Research on liquidity risk of commercial bank – from the view of comparison of Chinese and American commercial banks

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Abstract. The liquidity risk of commercial banks has become an important driver of the major risks in the modern economic system. This paper synthesizes the off balance sheet items which are often ignored in traditional bank liquidity researches, and uses the method of tracking and comparative analysis in different window periods to explore the liquidity changes and possible risks of Chinese commercial banks before, during and after the financial crisis. It is found that traditional loan projects, committed loan projects and demand deposits are important drivers of liquidity risk; Although the liquidity level of China's banks is high, due to the high demand deposit rate, low core capital ratio, rapid loan growth and high non-performing rate, and the lack of risk prevention awareness, liquidity risk is still a major risk that China's commercial banks need to face.

1 Introduction

The 2008 financial crisis is the most serious worldwide financial crisis since 1929 (Liu Xuesong and Hong Zheng, 2017) [1]. In view of the severity of the consequences and the complexity of the causes of liquidity risk, its related research has always been a frontier topic in Finance (Sadka, 2011) [2]. In the research on liquidity and its risk in China, there are many studies on the impact of on balance sheet items such as deposits and traditional loans on liquidity risk, but off balance sheet items are always ignored. According to the experience of developed countries, loans issued through off balance sheet projects are the main part of bank loan business. For example, 60% of the total loans of American banks are carried out through committed credit loans (Shockley and thakor, 1997) [3]. It is of great practical significance to analyze the liquidity changes of China's commercial banks in the case of economic recession and credit contraction in the external environment, and to compare and clarify the formation and characteristics of liquidity risk of China's commercial banks (Wang Mingming, 2017) [4]. Possible contributions of this paper: first, combined with on balance sheet and off balance sheet items, this paper explains in detail the impact of different banking businesses on liquidity level; Second, using window period segmentation, tracking and comparative research to explore the causes and consequences of

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liquidity risk; Third, using the data of Bank of America as the benchmark, subdivide it, and then compare China's commercial banks with it, so as to analyze the generation of different liquidity risks, and better reveal the connotation and impact of liquidity risk in China.

2 Literature review and research hypothesis

2.1 Literature review of commercial banks liquidity

The essence of commercial banks is to provide deposit demand and loan demand based on liquidity (Kashya et al., 2002) [5]. The Basel Committee defines bank liquidity as: liquidity refers to the ability of banks to finance and perform due debts in order to increase assets without bearing unacceptable costs [6]. The CBRC defines the liquidity risk of commercial banks as the risk that commercial banks cannot obtain sufficient funds in time at a reasonable cost to pay their due debts, fulfill other payment obligations and meet other capital needs for normal business [7]. Kashyap, Rajan and Stein found that due to the existence of management fees, there is a synergistic effect between deposits and loans (Kashya et al., 2002) [5], and their uncertainty will lead to liquidity risk. Schiozera and Oliveira (2004) believe that the restrictions on the flow of deposits and government reserves will make the flow of banks more vulnerable [8]. Young and Jang (2016) set the core deposit loan ratio and stable financing ratio as the key research objects of their liquidity risk [9]. Aydemir and guloglu (2016) examined the impact of bank liquidity risk and credit risk on bank development in the cycle and found that operating costs and bank operating efficiency will lead to liquidity risk [10]. When examining the liquidity risk, gatev et al. (2009) found that the growth of committed credit led to the fluctuation of stock returns and the growth of demand deposits [11].

2.2 Analysis on the impact of main businesses of commercial banks on Liquidity

The diversity of banking business determines that banks need to consider the impact of different businesses on liquidity. Bank demand deposits and loan commitments are crucial in liquidity management (gatev et al., 2009) [11]. Berger and Bouwman (2009) measured the liquidity of all U.S. banks from 1993 to 2003. The results show that the flow creation of banks is increasing every year, and the flow created by newly established banks is greater [12]. Fecht, et al. (2011) used return on assets, return on equity and total asset scale as variables for flow analysis [13]. Loutskina (2011) found that through asset securitization, banks can convert non current assets into current assets, making banks reduce the holding of current assets [14]. Imbierowicz and Rauch (2014) showed that in the 2008 U.S. financial crisis, most failed banks were affected by loan losses and insufficient liquidity [15].

