The Impact of Interest Rate Liberalization on the Systemic Risk—Based on the Panel Data of Commercial Banks

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**Abstract.** This paper uses coefficient of variation method and dynamic CoVar model to measure the level of interest rate liberalization and the systemic risk of commercial banks, and then based on the quarterly panel data of 14 listed commercial banks from the first quarter of 2009 to the fourth quarter of 2018, it empirically analyzes the impact of interest rate marketization process on the systemic risk of commercial banks. The results show that: the process of interest rate liberalization in China has significantly increased the overall systemic risk of commercial banks, and the robustness test further supports this conclusion.

1. Introduction

Since July 2013, China has fully liberalized the loan interest rate control of financial institutions, gradually abolished the floating upper limit of commercial deposit interest rate, promoted the "merger" of interest rate, promoted the conversion of individual credit pricing benchmark of stock floating interest rate, and improved the basic function of interest rate on market resource allocation and interest rate transmission mechanism, it promoted the liquidity creation of commercial banks and enhanced the interest rate regulation ability of the Central Bank of China. Nevertheless, the marketization of interest rate will lead to risk incentive and adverse selection effect (Wells, 2002)\(^{[1]}\), expand potential liquidity risk, lead to an uncertainty of deposit and loan interest spread and volatility of profit space, and eventually aggravate the systemic risk of commercial banks (Noy, 2004)\(^{[2]}\). At the same time, with the increasing downward pressure of China's national economic system, the probability of financial system suffers from systemic risk impact is likewise increasing. As China is a financial market dominated by indirect financing, the systemic financial risk is primarily focused in the banking organization. Thus, how to effectively prevent and bring down the systemic risk of commercial banks caused by interest rate marketization is a major strategic task faced by China's financial field. Based on this, this paper will canvass the impact of interest rate marketization on the systemic risk of commercial banks.

Since the reform of interest rate marketization has been comprehensively promoted in China, the academic circles have paid close attention to the impact of interest rate marketization on the systemic risk of commercial banks \(^{[3]}\). Among them, some studies think that the interest rate liberalization will increase the bank capital cost, reduce the bank profitability, and then increase the bank bankruptcy risk \(^{[4]}\). Therefore, the interest rate marketization improves the probability of systematic risk of commercial banks, and this impact has the characteristics of periodic and
permanent, and the systemic risk in the short term is higher than that in the long term. In addition, some studies based on the panel variable coefficient model show that different interest rate derivatives cause positive or negative systemic risk of commercial banks. However, these studies lack the relevant content of using the comprehensive evaluation method to measure the level of interest rate marketization, and the research of using dynamic CoVar model to calculate the systemic risk of commercial banks is also less. Established on the quarterly panel data of 14 listed commercial banks from the first quarter of 2009 in the fourth quarter of 2018, this paper empirically analyzes the impact of interest rate marketization on the systemic risk of commercial banks.

2. Measurement of Core Variables

2.1. Measurement of Interest Rate Marketization Level

Interest rate marketization is a gradual and dynamic process\(^5\). We need to measure the process of interest rate marketization to construct the institutional variables of interest rate marketization. In this paper, we first set up the grading index of interest rate marketization, and then standardize each index. Then we determine the comprehensive evaluation index by the coefficient of variation method, and finally calculate the time series of the comprehensive index of interest rate marketization.

2.1.1. Establishment of Index System

First of all, according to the business characteristics of commercial banks, we set three first-class interest rate marketization indicators: deposit and loan interest rate, money market interest rate and bond market interest rate. Among them, deposit and loan interest rate includes 4 indicators, money market interest rate includes 2 sub indicators, bond market interest rate includes 2 sub indicators, a aggregate of 8 secondary indicators. Because the relationship between each index and interest rate marketization is different, the whole index system must contain positive index and reverse index\(^6\). According to the data from wind database, the descriptive statistics of each index in China's interest rate marketization index system are shown in Table 1.

