



Assessing the Effectiveness of Risk Management Strategies in Enhancing Stress Resilience: A Study of China's Big Four Banks

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Abstract. This research explores the influence of risk management strategies on the resilience of China's Big Four banks: Industrial and Commercial Bank of China, China Construction Bank, Bank of China, and Agricultural Bank of China. Using financial data from 2018 to 2023, the study employs descriptive statistics and multiple regression analysis to assess the effectiveness of various risk management measures during periods of economic stress, particularly focusing on the pre-pandemic, pandemic, and post-pandemic phases. The findings indicate that the strategies implemented by these banks, such as managing the leverage ratio and risk-weighted asset ratio, significantly affect their capital adequacy and stability in stock price volatility. The results demonstrate that these measures had a considerable impact on the banks' ability to withstand stress during the COVID-19 crisis. This paper not only contributes empirical evidence to the theory of bank risk management but also provides recommendations for policymakers and regulators to enhance risk management frameworks, ensuring greater resilience in the face of future economic shocks.

Keywords: Risk Management, Compressive Strength, Regression Analysis, Banking Industry.

1 Introduction

The banking industry occupies a core position in the modern financial system, and its stability and ability to resist pressure are directly related to the healthy operation of the whole economic system. The 2008 global financial crisis revealed significant weaknesses in the risk management practices of many banks, leading to increased focus on the resilience of the banking system from both academic and industry perspectives. Hua analyzed the connection between macroeconomic factors and loan default rates by developing stress scenarios and employing a logit model, discovering that credit risk within the banking sector surged considerably under these conditions [1]. As risk management technologies have evolved, stress testing methods have also seen continuous improvement.

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In China, the Big Four banks (ICBC, CCB, BOC, ABC) are the pillars of the national economy, and their risk management strategies are of great significance to the country's financial stability. The bank's risk management strategy needs to comprehensively consider various risk types such as market risk, credit risk and operational risk. Huang emphasized the importance of comprehensive risk management in his work, and proposed that banks should establish a management system based on value-at-risk, optimize the risk management process, and improve the ability of risk identification, assessment and control [2]. In recent years, as the financial market has continuously developed and the process of internationalization has accelerated, the risks confronting China's four major banks have grown more complex and diverse. Among domestic researchers, Shen and Feng examined how shifts in macroeconomic indicators affect credit risk by creating a simultaneous equation system of macroeconomic variables and credit risk [3]. International studies, on the other hand, place greater emphasis on developing stress testing frameworks and analyzing risk transmission mechanisms.

Through empirical analysis, this study explores the impact of risk management strategies on the resilience of the Big Four banks and analyzes the performance of each bank in the face of financial risks under different strategies. The research aims to provide a new perspective and case for risk management research in the global banking industry by studying the risk management strategies of the four largest banks in China. Secondly, exploring the effect and impact of different risk management strategies in practice through empirical analysis can provide empirical support for risk management theory and help to improve the theoretical framework of risk management. Through the comparative analysis of the risk management strategies of the four major banks, it can summarize effective risk management experience and lessons, which can provide reference for other banks, so as to improve the risk management level of the whole banking industry.

The contributions of this paper are as follows: (1) Review relevant theories and research, find and point out the lack of quantitative means of banks' stress resilience in existing research; (2) Using quantitative analysis method, combined with descriptive statistical analysis and regression analysis, this paper conducts empirical research on the risk management strategy and resilience of the four major banks, and explores the specific quantitative relationship between the two; (3) Policy suggestions are put forward, and research limitations and future research directions are pointed out.

2 Methodology

2.1 Sample Selection and Data Sources

The data sources of this paper include two aspects: information related to banks' risk management strategies and indicators of resilience to stress. The financial data and market data of the four major banks from 2018 to 2023 are selected as the initial analysis samples. The data of the total six years from before the COVID-19 crisis to after the COVID-19 crisis can not only analyze their strategies and effectiveness, but

also empirically analyze the strategic changes of the four banks, which makes the study more practical for the evaluation of risk management strategies in the post-epidemic era.

Finally, the risk management strategy indicators of the four major banks within 6 years include: Non-performing Loan Ratio, Provision Coverage Ratio, Loan Loss Reserve Adequacy Ratio, Liquidity Coverage Ratio, Delinquency Ratio, Risk-Weighted Assets Ratio, Leverage Ratio, Return on Equity. The indexes of resilience include Mean Stock Price Volatility and Capital Adequacy Ratio. All the above data are from the iFind financial database.

2.2 Data Processing

Collate and clean the collected data to ensure integrity and consistency. A covariance matrix hotspot map is constructed for all risk management indicators, and its collinearity is analyzed, as shown in Figure 1.