2.3 Agent problem in liquidity risk of commercial banks

The principal-agent problem represents some possible limitations brought by the decentralization of management function in the market economy. Bank shareholders have ownership, while managers, as managers and decision-makers, their control and management function of capital is independent of ownership. The principal-agent problem and information asymmetry make the liquidity risk more serious (Liao et al., 2014) [16]. Aebi, Sabato and Schmid tested whether risk management in the context of corporate governance would enable banks to perform better in the 2007 / 08 financial crisis. It is

found that corporate governance variables are positively correlated with bank performance, although they lead to worse performance during the crisis (Aebi et al., 2012) [17].

Under the principal-agent conflict, the analysis path of commercial banks' current asset holding motivation and its risk impact is shown in Figure 1.

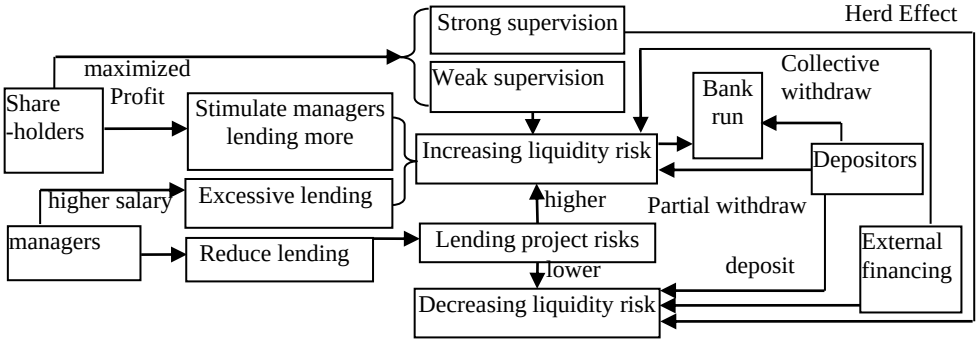

Fig. 1. Flow and risk formation path of commercial banks.

According to the logical deduction, the following research assumptions are obtained:

Hypothesis **H1**: loan project risk has a positive impact on liquidity risk.

Assumption **H2**: the increase of demand deposit will increase the current risk in the next period.

Hypothesis **H3**: relatively speaking, banks with serious principal-agent problems have greater liquidity risk.

3 Empirical research design

3.1 Data source and sample grouping

The data of this paper comes from the BANKSCOPE database and is analyzed by using the data of Bank of America and Bank of China. Based on the analysis of existing literature, large American banks account for the vast majority of American bank assets, and small American banks account for the vast majority of banks. According to the BANKSCOPE database, by 2015, there were 9620 banks in operation in the United States, and the frequency distribution is shown in Figure 2.

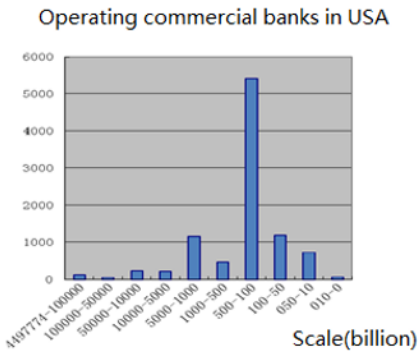

Fig. 2. Asset distribution frequency of operating banks in the USA in 2015.

Sample group 1, sample group 2, sample group 4 and sample group 5 are all selected from banks in normal operation up to 2015. Sample group 4 is the matching sample group

of failed U.S. banks. Because the bank size has an important impact on the banking business, and the overall asset distribution of failed U.S. banks cannot be simulated by sample 1 and sample 2, it is more comparable to analyze the results of banking business of matched sample group and failed banking business according to the asset size of failed banks. All the above data exclude financial institutions, such as finance companies, central banks, trust companies and investment banks, banks with discontinuous data, and banks without deposits and off balance sheet business data.

Table 1. Sample grouping description.

Group	Description	Grouping standard	Number
Sample1	Small-medium banks in USA	According to the frequency distribution ratio in Figure 2, 1000 U.S. banks were randomly selected for screening	642
Sample 2	Large banks in USA	The top 200 American banks in normal operation are selected for screening after sorting by asset order.	111
Sample 3	Bankrupted banks in USA	Select and screen American banks that failed after 2007.	95
Sample 4	Banks in USA which can compared with Sample 5	Compare the bank asset scale of the year before the collapse of sample group 3, and select samples from U.S. banks still operating with the same scale in 2015.	134
Sample 5	Banks in China	Select the Bank of China in normal operation until 2015 for screening.	99

3.2 Research variable design

This paper refers to the variable setting, combined with the model results and hypothesis test, needs to carry out variable design. The meaning, calculation and abbreviations of variables studied in this paper are shown in Table 2.

