REVIEW ARTICLE

Study on liquidity risk of commercial banks

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ABSTRACT

China's banking system, a product of its planned economy, is a means for China to implement its economic and financial development and consolidate its role in the global economy. Recently, this system has been decentralised by adapting specific regulations to international standards. Against this backdrop, the development of inter-bank activities has played a vital role in the rapid expansion of Chinese banking sector's assets. This study, uses data from 34 listed commercial banks between 2010 and 2018, to analyse the effect of interbank activities on commercial banks' liquidity risk using a panel data model. This determines whether the effects are the same for different commercial banks. The study concludes that the expansion of interbank activities has increased commercial banks' liquidity risk, and that this effect is more significant in joint-stock banks than in urban commercial banks. Therefore, commercial banks should sensibly position their interbank development model, conduct their interbank business prudently and rationally, and continuously strengthen their risk control measures. The supervisory authorities must continue to strengthen supervision of interbank activities and prevent funds from being de-realised.

KEYWORDS

commercial banks; interbank business; liquidity risk, China, panel data

1. Introduction

Since the 2008 financial crisis, interest rate marketisation and financial disintermediation in China have accelerated significantly (Liao and Tapsoba, 2014).

Against this backdrop, the returns from the commercial banks' traditional credit business have become limited, and the interbank business has become a new profit growth point for banks. According to the Central Bank's official website, between 2008 and 2013, commercial banks' interbank assets grew at a rate equivalent to their total assets.

The growth rate of interbank liabilities also reached 1.5 times that of total liabilities and deposits.

Simultaneously, the interbank business continued to innovate with products, such as agency interbank entrusted payments, bought-back financial assets, interbank entrusted targeted investments, and credit-linked total return swaps (Sun, 2019).

Banks have been cooperating with non-bank financial institutions, such as securities, insurance, and trusts, and inter-industry linkages have become closer.

In particularly, after 2010, macro-monetary policies tightened and banks began adopting regulatory measures, such as credit line management, capital controls, and restrictions on deposit-to-loan ratios.

Risks associated with the rapid expansion of interbank businesses have gradually emerged. The "money shortage" in 2013 highlighted the maturity mismatch of interbank business, creating a liquidity crisis for the banking system (Wang, 2017).

Additionally, the interbank business has increased risk contagion, as it has increased funding linkages in the banking sector (Mansour and Zouari, 2018).

In May 2014, the three central banks and the Foreign Exchange Bureau jointly issued the Circular on the Regulation of Interbank Business of Financial Institutions (herein referred to as Circular 127), which called for the suspension of many unregulated businesses and slowed the growth of the interbank business. However, the questions remain whether risk in the banking system be reduced. What is the relationship between the expansion of interbank business and bank liquidity? Is the effect on liquidity risk the same for different bank types?

Researchers have already published many high-quality papers on the following two topics: bank liquidity risk and interbank transactions. However, few studies have considered bank classifications to improve and deepen their analyses. Moreover, only a few studies have addressed the Chinese market, despite its specific features. The Chinese banking system is reshaping global industry, although it operates within a specific framework. A product of the "socialist market economy", a paradoxical invention of the Chinese regime at the dawn of the 21st century, it is governed by different statutes. While most companies are under the influence of the State, some are under the control of local authorities (provincial or municipal), and others are in the private sector. The commonality between them is that they operate under the direct or indirect control of the authorities and, therefore, the Chinese Communist Party.

Based on the existing theoretical analysis, this study empirically examines the impact of interbank business on the liquidity risk of 34 listed commercial Chinese banks.

This study provides valuable lessons for commercial banks to conduct interbank businesses with effective risk control. There is a distinction between interbank business in a broad and narrow sense. In terms of its relationship with banks' balance sheets, interbank business in a broad sense includes two types: first, on-balance sheet business and interbank investment and financing business, including interbank lending, buying, selling, interbank investment, selling, and repurchasing.

Second, the off-balance-sheet interbank business, such as the entrusted agency investment business and the provision of guarantees, commitments, or custody for the interbank business, or other innovative businesses, like the provision of investment products by banks to specific investors, that is, financial institutions.

This study focuses on interbank business, which includes interbank lending, buying and selling, interbank

deposits, and interbank borrowing. In the first section, we present the characteristics of the Chinese Banking System and a literature review, as well as the theoretical analysis, research hypotheses, and empirical results. Finally, we present the consequences and lessons to be drawn from the impact of inter-bank business on the liquidity of commercial banks.

2. The specifics of the Chinese banking system from 2010 to 2018

China's economic growth has slowed since 2012, and long-standing structural contradictions remain, including falling industrial export prices, declining real corporate profits, lower tax revenue growth, and increased potential economic risks. (Li, 2020). In July 2013, lending rates for banks and other financial institutions were liberalized, allowing banks to set their own lending rates. In 2015, the Deposit Insurance Regulations were announced (Lee and Hsieh, 2013), and China officially introduced a deposit insurance system. China's interest rate liberalization reform was completed by widening deposit interest differentials and introducing a deposit insurance system, despite a decline in economic growth.

China's banking system is centralized with different types of banks (Le et al., 2022). Half of the banking system's assets belong to large banks, which account for more than 60% of deposits and up to 50% of loans. Foreign banks' share is limited. These are large state-owned commercial banks with state-owned shares and are known as public commercial banks. They focus on financing large-scale infrastructure projects and critical projects within the country. Their shares are traded on various global stock exchanges (Shen et al., 2023).

