Chapter 46
Measurement of Liquidity Risk of Listed Commercial Banks

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Abstract Liquidity, profitability and safety are three principles of commercial bank's operation and management. With the bankruptcy of many financial institutions and the closure of commercial banks during the U.S. subprime mortgage crisis since 2007, liquidity risk has become the most fundamental and fatal risk. As Basel Committee issued Basel III in 2010 and China Banking Regulatory Commission issued The Management Measures on Commercial Bank Liquidity Risk in 2011, liquidity risk regulation of banking industry is strengthened. This paper uses 16 China's listed commercial banks as research objects and employs some indicators to measure the liquidity risk. The paper also studies the relationship between liquidity and profitability of commercial banks, and raises suggestions for strengthening liquidity risk management.

Keywords Liquidity risk • Commercial bank • Risk management

46.1 Introduction

In 2007, the large-scale subprime mortgage of the U.S. banking industry led to liquidity crisis, which resulted in a number of bank failures and financial crisis extending to the whole world. For a long time, the Chinese public is always having a concept that China's commercial banks, especially the four state-owned commercial banks, are backed by the national credit [1]. With the changes of economic and financial situations in home and abroad, the Chinese government has introduced a series of policies to deal with the international financial crisis influences and stimulate the economic development [2]. Weak awareness of liquidity risk and lagging management methods of some banks are fully exposed. Therefore,

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strengthening the management of commercial bank's liquidity risk is significant to the stability of banking system and the safety of financial market [3].

The paper aims to: (1) Establish the comprehensive indicator system to evaluate liquidity risk of China's listed commercial banks. (2) Study the relationship of bank's liquidity and profitability. (3) Give suggestions on risk management [4].

46.2 Theoretical Backgrounds

Liquidity includes the liquidity of assets and the liquidity of liabilities. The liquidity of assets means the assets can be quickly turned into cash without causing additional losses, while the liquidity of liabilities means the banks timely get the needed funds at the low cost. Mora proposes that banks may not be able to provide liquidity in a bank-centered crisis because a bank-centered crisis may lead investors to question the safety of bank deposits, even with deposit insurance [5].

Liquidity risk can be defined as the possibility of loss when the banks do not have enough cash to pay off debts or satisfy the customer's demands of withdrawing deposits and getting loans. There are many factors accounting for bank's liquidity risk [5]. Yao considers that the superficial reason is the irregularity and uncertainty of fund source and usage and the deep reason is the contradiction between profitability and liquidity. Li thinks that the mismatching of liquidity supply and liquidity demand is the fundamental reason for bank's liquidity risk. Anson thinks that liquidity risk arises from investing in an asset that cannot be sold in a timely manner, or can only be sold at a large discount [6].

Liquidity is of great importance to commercial banks, some scholars and regulatory institutions put forward the methods of measuring liquidity risk [7]. Xu and Liu put forward several indicators to measure liquidity risk: liquidity ratio, deposit-credit ratio, cash in hand-asset ratio, borrowing fund-deposit ratio, lending fund-deposit ratio, borrowing fund-asset ratio, cash reserve ratio and debt paying ability. The Basel Committee proposed to use liquidity coverage ratio (LCR) and net stable funding ratio (NSFR) to measuring commercial bank's liquidity risk all over the world in 2010. China Banking Regulatory Commission issued The Management Measures on Commercial Bank Liquidity Risk in 2011, pointing out that the regulatory indicators of commercial bank's liquidity risk includes liquidity coverage ratio, net stable funding ratio, deposit-credit ratio and liquidity ratio [8].

46.3 Empirical Research

The paper selects 16 China's listed commercial banks as research objects and uses the financial data of 2010 to do empirical research [9].

Table 46.1 Six indicators to measure liquidity risk

No.	Indicator	Calculation formula	Effect
1	Risk-free asset ratio	(Cash in hand + interbank deposits + government bonds)/total assets	Positive
2	Provision coverage ratio	Loan loss reserve/ not-performing loans	Positive
3	Changes of deposit ratio	(Deposits in the end of period–deposits in the beginning of period)/deposits in the end of period	Negative
4	Borrowing fund-deposit ratio	Funds borrowed from other banks/deposits	Negative
5	Liquidity ratio	Liquidity assets/liquidity liabilities	Positive
6	Deposit-credit ratio	Credits/deposits	Negative

46.3.1 Indicator Selection

Due to the information availability of China's listed commercial bank and the computability of indicators, we select six indicators to measure liquidity risk. Some of them are positive indicators while some negative indicators. Positive indicator means the greater the value of indicator is, the better the bank's liquidity is. That is to say, liquidity risk is smaller. The six indicators can be seen in Table 46.1.

