate. In this type of economic environment, banks tend to have good anticipations on economic development. Therefore, their expectation on investment returns during healthy economic times will be higher than during an economic depression. However, the relationship between M2G and bank risk-taking is negative. We argue that a rapid growth rate of money

supply will lead to persistent inflation pressure. The sustained inflation pressure will have a negative impact on the development of every walk of life.

$$Risk_{it} = \alpha + IR_t + \sum IV_{it} + \varepsilon_{it} \quad (2)$$

After analysing the relationship between a bank's risk-taking behaviour and the four legal benchmark interest rates, we use equation (2) to do the regression between banks' non-performing loans rates and their bank-level lending rates. Since bank loans and interest-based income are already affected by macroeconomic factors (e.g. GDP growth rate and money supply amount), we eliminate all these external variable in equation (1) and only regress banks' risk-taking variables on interest rates and a bank's personal financial condition index.

The regression results are presented in Table 3 (Appendix D). As we can see from the table, the regression outcomes from equation (2) using market level interest rates have similar indications over a bank's risk-taking behaviour, as shown in the results from equation (1), when using legal benchmark interest rates. In particular, bank-level lending rates have a significantly negative correlation (-17.60879) with bank risk-taking; the coefficients of bank size (-0.29214), total capital ratio (-0.15530), and ROAA (-2.50771) are also negative.

V. Conclusion and Further Discussion

In summary, we analysed factors that affect bank risk-taking behaviour, focusing on the relationship between the level of interest rates and bank risk-taking. We divided the control variables into internal (bank-level) and external (country-level) variables; the internal variables include ROAA, size, and total capital ratio, while external variables consist of GDPG and M2G. Moreover, we divided various interest rates into legal benchmark and market level interest rates.

In our empirical analysis, we finally chose two regression equations, according to our study and quantity of regression tests. The two regression equations include a model with four separate legal benchmark interest rates and a model with market level interest rates. In each estimated model we used non-performing loans ratio to represent the level of bank risk-taking. According to the regression results from our two empirical models, a low interest rate environment significantly increased bank risk-taking behaviour. In terms of other control variables, the results of both models using different types of interest rates were also similar. ROAA and M2G were significantly negative correlated with bank risk-taking, and GDPG showed significant, positive relationships with bank risk-taking; the coefficients of both bank size and total capital ratio were negative but not always significant in our multivariable regression models.

The measurement of bank risk-taking behaviour is a very complex task. Due to time constraints and our limited expertise, there are still many deficiencies with our study. First, there are many kinds of risks associated with banking operations, such as credit, legal, and

operation risks. We used a non-performing loan ratio to represent bank risk-taking, but this ratio cannot comprehensively represent every risk. Therefore, we need to find a more suitable dependent variable for future study. Second, the risk to banks is persistent, partially because a bank's risk-taking behaviour may be associated with the economic cycle and time lag may exist for banks to react to macroeconomic change. Therefore, the results of a static model, like the one we used, may be biased to a certain extent. To reflect the interminable characteristics of bank risk-taking, we should design a dynamic model that includes some risk variables that address the time lag issue.

Appendices: Tables and Figures

Appendix A

Table 1: Summary Statistics

Variable		Mean	Std. Dev.	Min	Max
Bank Risk Taken	NPLR	2.706	3.620	0.200	38.220
Internal Variables	ROAA	0.911	0.463	-0.770	3.000
	ToCapR	12.594	6.518	-0.390	56.590
	Size	5.125	0.996	1.230	8.270
External Variables	GDPG	10.521	1.970	7.650	14.160
	M2G	17.258	4.115	13.600	27.700
Various Interest rates	BLLeR	6.036	0.015	2.232	14.286
	LTLeR	6.631	0.479	5.760	7.490
	STLeR	6.062	0.480	5.310	6.930
	LTBoR	4.460	0.677	2.790	5.280
	STBoR	2.796	0.468	1.980	3.465

This table presents summary statistics for all variables used in our empirical analysis. Our sample includes 808 observations made on listed banks in China. The table reports the mean, standard deviation, minimum value, and maximum value for each factor. The variables are as follows: NPLR is the notation for non-performing loans ratio, which equals non-performing loans to total loans, ROAA is return on average assets, ToCapR is total capital ratio, size is the natural logarithm of total assets, GDPG is GDP growth rate, M2G is broad money growth rate, BLLeR is bank level lending rate, which is the ratio of total interest income to total loans, LTLeR is the more than five years lending rates, STLeR is the six months to one year lending rates, LTBoR is the five-year borrowing rates, and STBoR is the one-year borrowing rates.