Political banks are directly managed by the State and provide banking services to state-owned companies. They aim to stimulate the development of specific industries and do not seek to maximise their profits.

National joint-stock commercial banks serve the lending and savings needs of businesses and households, contributing to the creation of a competitive banking system. These banks are primarily state-owned banks through government agencies or state-owned enterprises. These relatively large credit institutions were incorporated by the government's decision to create market-oriented organizations free of government control for the benefit of shareholders.

Foreign commercial banks (FCBs), established as branches, subsidiaries, or independent banks of foreign capital, help customers develop common credit structures for their domestic use, support foreign companies, and provide services to foreign companies. We focus on projects that combine domestic and foreign companies. Customers in foreign trade.

Rural Commercial Banks (RCBs) are local mixed capital financial institutions established by rural and commercial enterprises. Its purpose is to provide financial services for the agricultural sector and rural economic development, and to promote the coordinated development of the urban economy. All rural cooperative banks were converted into rural commercial banks.

Urban commercial banks (UCBs) set up in large and medium-sized towns are more attractive than larger banks because of their flexibility for businesses with urgent capital needs. The government can encourage certain groups of banks to increase their wealth in rural areas (rural commercial banks), develop infrastructure projects (state commercial banks), and develop activities in cities (urban commercial banks).

China's banking system has undergone significant changes in recent years. This period began with a slowdown in economic growth and the search for new ways of economic development related to capital

exports and the implementation of infrastructure projects (Li et al., 2023). The crash of 2015–2016 exposed the problems that had been building up in the financial sector and required decisive government intervention. In 2018, trade relations with the United States deteriorated, leading to a decline in exports (Yang et al., 2023).

Simultaneously, foreign commercial banks significantly reduced their service income. Mobile payments are becoming increasingly popular. Financial innovations, such as the mobile Internet, have an impact on the banking sector. Zhao et al. (2022) found that innovation reduces banks' profitability and overall asset quality. This is more pronounced in large state-owned commercial banks, which improve their capital adequacy and governance efficiency.

3. Literature review

From the summary of the existing literature and research on interbank business and liquidity risk, foreign scholars generally consider the financial crisis as the starting point. Schnabel and Shin (2004) compared the financial crisis that occurred in 1763 in Northern Europe with the recent financial crisis.

Schnabel and Shin (2004) also found that financial crises were primarily caused by financial innovation and the highly leveraged behaviour of market participants (Jan and San, 2019).

The maturity mismatch triggered distress in the sales of assets and thus created liquidity difficulties. Although more than 200 years have passed since the financial crisis of 1763, the problems that led to it were generally similar.

In the aftermath of the 2008 financial crisis, Shin (2009) pointed out that the 2008 crisis within the banking system and the external financial market crisis were contagious and that the crisis in the banking system was a significant source of liquidity problems.

The high leverage of interbank operations and asset securitisation in financial markets, the liquidity crisis caused by a reversal in the economic situation, and the close capital and operational linkages between financial institutions increased the severity of the crisis.

Van Rixtel and Gasperini (2013) examined data on lending levels in Portugal and found that banks that relied more on interbank lending before the financial crisis reduced their credit supply more during the financial crisis. The reduction in credit availability during the financial crisis was more significant for small firms, leaving them in difficulty during the financial crisis, while banks with weaker solvency suffered more (Love, 2013).

Furthermore, it leads to liquidity hoarding in the central banking system, increasing financial risks. Berrospide (2012) also mentions the precautionary nature of liquidity demand. Berrospide (2012), in a study on the liquidity demand from large clearing banks in the UK and its impact on the short-term money market before and after the subprime crisis of 2007–2008, finds that large clearing banks We found that liquidity demand from Since then, clearing banks have left liquidity management to central banks. After this transition, liquidity demand became precautionary and increased when banks had high payment activity or high credit risk. This increases interbank overnight interest rates and reduces interbank lending volumes, thereby offsetting the potential liquidity risk. Therefore, the precautionary nature of liquidity demand is beneficial for bank supervision and risk prevention (Zheng et al, 2023).

The innovative business of commercial banks, such as the interbank business in China, started around

2000, which is a late start compared with developed countries in Europe and the US (Han, 2021).

It was not until after 2010 that research became abundant. These include numerous theoretical explorations and empirical analyses. Shi et al. (2021) combined the theory of interbank business with the actual situation of interbank development in China and argued that due to the imperfection of the interbank market lending mechanism, its blind expansion will bring a liquidity crisis to banks.

In 2014, based on describing the operation mode of the interbank business, Jiang and Fan (2021) further analysed the possible risks and potential impacts of high leverage on the banking system.

Ramlall (2018) argued that interbank business innovations are exposed to liquidity risk from maturity mismatches and credit risk from credit structure mismatches, which inject liquidity into the market, increase the money multiplier and liquidity speed, and increase the risk of financial contagion. Tran et al. (2022) examined the relationship between innovation and the liquidity risk of 37 commercial banks in Vietnam from 2010 to 2020. The results show that innovation helps commercial banks reduce liquidity risk. The impact of mobile banking applications is robust, even when using other risk indicators, such as RROA and loan loss provisions.