4 Empirical research results

4.1 Liquidity level before the financial crisis and performance of each sample group during the financial crisis

The median is not affected by the extreme value of the sample and can reflect the general level of the sample. This paper uses Wilcoxon (Mann Whitney u-rank test) to analyze different bank sample groups.

It can be seen from table 3 that in the early stage of the 2008 financial crisis, there was no significant statistical difference in the liquidity risk level between the sample group of bankrupt banks in the United States and the sample group of large banks and small and medium-sized banks. The amount of committed credit loans of banks in sample group 2 is very high, which is a multiple of that of other banks. As the committed credit loans may have loan asset outflow in the next stage, it can be seen that banks in sample group 2 are very confident in this part of asset outflow and can ensure that the liquidity risk will not increase due to the realization of random credit loans. Banks in sample group 2 pay more attention to loan business, with strong loan issuing ability and good asset profitability. Sample group 2 has the highest dividend rate. The profitability of sample group 2 banks decreased significantly, but at the same time, they paid more attention to loan quality, and the non-performing loan ratio decreased by more than half. Loans and credit loans

decreased in varying degrees, showing the characteristics of business contraction, so as to deal with the risks caused by insufficient liquidity during the financial crisis.

Table 2. List of abbreviations, calculations and meanings of variables.

Abb.	Measurement	Meaning
LIQD	Ratio of deposits with banks and other financial assets, derivative financial assets, etc. divided by total assets	The greater the value, the smaller the liquidity risk.
CREL	Committed credit line pair value	Credit risk.
CRELO	Ratio of committed credit line to total assets	
DEPT	Short term deposits divided by total deposits	Short term deposit ratio
TIER	Core capital divided by risk weighted assets	Reference value in Basel Accord >=6%
CRIN	Ratio of non-performing loans to total loans	Credit risk
CRLV	Loan growth rate	
CRAV	Standard deviation of return on assets	
PRLD	loan/deposit	ability to absorb deposits.
PRLA	loan/assets	ability to issue loans.
AMFY	Total loans / total number of employees	Management efficiency
AMSO	Ratio of employee compensation, annuity, stock and other expenses to operating costs	
AMCA	Operating costs / total assets	
AMPC	Management compensation / total number of employees	
AMDR	Annualized dividend ratio	
OTHAL	Interbank assets / interbank liabilities	Financing ability
OTFL	Short term financing ratio is short-term financing amount / total liabilities	

In the period of financial crisis, banks in sample group 3 have taken various measures to control liquidity risk in order to deal with the crisis. Before the financial crisis, the asset quality of sample group 3 was significantly lower than that of other sample groups. If the non-performing loan rate is the highest, and the growth rate of loan amount remains at a high level. However, its income is significantly lower than that of sample group 1 and sample group 4. It can be seen that sample group 3 has excessive lending behavior. In the financial crisis, the standard deviation data of asset return of sample group 3 banks are significantly higher than that of the control group, which shows that their asset stability is very poor. At the same time, sample group 3 showed obvious changes in the financial crisis

More typically, the management efficiency index of sample group 3 is significantly different from sample group 1 and sample group 4. The salary rate of employees and the per capita loan amount of employees are significantly higher than that of sample group 1 and sample group. There are two possible reasons for the high salary of employees: one is to carry out salary incentive in order to improve management efficiency, and the other is that the management has the tendency to make profits. Together with the excessive lending of banks with low interest rates, it can be judged that the principal-agent problem of banks in sample group 3 is more prominent. Before and during the financial crisis, the impact of

business characteristics on liquidity and risk of the sample group of bankrupt banks with typical characteristics is shown in Figure 3.