Appendix B

Figure 1: Non-Parametric Regression between NPLR and Bank-Level Lending Rates

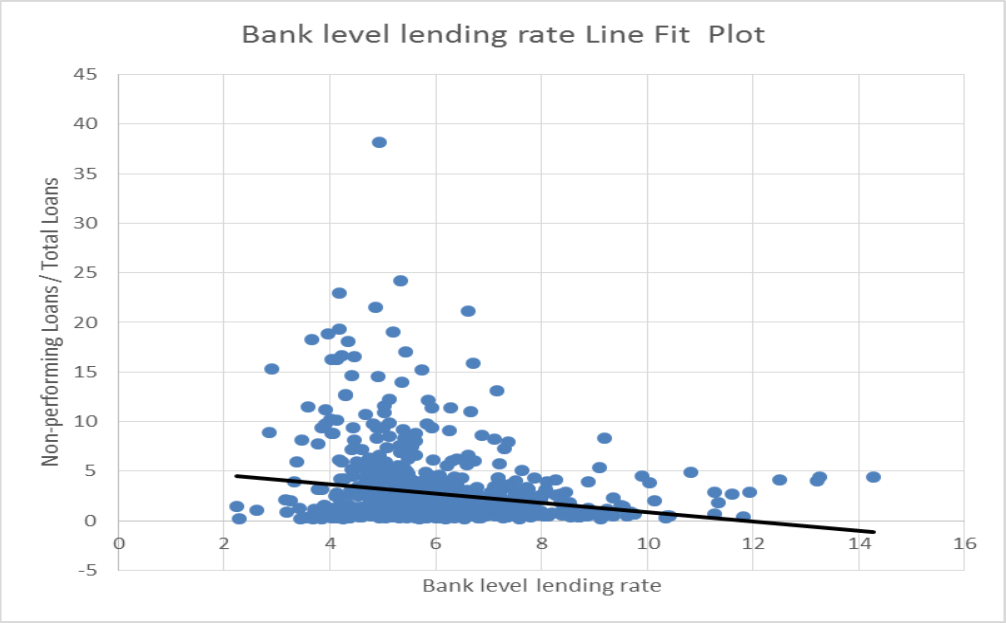

Fig. 1. Bank-level lending rates and non-performing loan ratios. The figure presents the non-parametric regression between bank risk-taking, measured by the ratio of non-performing loans to total loans, and the bank-level lending rates, measured by the ratio of interest income to total loans. The regression line reflects the negative relationship between non-performing loan ratios and the bank-level lending rates.

Appendix C

Table 2: Correlation Matrix

	NPLR	*ROAA*	*ToCapR*	*Size*	*GDPG*	*M2G*	*BLLeR*	*LTLeR*	*STLeR*	*LTBoR*	*STBoR*
NPLR	1.000										
ROAA	-0.389	1.000									
ToCapR	-0.296	0.099	1.000								
Size	-0.041	0.112	-0.203	1.000							
GDPG	0.204	-0.202	-0.243	-0.242	1.000						
M2G	0.054	-0.064	0.001	0.035	-0.139	1.000					
BLLeR	-0.196	0.428	0.019	-0.252	0.016	-0.321	1.000				
LTLeR	-0.174	0.132	0.039	-0.169	0.537	-0.664	0.467	1.000			
STLeR	-0.172	0.146	0.054	-0.146	0.478	-0.716	0.475	0.990	1.000		
LTBoR	-0.377	0.302	0.201	-0.032	0.119	-0.682	0.468	0.825	0.855	1.000	
STBoR	-0.341	0.305	0.213	-0.034	0.113	-0.655	0.495	0.854	0.890	0.949	1.000

This table presents correlation coefficients for the variables used in our research. The variables are as follows: NPLR is the notation for non-performing loans ratio, which equals non-performing loans to total loans, ROAA is return on average assets, ToCapR is total capital ratio, size is the natural logarithm of total assets, GDPG is GDP growth rate, M2G is broad money growth rate, BLLeR is bank level lending rate, which is the ratio of total interest income to total loans, LTLeR is the more than five years lending rates, STLeR is the six months to one year lending rates, LTBoR is the five-year borrowing rates, and STBoR is the one-year borrowing rates.

Appendix D

Table 3: Multivariable Regression Results

	I	II	III	IV	V
ROAA	-1.91304	-2.09204	-1.68002	-2.01586	-2.50771
ToCapR	-0.09402	-0.10746	-0.08184	-0.10441	-0.15530
Size	-0.088357	-0.1448	-0.06867	-0.16231	-0.29214
STBoR	-2.82138				
SRLeR		-3.05917			
LTBoR			-2.58080		
LTLeR				-3.39049	
BLLeR					-17.60879
GDPG	0.22719	0.47280	0.25812	0.56304	
M2G	-0.16049	-0.19051	-0.23635	-0.19021	

The table shows the regression coefficients. In regression I-V dependent variable is the ratio of non-performing loans to total loans. We use short term borrowing rate(STBoR), long term

borrowing rate(LTBoR), short term lending rate(STLeR), long term lending rate(LTLeR) and bank-level lending rate(BLLeR) in regression I-V respectively. The explanatory variables are as follows: ROAA is return on average assets, ToCapR is total capital ratio, size is the natural logarithm of total assets, GDPG is GDP growth rate, M2G is broad money growth rate, BLLeR is bank level lending rate, which is the ratio of total interest income to total loans, LTLeR is the more than five years lending rates, STLeR is the six months to one year lending rates, LTBoR is the five-year borrowing rates, and STBoR is the one-year borrowing rates.

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