<table>
<thead>
<tr>
<th>Primary Index</th>
<th>Secondary Index</th>
<th>Average Value</th>
<th>Standard Deviation</th>
<th>Minimum Value</th>
<th>Maximum Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Deposit and loan</td>
<td>Fixed deposit interest rate (positive)</td>
<td>2.35</td>
<td>0.72</td>
<td>1.50</td>
<td>3.50</td>
</tr>
<tr>
<td></td>
<td>Term loan rate (reverse)</td>
<td>5.06</td>
<td>0.62</td>
<td>4.35</td>
<td>6.10</td>
</tr>
<tr>
<td></td>
<td>Foreign currency deposit interest rate (positive)</td>
<td>2.57</td>
<td>0.83</td>
<td>1.47</td>
<td>4.95</td>
</tr>
<tr>
<td></td>
<td>Foreign currency loan interest rate (reverse)</td>
<td>2.82</td>
<td>0.73</td>
<td>1.49</td>
<td>4.41</td>
</tr>
<tr>
<td>Money market interest</td>
<td>Interbank offered rate (reverse)</td>
<td>3.11</td>
<td>0.94</td>
<td>1.01</td>
<td>4.70</td>
</tr>
<tr>
<td></td>
<td>Discount rate (reverse)</td>
<td>3.76</td>
<td>1.35</td>
<td>1.20</td>
<td>7.79</td>
</tr>
</tbody>
</table>

Table 1. Descriptive Statistics of China's Interest Rate Marketization Index System.
2.1.2. Data Standardization

The method of standardizing the original data is shown in the following formula \(^7\). Suppose there are \(N\) evaluation indicators, for positive indicators:

\[
\alpha_i = \frac{x_i - \min\{x_i\}}{\max\{x_i\} - \min\{x_i\}}, \quad (i = 1,2,\cdots, n) \tag{1}
\]

For reverse indicators:

\[
\alpha_i = \frac{\max\{x_i\} - x_i}{\max\{x_i\} - \min\{x_i\}}, \quad (i = 1,2,\cdots, n) \tag{2}
\]

The maximum and minimum values of each index after standardization are 1 and 0 respectively.

2.1.3. Determination of Comprehensive Evaluation Index

Variation coefficient method is an objective evaluation method to determine the weight of comprehensive evaluation index by weighting the variation degree of each index \(^8\). The specific calculation method of coefficient of variation method is shown in formula (3), (4) and (5):

\[
V_i = \frac{S_i}{\bar{\alpha}_i} \tag{3}
\]

\[
S_i = \sqrt{\frac{1}{m} \sum_{j=1}^{J} (\alpha_{ij} - \bar{\alpha}_i)^2} \tag{4}
\]

\[
\bar{\alpha}_i = \frac{1}{m} \sum_{j=1}^{J} \alpha_{ij} \tag{5}
\]

Where \(i\) represents the \(i\)-th index, \(J\) represents the \(j\)-th quarter, and \(\alpha_{ij}\) is the value of index \(I\) in the \(j\) quarter, \(V_i\) is the coefficient of variation of index \(I\), \(S_i\) is the standard deviation of index \(I\), \(\bar{\alpha}_i\) is the average value of index \(I\). According to the corresponding coefficient of variation, the calculation method of index \(I\) weight is shown in formula (6):

\[
\omega_i = \frac{V_i}{\sum_{i=1}^{n} V_i} \tag{6}
\]

After calculating the weight of each index \(\omega_i\), the comprehensive evaluation of the index score of interest rate marketization is shown in formula (7):

\[
f(\theta) = \sum_{i=1}^{n} \omega_i \times \alpha_{ij} \tag{7}
\]

The weight of comprehensive evaluation index \(\omega_i\) is shown in Table 2.
<table>
<thead>
<tr>
<th>Primary Index</th>
<th>Weight</th>
<th>Secondary Index</th>
<th>Weight</th>
</tr>
</thead>
<tbody>
<tr>
<td>Deposit and loan interest rate</td>
<td>0.596</td>
<td>Fixed deposit interest rate (positive)</td>
<td>0.190</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Term loan rate (reverse)</td>
<td>0.133</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Foreign currency deposit interest rate (positive)</td>
<td>0.103</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Foreign currency loan interest rate (reverse)</td>
<td>0.170</td>
</tr>
<tr>
<td>Money market interest rate</td>
<td>0.208</td>
<td>Interbank offered rate (reverse)</td>
<td>0.133</td>
</tr>
<tr>
<td>Bond market interest rate</td>
<td>0.196</td>
<td>Discount rate (reverse)</td>
<td>0.075</td>
</tr>
</tbody>
</table>

The evolution trend of interest rate marketization index after comprehensive evaluation is shown in Figure 1.