Some scholars have also used data on interbank business in banks' balance sheets to conduct empirical analyses. Qi et al. (2022) compared and analysed the development characteristics of the interbank business from three aspects: business scale, business structure, and capital flow, and explored the direction of capital flow and potential risks of the interbank business.

In their study conducted in the Chinese market, Liu et al. (2023) indicated that the elimination of non-performing loans plays an essential role in maintaining the stability of interbank networks (Salem et al., 2020). The banks' liquidity repayment ratio has the most significant effect on the interbank network in China and adjusting this ratio is an effective method for preventing liquidity risk. In addition, compared to small commercial banks, large commercial banks have a greater capacity to resist liquidity risk, as they were created by capital injections from the Chinese government.

Hai et al. (2023) investigated the liquidity transmission of traditional and structural monetary policy instruments in the interbank market and their impact on bank credit growth using 107 banks. They find that the monetary policy credit channel differs for banks with heterogeneous liquidity. Liquidity released through open market operations (OMO) cannot stimulate credit growth. However, this increases the net interbank assets of primary banks and decreases the net interbank assets of non-primary banks.

These studies focus on the impact of interbank business on liquidity risk. Regarding the impact of liquidity shocks on interbank business, Sifat et al., (2022) studied the liquidity risk among dealers in China's interbank market and its contagion effect using a stress test to study liquidity risk and its contagion effect among dealers in China's interbank market. This finding suggests that China's interbank business is stable under liquidity risk shocks.

As the liquidity crisis spread rapidly across interconnected financial markets, financial institutions took on excessive risks and failed. In this context, Li (2019) showed that the higher the liquidity risk of commercial banks, the greater their contribution to systemic risk. Furthermore, the larger the bank, the greater its contribution to systemic risk.

Regarding the regulation of liquidity risk, banks would do better to use liquidity creation

indicators and liquidity ratios rather than loan/deposit ratios.

According to Hu et al. (2023), constructing a multilayer interbank network to analyse the interconnection and contagion of risks in the Chinese banking sector decomposes systemic risk and explores the relative importance of different contagion channels.

However, few empirical analyses of commercial banks' interbank businesses exist. Most of them generalise all listed banks in their empirical analyses and lack comparative analyses among the different types of banks. Therefore, based on an empirical analysis of commercial banks' interbank business data, this study develops separate models for different types of commercial banks to study the impact of interbank business on liquidity risk.

4.   Theoretical analysis and research hypotheses

4.1.   Interbanking and liquidity risk

In addition to traditional deposit and loan businesses, recently, commercial banks have conducted profitable interbank businesses which have become essential sources of profit for commercial banks. The large number of maturity mismatches in the interbank business makes it prone to liquidity risk.

Banks raise interbank funds through interbank deposits or interbank banking and use these funds to buy, sell, or invest in interbank investments.

Underlying investments are usually large-scale, high-yielding, and illiquid assets, such as real estate, illiquid trust investment plans, and local government financing platforms.

A liquidity crisis arises if banks cannot support their long-term assets through short-term funding (Liu et al., 2023, Xu, 2017). Therefore, Hypothesis 1 was derived.

Hypothesis 1: Expanding commercial banks' interbank businesses increases liquidity risk in the banking system.

4.2.   The effect of different types of interbank business on liquidity risk

Since 2000, the interbank business of commercial banks in China has been developing, and since 2007, banking financial institutions have become increasingly crucial to the interbank business because of market conditions such as interest rate marketisation and financial disintermediation.

Due to the large scale of business, substantial capital, and high market share of state-owned and large joint-stock banks, the interbank business developed earlier. It has matured, and the business chain has become complete (Hai et al., 2023; Hu et al., 2023).

However, owing to their small size, short establishment time, and geographical restrictions, the interbank business of urban commercial banks is not as developed as that of state-owned and joint-stock banks.

The impact of interbank business on bank liquidity risk may differ from that of the other two types of banks. Therefore, Hypothesis 2 was proposed.

Hypothesis 2: The effect of the interbank business on the liquidity risk of state-owned and joint-stock

banks differs from that of urban commercial banks.

5. Materials and methods

5.1. Model setting

This study empirically tests the impact of the expansion of commercial banks' interbank business on banks' liquidity risk with interbank business as the primary independent variable and liquidity risk as the dependent variable.

Other factors also affect bank liquidity. With regard to bank-level influences, the introduction of total assets, capital adequacy ratio, non-performing loans, and liquidity risk are considered.

For macroeconomic influences, M2 and GDP growth rates are considered control variables.

Therefore, the econometric model is set up in this paper as follows:

$$Liquid_{it} = \alpha 0 + \alpha 1 Tyzc_{it} + \alpha 2 \ln Ta_{it} + \alpha 3 Roa_{it} + \alpha 4 Car_{it} + \alpha 5 Npl_{it} + \alpha 6 Cdb_{it} + \alpha 7 M2_{it} + \alpha 8 Gdp_{it} + \varepsilon_{it} \quad (1)$$

where: $Liquid_{it}$ is the level of liquidity risk of commercial banks, $Tyzc_{it}$ is the size of the banks' interbank asset business and bank control variables, $lnTa_{it}$ is the logarithm of banks' total assets, Roa_{it} is the asset margin, Car_{it} is the capital adequacy ratio, Npl_{it} is the non-performing loan ratio, and Cdb_{it} is the depository ratio.