46.3.2 Weight Calculation

Record the indicators of each bank involved in the measurement of liquidity risk by vector and write down the original matrix X as (46.2). The values of indicators of banks can be seen in Table 46.2.

$$x_i = (x_{i1}, x_{i2}, \ldots, x_{im}), i = 1, 2, \ldots, n \tag{46.1}$$

$$X = \left(x_{ij}\right)_{n \times m} \tag{46.2}$$

Table 46.2 Entropy values, difference coefficient and weights of six indicators

Item	Entropy value e_j	Difference coefficient g_j	Weight w_j
Indicator 1	0.970096	0.029904	0.6395
Indicator 2	0.990447	0.009553	0.2043
Indicator 3	0.999972	0.000028	0.0006
Indicator 4	0.999997	0.000003	0.0001
Indicator 5	0.992794	0.007206	0.1541
Indicator 6	0.999935	0.000065	0.0014

Select the maximum and the minimum from the original matrix and deal with positive indicators as (46.4) and negative indicators as (46.5) on the basis of the objective optimization formula. Thus, write down the evaluation matrix Y as (46.6).

$$x_j^* = \max\{x_{ij}\}, \quad x_j^0 = \min\{x_{ij}\} \tag{46.3}$$

$$y_{ij} = \frac{x_{ij} - x_j^o}{x_j^* - x_j^0}, \quad 1 \le i \le n, \ 1 \le j \le m \tag{46.4}$$

$$y_{ij} = \frac{x_j^* - x_{ij}}{x_j^* - x_j^0}, \quad 1 \le i \le n, \ 1 \le j \le m\frac{1}{2} \tag{46.5}$$

$$Y_{ij} = (y_{ij})_{n \times m} \tag{46.6}$$

Calculate the proportion of y_{ij} and record the features proportion matrix P as (46.7).

$$P_{ij} = \frac{y_{ij}}{\sum\limits_{i=1}^{n} y_{ij}}, \quad 1 \le i \le n, \ 1 \le j \le m \tag{46.7}$$

Calculate each indicator's entropy value as (46.8) and difference coefficient as (46.9) respectively and they are shown in Table 46.3.

$$e_j = -k \sum_{i=1}^{n} p_{ij} \ln p_{ij}, \quad k = 1/\ln n \tag{46.8}$$

$$g_j = 1 - e_j \tag{46.9}$$

Table 46.3 Comprehensive measuring values of China's listed commercial banks in 2010

No.	Name	Vi
1	Bank of Beijing	0.7700
2	Industrial and commercial bank of China	0.5599
3	China ever bright bank	0.7569
4	Huaxia bank	0.5231
5	China construction bank	0.5893
6	Bank of communications	0.4776
7	China Minsheng bank	0.6954
8	Bank of Nanjing	0.6146
9	Bank of Ningbo	0.5284
10	Agricultural bank of China	0.4868
11	Shenzhen development bank	0.6618
12	Industrial bank	0.7644
13	China merchants bank	0.7045
14	China bank	0.5588
15	China citic bank	0.5651
16	SPD bank	0.8815

Compute the weight of each indicator. See Table 46.3.

$$E_e = \sum_{j=1}^{m} e_j \tag{46.10}$$

$$w_j = \frac{1}{n - E_e} g_j = \frac{g_j}{\sum\limits_{j=1}^{m} g_j} \tag{46.11}$$

46.3.3 Liquidity Risk Measurement

The liquidity risk of every bank can be calculated as (46.12). V is the comprehensive measuring value, standing for the bank's liquidity and the greater the value of V is, the smaller the liquidity risk is. The results are presented in Table 46.3.

$$V_i = \sum_{j=1}^{m} p_{ij} w_j, \quad i = 1, 2, \ldots, n \tag{46.12}$$

46.3.4 Further Study

Liquidity, profitability and safety are three principles of commercial bank's operation and management. Gaining profits is a prerequisite for the development of business. To survive and develop in the competitive industry, commercial bank is inclined to reduce the cash assets, decrease the cash reserves to a minimum and attract deposits as many as possible so that it can use these funds on loans and investments that are more profitable. Maintaining liquidity is the premise for commercial banks of continually gaining substantial funds to keep the normal credit operations. Actually, the ultimate reason for liquidity risk is the contradictory relationship of profitability and liquidity of assets and liabilities. If the assets are all cash assets or assets that can be easily turned into cash, liquidity risk will not happen. However, oriented to profit-maximization, commercial banks will not give up profits to avoid liquidity risk. What they will do is to maximize profits at the cost of bearing small liquidity risk.