![Figure 1. Evolution Trend of Interest Rate Marketization.](image)

2.2. Measurement of Systemic Risk of Commercial Banks in China

2.2.1. The Establishment of Dynamic CoVaR Model

Due to the potential loss of the portfolio held in a given period of time under a given confidence level, the traditional VAR model can measure the potential maximum loss and measure the systemic risk of financial institutions or markets \(^9\). \( VaR_q^i \) can be defined as the quantile of \( q \), which is a common index to measure the risk of a single financial institution. The expression is shown in formula (8):

\[
Pr(X^i \leq VaR_q^i) = q
\]  

(8)

After the subprime mortgage crisis in the United States, the CoVaR model came into being (Adian and Brunnermeier, 2008) \(^10\). The model considers the risk spillover effect among financial institutions. The specific model is expressed in formula (9):

\[
Pr(X^i \leq CoVaR_q^{i|j} | X^j = VaR_q^j) = q
\]  

(9)
Among them, \( CoVaR_{ij} \) is conditional value at risk. Under the given confidence level, when the financial institutions or portfolio \( j \) may occur the maximum risk loss value is equal to \( VaR_i \). Furthermore, we can define the risk spillover effect \( \Delta CoVaR_{ij} \) is used to measure the intensity of risk spillover effect on financial institutions or asset portfolio \( i \) when risk loss occurs to financial institutions or asset portfolio. The expression is shown in formula (10):

\[
\Delta CoVaR_{ij} = CoVaR_{ij}^{X_j=VaR_j} - VaR_{ij} \tag{10}
\]

### 2.2.2. Index Selection and Data Sources

According to the data availability, this paper selects 14 listed commercial banks in China as research samples, and uses Shen-Wan banking sector index to represent the overall situation of the banking industry. The stock prices of 14 listed commercial banks are obtained by the way of pre reversion, and the time unit is days. This paper uses stata15.1 software for quantile regression to calculate the \( \Delta CoVar \) values of 14 listed commercial banks in China when \( q = 0.1 \) and \( 0.5 \), and standardize the values.

### 3. Empirical Analysis

#### 3.1. Model Setting

According to the above theoretical analysis, this paper constructs the following model to investigate the impact of interest rate marketization on the systemic risk of commercial banks:

\[
\ln \Delta CoVaR_{it} = \alpha_0 + \alpha_1 \ln MIR_{it} + \alpha_2 \ln SIZE_{it} + \alpha_3 \ln CAR_{it} + \alpha_4 \ln ROE_{it} + \alpha_5 X_{it} + \epsilon_{it} \tag{11}
\]

Among them, \( i \) is the cross-sectional unit of China's 14 listed commercial banks, \( i \) represents the quarter; \( \Delta CoVaR \) represents the systemic risk of commercial banks and is the explanatory variable of this paper; MIR represents the level of interest rate marketization, which is the core explanatory variable; SIZE, CAR and ROE represent the operating scale, capital adequacy ratio and return on net assets of commercial banks respectively; \( X \) is a series of control variables; \( \alpha_0-\alpha_5 \) is a series of coefficients to be estimated and \( \epsilon \) is a random disturbance term.