In addition, for the macroeconomic control variables, $M2_{it}$ represents the broad money growth rate and Gdp_{it} represents the gross domestic product growth rate.

5.2. Variable selection and description

This study selected 34 commercial banks' annual data from to 2010–2018 as the research sample for the following reasons: the interbank business of commercial banks in China was less developed before 2007 and did not form a certain scale, and even a considerable number of commercial banks had not yet developed an interbank business.

After 2007, the interbank business of commercial banks in China was on a big explosion, and banks that had not launched interbank business before also started to develop interbank business vigorously for capital financing. Therefore, it is more meaningful to select data after 2008.

Data on banks are obtained from the China Stock Market and Accounting Research (CSMAR) series research database, and macroeconomic data are obtained from the official website of the Statistical Bureau of the People's Republic of China.

The 34 commercial banks included five large commercial banks, 12 national joint-stock commercial banks, and 17 city commercial banks. The methodology for classifying banks is based on Shi et al. (2022).

The variables involved in the model were selected as follows:

(1) Liquidity risk variables

In this study, the liquidity ratio of commercial banks is selected as a variable to measure bank

liquidity risk, which is calculated as Liquid = Liquidity assets/liquid liabilities. The liquidity ratio is used to measure the short-term solvency of an enterprise.

The higher the value, the stronger is the short-term solvency of the enterprise, whereas the lower the value, the weaker is its short-term solvency. In commercial banks, higher liquid implies lower liquidity risk. The smaller the liquid value, the greater the liquidity risk.

(2) Interbank asset business variables

Since the interbank business of commercial banks in China is mainly the interbank asset business and the proportion of the interbank liability business is relatively small, this study uses interbank.

The scale of the interbank asset business represents the scale of interbank business of commercial banks. This study uses the ratio of interbank assets to total bank assets (Tyzc) as the interbank assets business scale variable.

Interbank assets are the sum of funds on offer, interbank deposits, and bought-back financial assets.

(3) Control variables on banks

The liquidity risk of commercial banks is affected by many factors. Therefore, in order to ensure the rationality and completeness of the empirical model, this study introduces some commercial banks' financial indicators as control variables, including asset margin, non-performing loan ratio, capital adequacy ratio, and loan-to-deposit ratio, denoted by *Roa*, *Car*, *Npl*, and *Cdb*, respectively.

These financial indicators monitor the stability of commercial banks' daily operations, and changes in their values reflect changes in banks' profitability or liquidity risk.

(4) Control variables on macroeconomics

The liquidity risk of commercial banks is not only affected by the development of their own businesses and changes in financial indicators, but also, to a large extent, by external macroeconomic conditions. Among these, economic growth and monetary policy have always been the most important macroeconomic variables affecting commercial banks' profitability and risk.

This study uses the GDP growth rate. In this paper, the growth rate of gross domestic product (Gdp) represents the economic growth variable.

Furthermore, because monetary policy is often implemented by regulating money supply, the broad money supply (M2) growth rate is used to represent the monetary policy variables in this study.

6. Results

6.1. Panel data empirical results for a total sample of 34 listed banks

In response to Hypothesis 1, an empirical analysis is first conducted on panel data with a sample of 34 commercial banks to explore the scale of interbank businesses in China's commercial banks.

By performing the Fisher F-test, the hypothesis of a perfectly homogeneous panel structure

was rejected; consequently, the models were either fixed or random effects. The specification of these effects according to the Hausman et al. (1984) test indicates that the models that adapt to the structure of the sample data are fixed-effects models (Sheytanova, 2015). The empirical results are presented in **Table 1**. For this reason, multicollinearity, stationarity, heteroscedasticity, and specification tests were conducted before proceeding with the estimation.

Table 1. Estimation results of the fixed effects panel data model on interbank business and liquidity risk for 34 listed banks.

	Liquid model 1	Liquid model 2	Liquid model 3	Liquid model 4	Liquid model 5	Liquid model 6	Liquid model 7	Liquid model 8
C	86.26101***	99.81142***	74.91348***	81.52017***	87.35199***	67.66408***	64.45441***	69.16926***
	(16.27079)	(18.01063)	(16.3742)	(17.8650)	(18.1892)	(15.6704)	(16.0587)	(16.2937)
Tyzc	−13.11974*	−10.32282*	−13.551**	−11.2717*	−11.0771*	−13.859**	−3.663921	−4.358593
	(7.72917)	(7.874016)	(7.59109)	(7.73948)	(7.74280)	(7.58611)	(8.18603)	(8.13237)
Inta	−0.55370**	−1.00864**	−0.52540*	−0.74677*	−0.8278**	−0.29827	−0.5109**	−0.54718*
	(0.573832)	(0.627465)	(0.56660)	(0.61362)	(0.62142)	(0.54754)	(0.55814)	(0.55977)
ROA	−5.536245	−4.915864	−7.77175	−6.938898	−7.176511	−7.539209		−5.245852
	(2.202402)	(2.224888)	(2.25822)	(2.27605)	(2.28706)	(2.25062)		(2.39328)
CAR			1.201***	1.164***	1.170***	1.193***	0.9037**	1.130***
			(0.34523)	(0.34410)	(0.34501)	(0.34446)	(0.32932)	(0.34181)
NPL							−3.8638**	−3.0487**
							(0.98039)	(1.04373)
Cdb	−0.2228***	−0.2164***	−0.230***	−0.248***	−0.242***	−0.245***	−0.252***	−0.248***
	(0.068445)	(0.068247)	(0.06776)	(0.06755)	(0.06761)	(0.06772)	(0.06730)	(0.06699)
Gdp		−19.56717		−17.93701	−17.4199			
		(11.46523)		(11.2731)	(11.2911)			
M2	−6.534815*	−5.601283	−7.46666		−6.717698		−5.032878	−6.372628
	(6.891946)	(6.888143)	(6.77111)		(6.77394)		(6.71493)	(6.69766)
R_2	33.34	34.10	25.20	25.59	27.28	22.09	24.57	29.73