In general, liquidity and profitability are often contradictory. When liquidity is good, profitability is generally low. When profitability of the assets is high, liquidity is bad and liquidity risk is big. So we will further study the relationship of profitability and liquidity. We adopt the indicator of ROA (return on assets, the value of net profits divided by total assets) to measure profitability and calculate ROAs of China's listed commercial banks in 2010. Regression analysis of V and ROA will be used. First, we drop the observed value of Huaxia Bank (V = 0.5231, ROA = 0.0064) which greatly diverge from other observations that can be seen in Fig. 46.1. Then we test whether the coefficient is significant or not. The results are presented in Table 46.4, showing that there is a bit negative correlation between V and ROA but the coefficient is not significant in 95 % confidence interval.

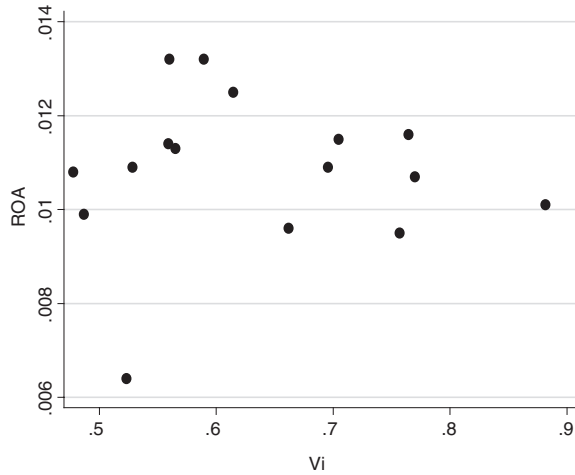**Fig. 46.1** The relationship of VI and ROA

Table 46.4 The results of regression analysis

ROA	Coefficient	Standard error	t	P > |t|	[95 % Con. Interval]
Vi	−.0027098	.0026146	−1.04	0.319	−.0083583 .0029388
_cons	.012877	.0017024	7.56	0.000	.0091991 .0165549
Number of obs = 15	F(1,13) = 1.07	Pro > F = 0.3189			R-squared = 0.0763

46.4 Liquidity Risk Management

Keeping liquidity is the most fundamental condition for normal operation of commercial banks, so liquidity risk management is of great significance.

What the regulatory institutions should do:

Build a more reliable and early-warning system. The establishment of early-warning system of liquidity risk, which includes reliable indicators to measure liquidity risk, the effective transmission of indicators and the timely reflect mechanism, is an important part of pre-regulation that improves the ability of risk prevention. Adverse trends can be identified through this system so that the bank's management can give rational evaluation of risk and timely response.

Strengthen the effective supervision of liquidity. Regulatory institutions require banks to provide information about the risk exposure and risk analysis reports and at the same time they should observe and assess the measures for risk prevention to ensure the timeliness and effectiveness.

What the commercial banks should do:

Raise the awareness of liquidity risk management. Compared with the credit risk and operational risk, China's commercial banks are lacking in the cognition for liquidity risk crisis. To achieve the goal of stable operation, commercial banks should establish a scientific system for liquidity risk management and strengthen executive force for the system.

Strengthen management of liquidity forecasting and liquidity gap. One of the important responsibilities for commercial banks is to maintain adequate funds to

meet liquidity demands. Too much liquid assets will result in underutilization of funds, while too little access will reduce the level of profitability. So commercial banks should forecast the potential liquidity supply and liquidity demand by collecting information on fund changes.

Draw up an all-around contingency plan. Commercial banks can make a contingency plan on the basis of their business size, risk level and organizational framework and analyze the potential liquidity risk in line with business conditions and cash flow. Contingency plans should be timely assessed and revised to ensure the planned measures smoothly implemented in case of emergency.

Improve the level of fund utilization. Under the circumstances that new risks won't be caused, commercial banks can improve the usage of funds by financial innovation, which can enrich the financing channels, decentralize risks and improve liquidity risk management.

Establish the mechanism of reputation risk management and coordination [9]. Crisis of confidence is an important factor to accelerate the deterioration of liquidity risk. The ability of banks to maintain liquidity depends on the cultivation of long-term and stable relationships, the management of reputation risk and the establishment of coordination mechanism.

46.5 Conclusion

First, we construct an indicator system to measure the commercial bank's liquidity risk. By reflecting the asset liquidity, liability liquidity and asset-liability liquidity, the six indicators effectively measure liquidity risk.

Second, liquidity of 16 China's listed commercial banks is well on the whole, but banks should still put emphasis on risk management.

Third, the study of the relationship between liquidity and profitability shows that negative correlation is not significant.

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