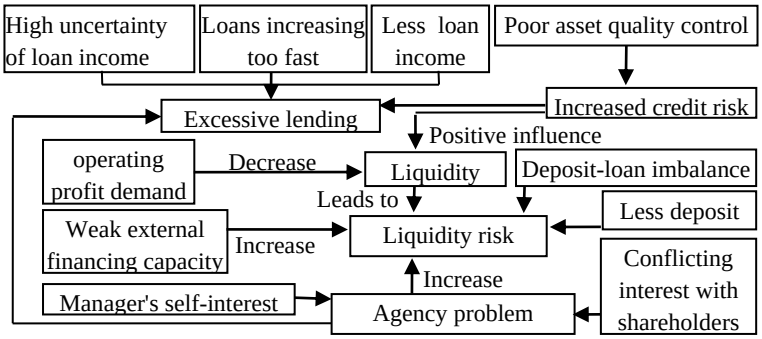

Fig. 3. Analysis of the impact of business characteristics of sample group 3 on liquidity and risk before and during the financial crisis.

Table 3. Wilcoxon test of sample group variables from 2004 to 2009.

	Year: 2004-2006				**Year:2007-2009**			
	Sample 1	Sample2	Sample3	Sample4	Sample1	Sample2	Sample3	Sample4
LIQD	0.0695	0.0661	0.0638	0.0818**	0.0712	0.0786*	0.1104***	0.1008***
DEPT	0.1421	0.1179***	0.1102*+	0.1392	0.1307	0.1254	0.1335***++	0.1367
CREL	1.1550	3.5731***	1.1030 +	1.0616	1.1644	3.5598***	1.4110 ++	1.0027***
CRELO	0.1020	0.2776***	0.0872	0.0860	0.0899	0.2341***	0.0858**	0.0759*
TIER	0.1424	0.1071***	0.1238 +++	0.175***	0.1335	0.1055***	0.1383**+++	0.1529***
CRIN	0.3933	0.3400	0.4333*+++	0.3333*	1.2666	1.3500	4.4466***+++	1.0533*
CRLV	0.0660	0.1043***	0.0930***+++	0.0603*	0.0620	0.0713	0.0185***+++	0.0518
CRAV	0.1567	0.1363	0.1784***	0.1965***	0.2371	0.3353**	0.9978***+++	0.3008**
PRLD	0.7972	0.8638***	0.8121*++	0.7773*	0.8095	0.8589***	0.8431	0.0140
PRLA	0.6718	0.6612	0.6559	0.6443**	0.6867	0.6752*	0.7234	0.6626**
AMFY	3.1982	5.4309***	3.3838***+++	3.0242	3.6963	6.9124***	4.794***+++	3.6361
AMSO	0.5606	0.4887***	0.5265**+++	0.0285*	0.5421	0.4555***	0.5052***+++	0.5404
AMCA	0.0278	0.0249*	0.0273	0.0285	0.0282	0.025***	0.0321**	0.0295
AMPC	0.0493	0.0677***	0.0536***++	0.0505	0.0563	0.0791***	0.0705***+++	0.0562
AMDR	0.3943	0.5678***	0.0821***++	0.3159	0.4092	0.5196	0.0649***+++	0.2401*
OTFL	0.0218	0.0676***	0.0321**+++	0.0114***	0.0270	0.0628***	0.0635**+++	0.0134***

*, **, ***respectively represent the significance of statistical parameters of sample group 1 and sample groups 2, 3 and 4 at the confidence level of 10%, 5% and 1%; +, ++, +++ It indicates the significance of the statistical parameters of sample group 3 and sample group 4 at the confidence level of 10%, 5% and 1%, respectively.

According to the above results, the asset quality of sample group 3 is significantly lower than that of other sample groups. The asset stability and profitability are poor. At the same time, compared with the comparable sample group 4, the committed credit loan amount of sample group 3 is higher. Therefore, according to the data performance, it can be judged that sample group 3 has obvious excessive lending behavior compared with sample group 1 and sample group 4. Based on the loan items on and off the balance sheet, the increase of loan project risk will lead to the increase of liquidity risk. Assuming that **H1** is verified, that is, the loan project risk has a positive impact on liquidity risk.

The number of demand deposits of banks in sample group 3 increased greatly during the financial crisis, and demand deposits accounted for a large proportion of deposits. With the

increase of loans, it has assumed more uncertain responsibilities Withdrawal pressure. Therefore, it is assumed that **H2** is verified, that is, the increase of demand deposit limit will increase the liquidity risk in the next period.