Note: The standard deviation of a variable coefficient is shown in parentheses below the coefficient and ***, **, * represent significance at the 1%, 5%, and 10% levels of value, respectively.

It can be seen that from models 1 to 8, the coefficients before the variable Tyzc are all negative, and this coefficient is significant in models 1 to 6, which indicates that an increase in the size of interbank operations will reduce the liquidity of commercial banks and increase the likelihood of liquidity risk.

This is generally consistent with Hypothesis 1. Commercial banks widely use interbank business because of their capital financing and liquidity regulation functions, and interbank lending is an essential part of the money market.

The development of interbank businesses should increase the liquidity of commercial banks. However, the reality was the opposite, as the interbank business was an essential short-term liquidity tool in the money market.

By contrast, the expansion of interbank business has increased banks' liquidity risk. This may be due to the following reasons: (1) interbank businesses' short-term lending and long-term borrowing exacerbate banks. (2) due to the regulatory avoidance nature of interbank business, some banks have blindly expanded their interbank business. (3) At present, the development of the interbank business of commercial banks in China is still concise, and the mechanism of interbank lending still needs improvement. interbank business should be used as a tool to stabilise the liquidity of commercial banks.

However, liquidity risk is exacerbated by the immaturity of China's interbank market, imperfect regulations, inadequate supervision, and the banking system's inherent vulnerability. Moreover, in Models 1 to 8, the coefficient before lnTa is mainly negative, indicating that an increase in total bank assets increases liquidity risk. This may be because an increase in assets implies an increase in bank size, which leads to more maturity mismatches and other problems (Sifat et al., 2022).

Regarding the remaining control variables, the effects of Car on Liquid are all significantly positive in Models 3–8. The higher the capital adequacy ratio, the more liquid the bank, and the lower the likelihood of liquidity risk. In Models 7 and 8, the pre-NPL coefficients are all significantly negative, indicating that an increase in the NPL ratio reduces the liquidity of commercial banks. As non-performing loans result in the bank's credit facilities not being recovered within the agreed upon timeframe, they affect the bank's liquidity. However, banks can reduce their impact on liquidity by making provisions for non-performing loans (Liu et al., 2023).

In Models 1–8, the pre-Cdb coefficients are mainly positive, indicating that an increase in a bank's loan-to-deposit ratio can enhance its liquidity. The effect of GDP on liquidity in Models 2, 4, and 5 is negative in terms of the coefficient, but is not statistically significant, suggesting that the rapidity of GDP growth is not significantly associated with commercial bank liquidity.

Similarly, in Models 1, 2, 3, 5, 7, and 8, the pre-M2 coefficients are all negative, but also largely insignificant, suggesting that an increase in broad money supply has no significant impact on the increase in bank liquidity. Both macroeconomic variables have non-significant effects on bank liquidity risk, possibly because of macroeconomic factors.

This may be due to the time lag of the macro-economy affecting various sectors of society, the diverse causes of liquidity crises in the banking system, and the complex formation mechanisms. The influence of macroeconomics as an explanatory variable was relatively weak.

6.2. Panel data comparison results of the effect of interbank business on liquidity risk by different types of banks

The panel data model of 34 listed banks shows that expanding interbank business increases the possibility of bank liquidity risk. However, it is yet to be determined whether the effect of interbank businesses on liquidity risk is the same for different natures of banks.

Therefore, the data from the 34 banks are modelled separately, compared, and referred to as the state-owned bank group, the joint-stock bank group, and the city commercial bank group. Similarly, a fixed-effects model was selected for the three data groups using the likelihood ratio and Hausman tests.

Tables 2, 3, and **4** present the empirical results of the panel data for state-owned, joint-stock, and

city–merchant banks, respectively.

As can be seen from **Table 2**, in Models 1 to 6, the coefficients before Tyzc are all negative, but none of them are significant, indicating that in large state-owned banks, an increase in the ratio of interbank business to total business, an indicator reflecting the size of the interbank business, does not significantly impact bank liquidity risk (Sifat et al., 2022).

Table 2. Estimated results of the fixed effects panel model on interbank business and liquidity risk for the Stated-owned bank group.