#### 3.2. Empirical Results and Analysis

Table 3 reports the estimated results of panel data regression. In columns (1) and (2) of Table 3, after adding the other five control variables, the interest rate marketization has significant impact on the systemic risk of commercial banks at the level of 1%, and the coefficient is positive, which indicates that the interest rate marketization has indeed promoted the systematic risk of commercial banks, which conforms to the theoretical expectation. The Hausman test results in columns (1) and (2) on the board show that the fixed effect model should be selected, and the random effect model used in column (2) is only utilized for comparability in this benchmark regression. The estimation results of the fixed effect model in column (1) show that the return on net assets, GDP growth rate and banking prosperity index have significant negative effects on the systemic risk of commercial banks, while the consumer price index, M2 growth rate and national housing boom index have significant positive effects on the systemic risk of commercial banks. The coefficient of bank scale and capital adequacy ratio of the systemic risk of commercial banks is negative, and the coefficient...
symbol is in line with the expectation but not significant. Consequently, the benchmark regression cannot afford a definite solution to the relationship between the two variables and systemic risk, which requires further confirmation. In column (3), the strategy of replacing the explained variable is adopted, and $\Delta CoVaR_{0.1}$ as $\Delta CoVaR_{0.5}$, which represents the systemic risk of commercial banks. It can be understood that the marketization of interest rate significantly improves the systemic risk of commercial banks, and the benchmark analysis mentioned above has strong robustness.

Table 3. Benchmark Regression and Robustness Test.

<table>
<thead>
<tr>
<th>Variable</th>
<th>(1)</th>
<th>(2)</th>
<th>(3)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>FE</td>
<td>RE</td>
<td>FE</td>
</tr>
<tr>
<td>lnMIR</td>
<td>1.409***</td>
<td>1.475***</td>
<td>0.767*</td>
</tr>
<tr>
<td></td>
<td>(-0.503)</td>
<td>(-0.494)</td>
<td>(0.398)</td>
</tr>
<tr>
<td>lnSIZE</td>
<td>-0.042</td>
<td>-0.082</td>
<td>0.103</td>
</tr>
<tr>
<td></td>
<td>(-0.09)</td>
<td>(-0.056)</td>
<td>(0.100)</td>
</tr>
<tr>
<td>lnCAR</td>
<td>-0.04</td>
<td>-0.063</td>
<td>0.347</td>
</tr>
<tr>
<td></td>
<td>(-0.273)</td>
<td>(-0.238)</td>
<td>(0.726)</td>
</tr>
<tr>
<td>lnROE</td>
<td>-1.388***</td>
<td>-0.46</td>
<td>-0.444</td>
</tr>
<tr>
<td></td>
<td>(-0.521)</td>
<td>(-0.29)</td>
<td>(0.979)</td>
</tr>
<tr>
<td>Controls</td>
<td>YES</td>
<td>YES</td>
<td>YES</td>
</tr>
<tr>
<td>N</td>
<td>560</td>
<td>560</td>
<td>560</td>
</tr>
<tr>
<td>$R^2$</td>
<td>0.637</td>
<td>0.679</td>
<td>0.599</td>
</tr>
<tr>
<td>Hausman Test</td>
<td>Chi2(2)=36.08 (Prob=0.00)</td>
<td>——</td>
<td></td>
</tr>
</tbody>
</table>

Note: ***, **, * denote the significance level of 1%, 5% and 10%; the values in brackets below the coefficient are the standard error; Fe and RE represent the fixed effect model and random effect model respectively.

4. Conclusion

This paper analyzes the impact of interest rate volatility on China's commercial banks through the panel model of interest rate volatility and the systematic analysis of China's commercial banks' market risk through the panel model of interest rate volatility. The outcomes indicate that the marketization of interest rate significantly aggravates the systemic risk of China's commercial banks.

From this paper, we can get the Enlightenment: the reform of interest rate marketization in China is facing a complicated situation. Foremost of all, China should continue to deepen the market-oriented reform of deposit and loan benchmark interest rate and money market interest rate, and finally from the securities industry to fix the price of capital, so that the market can allocate capital resources reasonably and effectively. Secondly, commercial banks should combine their own
characteristics, optimize the financial mechanism and financial instruments, and actively deal with the operational risk, liquidity risk and credit risk brought by the change of interest rate, so as to avoid the occurrence of systemic risk. At the same time, we should further strengthen the macro prudential supervision, establish the risk early warning index system more perfect, actively, reasonably and prudently develop financial instruments to avoid interest rate risk, and then comprehensively prevent the systemic risk caused by the sharp fluctuation of interest rates.

References