Before the financial crisis, the short-term financing ratio of banks in sample group 3 was significantly lower than that in sample group 1 and sample group 4. During the financial crisis, the amount of short-term financing doubled as an emergency measure to control liquidity risk. The short-term financing rate of sample group 3 is significantly higher than that of sample group 1 and sample group 4, that is, when the principal-agent problem is serious, the bank financing amount is larger. The income of sample group 3 was significantly lower than that of sample group 1 and sample group 4. These performances lead to very high liquidity risk, which eventually makes the sample group 3 banks have to end up in bankruptcy. Therefore, it is assumed that **H3** is verified: relatively speaking, the liquidity risk of banks with serious principal-agent problem is greater.

4.2 Liquidity level after the financial crisis and performance of each sample group at the current stage of operation

After the financial crisis, this study uses sample group 1 and sample group 2 as benchmarks to analyze the operating characteristics of China's commercial banks. The sample group of American small and medium-sized banks can best represent the overall operation of American banks. Due to the influence of scale effect, large American banks are less comparable with other groups of data, but as the basis of benchmarking analysis, its characteristics are worthy of reference.

Table 4. Wilcoxon test of sample group variables from 2010 to 2015.

	Year: 2010-2012			**Year: 2013-2015**		
	Sample 1	Sample 2	Sample 5	Sample 1	Sample 2	Sample 5
LIQD	0.0994	0.0773	$0.2984^{***}{}_{+++}$	0.0827	0.0804	$0.2495^{***}{}_{+++}$
DEPT	0.1469	0.2086^{**}	$0.4524^{***}{}_{+++}$	0.1853	0.2780^{***}	$0.3978^{***}{}_{+++}$
CREL	1.1700	3.6101^{***}	3.2201^{***}	1.2745	3.7808^{***}	3.5392^{***}
CRELO	0.0759	0.1967^{***}	$0.0198^{***}{}_{+++}$	0.0920	0.2330^{***}	$0.0193^{***}{}_{+++}$
TIER	0.1459	0.1358^{***}	$0.1169^{***}{}_{++}$	0.1537	0.1233^{***}	$0.1096^{***}{}_{+++}$
CRIN	2.5333	2.2200	$0.7400^{***}{}_{+++}$	1.5166	1.1233^{**}	1.1566^{***}
CRLV	0.0372	0.0422^{*}	$0.2721^{***}{}_{+++}$	0.0315	0.0621^{***}	$0.1723^{***}{}_{+++}$
CRAV	0.2232	0.2928	$0.1881^{***}{}_{+++}$	0.1431	0.1249^{**}	0.1397^{**}
PRLD	0.7326	0.8195^{***}	$0.5368^{***}{}_{+++}$	0.7500	0.8284^{***}	$0.5222^{***}{}_{+++}$
PRLA	0.6312	0.6385	$0.4824^{***}{}_{+++}$	0.6484	0.6641	$0.4523^{***}{}_{+++}$
AMFY	4.1231	7.2774^{***}	$50.4951^{***}{}_{+++}$	4.3147	8.4247^{***}	$54.7668^{***}{}_{+++}$
AMSO	0.5365	0.483^{***}	0.5513_{+++}	0.5529	0.5005^{***}	$0.5589^{*}{}_{+++}$
AMCA	0.0288	0.0253^{***}	$0.0101^{***}{}_{+++}$	0.0277	0.0244^{***}	$0.0101^{***}{}_{+++}$
AMPC	0.0614	0.0866^{***}	$0.2996^{***}{}_{+++}$	0.0667	0.0978^{***}	$0.2981^{***}{}_{+++}$
AMDR	0.2519	0.3487^{***}	0.2264_{+++}	0.3248	0.4864^{***}	0.2686_{+++}
OTHAL	0.0369	0.0428	$1.2550^{***}{}_{+++}$	0.1857	0.0374^{**}	$0.8487^{***}{}_{+++}$
OTFL	0.0105	0.0321^{***}	$0.0137^{*}{}_{+++}$	0.0047	0.0229^{***}	0.0204^{***}

*, **, ***respectively represent the significance of statistical parameters of sample group 1 and sample groups 2, 3 and 4 at the confidence level of 10%, 5% and 1%; $_{+}$, $_{++}$, $_{+++}$ It indicates the significance of the statistical parameters of sample group 3 and sample group 4 at the confidence level of 10%, 5% and 1%, respectively.

It can be seen from table 4 that compared with Bank of America, the liquidity level of Chinese banks is higher and the relative liquidity risk is smaller. However, at the same time,

the demand deposit rate in the total deposit is much higher than that in sample group 1 and sample group 2. Due to the uncertainty of withdrawal of demand deposit, it may face greater run risk, that is, the liquidity risk of deposit is significant.