	Liquid model 1	Liquid model 2	Liquid model 3	Liquid model 4	Liquid model 5	Liquid model 6
C	−8.31100***	−13.6140***	−27.8201***	−28.9595***	−28.8925***	−28.2915***
	−69.06873	−64.36529	−67.4147	−68.79204	−76.5436	−75.03581
Tyzc	−26.90299	−29.17323	−77.30322	−79.22102	−79.21617	−77.38549
	−55.70245	−54.17596	−63.3049	−64.58962	−65.83085	−64.54363
Inta	−1.550833	−1.649523	−1.033738	−1.127134	−1.125678	−1.052805
	−2.356702	−2.290066	−2.454473	−2.504187	−2.629062	−2.577652
ROA			15.27813	15.30631	15.30984	15.25856
			−12.91124	−13.17563	−13.45583	−13.19064
CAR	0.3532998**	0.3170227**	0.919081***	1.117753***	1.11711***	0.916536***
	−1.303533	−1.278635	−1.368645	−1.391003	−1.426028	−1.403657
NPL			−5.31232**	−4.922111**	−4.921354**	−5.316545**
			−2.60287	−2.644543	−2.703739	−2.662191
Cdb	0.1174001*	0.130748**	0.3172671**	0.3076194**	0.3074433**	0.3182456**
	−0.2175266	−0.2072153	−0.2238731	−0.2283751	−0.2459062	−0.2411558
Gdp	−6.797786				−0.0639734	−0.3548521
	−29.42728				−30.18621	−29.5924
M2			−11.96771			−11.96852
			−7.461957			−7.565173
R$_2$	33.54	33.41	55.61	26.73	26.74	55.49

*Note: The standard deviation of a variable coefficient is shown in parentheses below the coefficient and*** , ** , * *represent significance at the 1%, 5%, and 10% levels of value, respectively.*

In Models 1–6, the coefficient before Car is significantly positive, indicating that the capital adequacy ratio is positively related to bank liquidity. In Models 3 to 6, the pre-Npl coefficients are significantly negative, indicating that an increase in the NPL ratio lowers the liquidity levels of state-owned banks. In Models 1 to 6, the pre-Cdb coefficients are significantly positive, indicating that an increase in the deposit-to-loan ratio benefits the liquidity of state-owned banks.

As shown in **Table 3**, in Models 1 to 6, the coefficient before Tyzc is significantly negative, indicating that, in the case of joint-stock banks, the scale of interbank business expansion affects exposure to liquidity risk. In Models 1 to 6, the coefficient before lnTa is significantly negative, indicating that the expansion of interbank assets also significantly reduces banks' liquidity, leading to liquidity risk.

Table 3. Estimated results of the fixed effects panel model on interbank business and liquidity risk for the joint-stock bank group.

	Liquid model 1	Liquid model 2	Liquid model 3	Liquid model 4	Liquid model 5	Liquid model 6
C	200.8971***	179.0586***	260.0434***	217.5508***	234.9997***	273.2078***
	–34.49131	–29.56334	–39.32877	–34.91535	–39.43205	–42.69577
Tyzc	–28.17224**	–33.14195***	–27.54843***	–28.30999***	–25.47086***	–25.35794***
	–11.99741	–11.26336	–11.72211	–11.95021	–12.34809	–12.12772
Inta	–5.454972***	–4.686899***	–7.504272***	–6.353111***	–6.971642***	–7.982005***
	–1.289937	–1.129289	–1.471735	–1.399918	–1.542405	–1.589572
ROA			2.409679	3.564543	4.307771	3.081804
			–4.732728	–4.800097	–4.862766	–4.806859
CAR	2.480064***	2.458157***	2.195253***	2.602442***	2.590454***	2.200543***
	–0.761315	–0.76274	–0.769652	–0.764162	–0.764836	–0.771409
NPL			–4.044684	–5.036125*	–4.701018*	–3.798902
			–2.207822	–2.205815	–2.235544	–2.234529
Cdb	0.2774199**	0.3015345***	0.2812317***	0.3429538***	0.3204859***	0.2648851***
	–0.084688	–0.082659	–0.084215	–0.081163	–0.084653	–0.087008
Gdp	–25.27902				–20.4487	–16.6024
	–21.02209				–21.71597	–21.38561
M2			–47.8652*			–46.5015*
			–21.31911			–21.44036
R_2	84.9	84.2	85.06	85.31	85.25	83.94

Note: The standard deviation of a variable coefficient is shown in parentheses below the coefficient and ***, **, * represent significance at the 1%, 5%, and 10% levels of value, respectively.

The remaining control variables–the pre-Car coefficients in Models 1 to 6–are primarily significant and positive, suggesting that expanding interbank assets significantly reduces banks' liquidity, leading to an increased likelihood of liquidity risk.

The pre-Cdb coefficients of Models 1–6 are all significantly positive, indicating a positive relationship between the deposit-to-loan ratio and bank liquidity.

In Models 3–6, half of the pre-Npl coefficients are significant, and half are insignificant, which cannot fully explain the fixed effects panel model on interbank business and liquidity risk for the state-owned bank group.

Models 3 and 6 show a significantly negative relationship between M2 and bank liquidity, indicating that an increase in broad money reduces shareholding bank liquidity.

As shown in **Table 4**, in Models 1 to 6, the coefficients before Tyzc are all negative. However, none of them are significant, indicating that in the case of urban commercial banks, the expansion of interbank businesses impacts their liquidity risk (Sifat et al., 2022).

The impact of the expansion of interbank business on liquidity risk is insignificant. In Models 1 to 6, the coefficients before the variable Car are all significant and positive, indicating that the

higher the capital adequacy ratio of a city bank, the higher its liquidity.