The absolute amount of committed credit loans of Chinese banks is larger than that of Bank of America, but due to the large scale of Chinese banks, their relative committed credit loan asset ratio is still insufficient. More than half of the loans in the United States are actually issued through credit loans, which shows that there is still great room for the development of credit loans in China. After the financial crisis, the core capital ratio of Chinese banks has been at a low level compared with the United States. At this stage, when the United States generally increases, the core capital ratio of Chinese banks decreases again. This makes the ability of Chinese banks to deal with the liquidity crisis decline, and exposes the shortage of risk prevention awareness.

Although the loan growth rate index in sample group 5 is high, it is essentially different from the excessive lending in sample group 3. It can be judged by the high loan interest rate in sample group 5. In addition, China's inter-bank market financing is significantly stronger than the U.S. inter-bank market. Once liquidity risk occurs, inter-bank infection will be very serious. Compared with Bank of America, China has not effectively carried out asset securitization business. The business and liquidity risk analysis of China's sample group after the financial crisis is shown in Figure 4

5 Conclusion

This paper theoretically determines the bank liquidity decision and its relationship with deposits and loans. On this basis, different types of banks in the United States are sampled and grouped, and the data of the United States are used as the comparison standard to analyze the business characteristics of Chinese banks. The sample group is divided into four time stages for analysis: the early stage of the financial crisis from 2004 to 2006, the period of the financial crisis from 2007 to 2009, the end of the financial crisis from 2010 to 2012, and the current stage of bank operation from 2013 to 2015. After analyzing the changes of bank liquidity related businesses and the risks contained therein, it is found that:

(1) Loan project risk has a positive impact on liquidity risk. The increase of the current deposit limit will reduce the current liquidity risk, and the increase of the current deposit limit will increase the bank liquidity risk in the next period. The increase of credit line has a negative impact on liquidity risk

(2) When the principal-agent problem is serious, the bank has excessive lending behavior, the credit loan line is larger, and the bank financing line is increased.

(3) Before the financial crisis, the financing level of American banks that went bankrupt during the financial crisis was significantly higher than that of other banks. In the crisis, the demand deposits of bankrupt banks increased greatly. At the same time, the high rate of non-performing loans, coupled with the rapid growth rate of loans and low interest income, make the bank have too much risk of liquidity outflow in loans, the combination of various risks, and finally have to end in bankruptcy.

(4) During the financial crisis, the profitability of large, medium and small banks in the United States continued to operate decreased significantly, but at the same time, they paid more attention to loan quality, the loan growth rate decreased significantly, the non-performing loan ratio decreased, and the core capital ratio increased significantly.

(5) Compared with Bank of America, the liquidity level of Chinese banks is higher, but the demand deposit rate is too high, which faces greater liquidity risk in terms of deposits. At the present stage, when the United States generally increases, the core capital ratio of Chinese banks decreases, which exposes the problem of lack of risk prevention awareness. At present, China's non-performing loan ratio has risen sharply, which is contrary to the

current international bank liquidity management goal. In terms of business, the asset ratio of committed credit loans of Chinese banks is still insufficient, and there is still much room for development in the future; Asset securitization has not been carried out effectively.

(6) The empirical results that the liquidity risk of Chinese banks has a positive impact on bank performance are worthy of vigilance. China's banks actually sacrifice the liquidity level and issue loans. This business mode of pursuing business performance bears the liquidity risk. The instability of bank asset income and high non-performing loan rate make the operating performance damaged. The operating performance of Chinese banks depends too much on the income of loans, and the loan quality is lack of control. Under the background of the rapid growth of loan scale, it is very easy to produce the liquidity risk of loan expenditure. At the same time, the demand deposit rate of Chinese banks is much higher than that of the sample group of American banks, and the withdrawal uncertainty of demand deposits is the largest source of bank run risk. Therefore, the liquidity risk of Chinese banks in deposits is also very significant.

Chinese commercial bank asset securitization has not been effectively carried out. Thirdly, the deposit insurance mechanism has not been fully implemented. The management related business plans such as salary incentive and business distribution of the bank's management and other employees still need to be optimized to reduce the impact of the principal-agent problem. In addition, China's banks still have great room for improvement in protecting shareholders' rights and interests.

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