Table 4. Estimated results of the fixed effects panel model on interbank business and liquidity risk for the city bank group.

	Liquid model 1	Liquid model 2	Liquid model 3	Liquid model 4	Liquid model 5	Liquid model 6
C	86.98022***	49.71078***	3.281593**	22.91857**	48.19549**	29.29404**
	–32.97815	–27.25184	–39.71478	–30.35335	–35.89779	–44.43672
Tyzc	–20.32978	–27.89532	–4.218045	–5.165232	–1.303241	–0.4956044
	–12.86914	–12.40602	–12.80883	–12.74452	–13.06046	–13.12054
Inta	–0.820746	–0.5133314	1.751308	1.111397	–0.215264	–0.8326699
	–1.170334	–0.963174	–1.312606	–1.015044	–1.221957	–1.490437
ROA			1.577597	0.7998884	1.296208	2.021439
			–3.710885	–3.553959	–3.565661	–3.719424
CAR	0.9175923**	0.8811591**	1.068812**	1.105947**	1.102584**	1.06715**
	–0.466527	–0.470729	–0.457853	–0.454038	–0.453035	–0.456995
NPL			–6.781469***	–6.398085***	–6.199063***	–6.565623***
			–1.755395	–1.678619	–1.681788	–1.759887
Cdb	0.3468368***	0.3565622***	0.4090048***	0.4033814***	0.3997656***	0.4055237***
	–0.120908	–0.121953	–0.11918	–0.118611	–0.118313	–0.118909
Gdp	–38.53998*				–24.92068	–24.39172
	–19.53791				–19.13241	–19.18373
M2			–14.38747			–13.59775
			–19.13128			–19.09519
R_2	25.9	18.49	31.26	30.25	30.53	31.27

Note: The standard deviation of a variable coefficient is shown in parentheses below the coefficient and ***, **, * represent significance at the 1%, 5%, and 10% levels of value, respectively.

The higher the capital adequacy ratio, the better the bank's liquidity and the less prone it is to liquidity crises, which is generally consistent with the empirical results of joint-stock banks. Regarding the other control variables, Models 3–6 show that banks are less prone to liquidity crises.

In Models 3 to 6, the pre-NPL coefficients are mainly negative, indicating that an increase in the NPL ratio leads to increased liquidity risk for banks (Koroleva et al., 2021). In models, 1 6, the coefficient before the variable Cdb is significantly positive, and the relationship between the deposit-to-loan ratio and liquidity are positive, consistent with that of joint-stock banks.

Comparing the empirical results of state-owned banks, joint-stock banks, and city commercial bank groups, three conclusions can be drawn.

First, for state-owned banks and joint-stock banks, the expansion of interbank businesses leads to a more severe liquidity crisis for joint-stock banks, and this effect is significant, while the effect is not significant for state-owned. Second, the impact of the increase in interbank business on liquidity risk is insignificant for joint-stock banks compared with city merchant banks (Shi et al., 2021).

Third, the impact of interbank businesses on liquidity risk is not significant for state-owned or

city merchant banks. In this study, the reasons for these findings are divided into the following points. State-owned banks are different from joint-stock banks in terms of their usefulness because they are the oldest, largest, most well-capitalised, and most liquid of all types of banks, and they better understand the different types of interbank businesses.

The risk management model for the interbank business is more mature and has a better capital chain and capital operation model. By contrast, joint-stock banks are currently developing their markets.

However, compared to the increase in interest income, the non-interest income of joint-stock banks has increased more rapidly, and interbank business is one of the critical aspects.

In recent years, joint-stock banks have devoted themselves to expanding the volume of interbank business, thus ignoring the restructuring of the interbank business, resulting in serious maturity mismatch problems (Chen et al., 2015).

This, coupled with the fact that they have yet to reach the same level of risk-management capability as state-owned banks because of their relatively short development time, magnifies the possibility of liquidity risk.

The reason for the difference in effectiveness between urban commercial banks and joint-stock banks is that, owing to their strong geographical characteristics, the development of city banks mainly depends on the level of economic development in the regions in which they are located (Jigeer and Koroleva, 2023).

In the context of interest rate marketisation and financial disintermediation, many financial institutions have been making financial innovations and competing for market share, leaving most city merchant banks with limited room for development, low non-interest income, and low interbank income.

In addition, the financial sector needs to be developed in regions with fewer financial institutions, such as securities, investments, and trusts.

This, coupled with the fact that the financial sector is less developed in some regions and that there are fewer financial institutions, such as securities, investment, and trusts, has left these banks without sufficient channels to carry out a large amount of interbank business cooperation and innovation, which will inevitably bring certain risks to the banking system (Tran et al., 2022).

Moreover, except for the Bank of Beijing, Bank of Nanjing, and Bank of Ningbo, which located in developed regions, most other city merchant banks are small banks with less capital, fewer technical skills, simpler business chains, and lower risk management capabilities, which makes them more disadvantaged in the face of state regulations and regulatory arbitrage.

Joint stock banks have undergone rapid development in recent years. To seek higher interest and market share, their financial innovation has gained momentum and they have a relative advantage over city banks in dealing with regulations.

Consequently, the liquidity risk of urban commercial banks is less affected by the expansion of interbank businesses than that of joint-stock banks.

State-owned banks and city merchant banks have the same effect, and among the three types of banks, the degree of development follows the order: state-owned banks > joint-stock banks > city merchant banks.

There is a significant difference between state-owned and urban commercial banks in terms of size, capital strength, or risk management ability.

In this model, the effect of interbank business on liquidity risk is the same for state-owned banks and urban merchant banks. However, the reasons differ. State-owned banks are more developed in their interbank business.

Although city merchant banks have developed rapidly in recent years, they generally have lower non-interest income, fewer interbank businesses, and lower innovative capacity.

Similarly, although urban merchant banks have developed rapidly in recent years, they generally have lower non-interest incomes, fewer interbank businesses, and less innovative ability. The regulatory arbitrage phenomenon is not serious; therefore, liquidity risk is unlikely.

The comparison of the empirical results of the state-owned bank, joint-stock bank, and city commercial bank groups is consistent with Hypothesis 2. The impact of interbank business on liquidity risk is lower for the three different types of banks.

An increase in the size of the interbank business significantly increases the liquidity risk of joint-stock banks. Simultaneously, this significantly affects the liquidity risk of large state-owned banks.

China's banking system also includes rural commercial banks. However, no statistics are used in this study because of the poor availability of data and the fact that they are currently much less developed than the first three types of banks mentioned above.

7. Discussion and conclusion

Through an empirical analysis of data from 34 listed commercial banks from 2010-2018, this study examines the impact of interbank businesses on commercial banks from two perspectives.

First, commercial banks of different natures are included in the same model to study the impact of interbank businesses on the liquidity of commercial banks as a whole. Second, banks of different natures are divided into three types–state-owned banks, joint-stock banks, and city commercial banks–to build separate models and empirical results.

The final findings are as follows. The effect of interbank business on liquidity risk differs among the three types of banks: the increase in the scale of the interbank business of joint-stock banks has a significant effect on liquidity.

In recent years, it has been used by many banks as a "volume" tool, especially for many small and medium-sized banks to pursue asset scale expansion. However, the interbank business has also led to the phenomenon of capital short-circuiting in the commercial banking system, and interbank short-circuiting is common.

Therefore, Circular 127 imposes strict restrictions on irregularities such as interbank

business dovetailing with non-standard assets and bypassing regulations, demonstrating a strong determination to deleverage.

In April 2017, the CBRC issued a circular on the special treatment of "regulatory arbitrage, idle arbitrage, and connected arbitrage" in the banking sector, stating that it would focus on checking the interbank operations of commercial banks that invested funds in real estate and the "two high and one surplus" sectors through interbank operations, as well as other forms of idle interbank certificates of deposit and interbank funds.

In this context, commercial banks should focus on checking interbank operations through interbank businesses to invest funds in real estate and the "two high and one surplus" sectors as well as other forms of interbank certificates of deposit and interbank fund transfers. Given this background, how should commercial banks promote the healthy development of interbank businesses, reduce leverage and liquidity risks, and how should the regulatory authorities effectively supervise them?

First, commercial banks should reasonably position their interbank development models and conduct business rationally.

In an environment in which interbank regulation is not yet sound; some banks use large independent funds and an enlarged maturity mismatch model for capital profit-seeking activities. These banks should be rational about the expansion of interbank business and should not blindly rush, increase leverage, or seek high returns, but should slow down and reasonably carry out financial innovation business within the scope of ensuring risk control. State-owned banks, equity and city merchant banks should reasonably position their interbank business development models according to their capital strength, profitability needs, and risk management capabilities, and place their interbank business models within their liquidity management framework.

Second, commercial banks should continuously strengthen their risk control tools. In addition to high liquidity risk, commercial banks face major credit, operational, and counterparty risks.

As interbank business can be conducted across regions, institutions, and markets, banks have extensive business ties with many non-bank financial institutions, and the contagiousness of risks is gradually increasing.

Therefore, commercial banks should strengthen their review of various businesses, conduct strict assessments of business risks, and focus on selecting nonbank financial institutions with high credit ratings for cooperation to reduce their risks.

Simultaneously, banks should continue to enhance their active debt capacity and promote the diversification of debt sources to reduce debt concentration, thereby diversifying risks and maintaining stable liquidity. Third, the central bank, CBRC, and other regulatory authorities have been strengthening supervision to prevent funds from diverting from the real to the virtual. The central bank, CBRC, and other regulators should continue to strengthen the supervision of commercial banks' interbank business compliance, and interbank supervision should follow the principle of "substance over form".

Additionally, the government has adopted the principle of "style" to accurately measure risks and

make provisions to avoid regulatory arbitrage by banks while directing the flow of monetary funds to the real economy and avoiding the creation of bubbles in the virtual economy.

The, regulatory authorities should continuously strengthen supervision to guide the economy away from the virtual economy to the real economy, prevent excessive financial innovation, and make it possible for the majority of banks, especially small- and medium-sized ones, to invest in the real economy by strengthening the supervision of the scale and mode of interbank business.

By strengthening the regulation of the scale and mode of interbank business, banks, especially small and medium-sized cities and agricultural banks, should take the initiative to reduce leverage and avoid idling of interbank funds, thereby reducing liquidity risks and promoting the healthy development of interbank business.

This will reduce liquidity risk, promote healthy development of interbank businesses, and fundamentally ensure the stability of China's banking sector.

Conflicts of Interest

The author declare no conflict of interest.

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