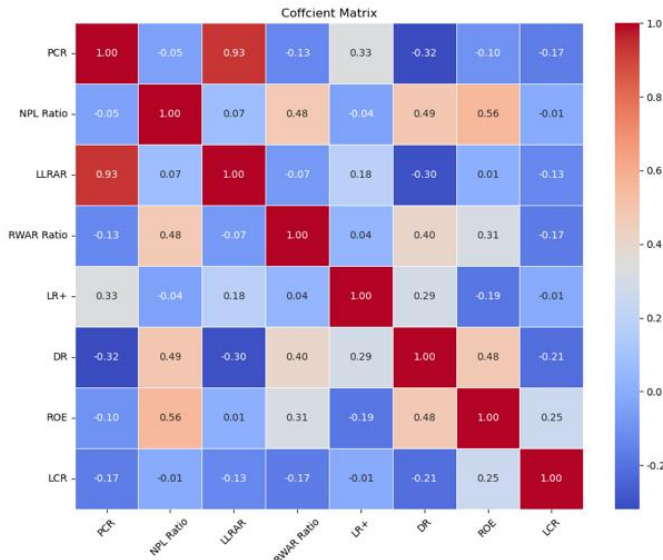


Fig. 1. Covariance matrix.

Multicollinearity analysis of risk management indicators and observation of VIF values found that provision coverage (PCR) had a very significant collinearity ($VIF > 10$), and therefore dropped from the model. Re-analysis of covariance matrix (see Figure 2), $VIF < 10$ of all variables, indicating that there is no obvious collinearity among the remaining variables.

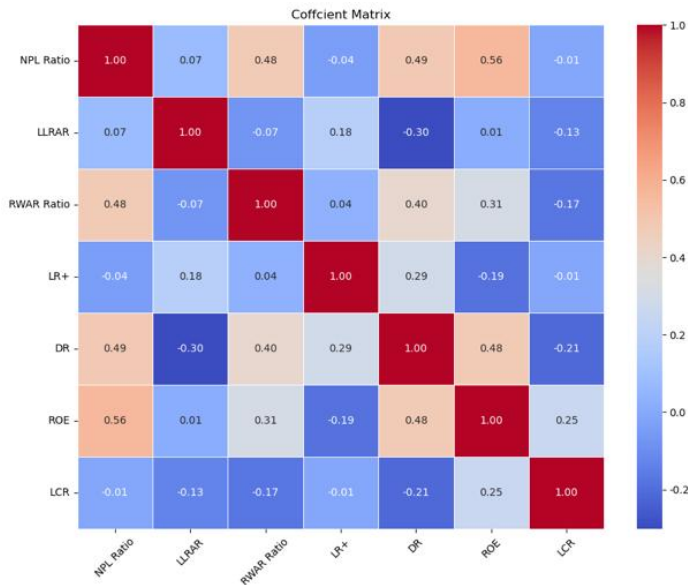


Fig. 2. Re-analysis of covariance matrix.

Considering the base differences of different indicators, the data are uniformly standardized, so that all the data participating in regression analysis can have the same statistical distribution, which is convenient for comparison and analysis of the significance of regression coefficients.

2.3 Modelling and Analysis

Descriptive Statistical Analysis. The descriptive statistical analysis is mainly used to understand the basic situation of the risk management strategies and resilience of the four major banks in the three time periods of pre-crisis (2018-2019), in-crisis (2020-2022) and post-crisis (2023). The basic characteristics of the data can be shown through descriptive analysis and statistics such as mean and standard deviation.

Regression Analysis. Regression analysis is used to further quantitatively analyze the specific degree of impact of different risk management strategies on banks' resilience to stress. Through the construction of multiple linear regression model, the ability to withstand stress is taken as the dependent variable, and the financial indicators that can reflect the risk management strategy are taken as independent variables [4]. Through the fitting and testing of the model, the impact of various risk management strategies on the bank's resilience to stress is evaluated [5].

The regression analysis model used in this paper is OLS regression. In this model, the index of stress tolerance is MSPY or CAR, which correspond to the stress tolerance of different dimensions respectively; The financial variables related to risk

management strategy are NPL_Ratio, LLRAR, RWAR_Ratio, LR+, DR, LCR, and ROE.

The bank's capacity to endure stress should be evaluated from two distinct perspectives. At the bank level, stress resilience is primarily measured by the capital adequacy ratio, a key indicator of the bank's operational stability [6]. This ratio reflects the ability of commercial banks to absorb losses from defaulted assets and assess the extent of their capital risk. At the market level, stress resilience is gauged through the volatility of the bank's stock price. Stock price fluctuations offer an objective measure of the market's perception of the bank's performance and its ability to cope with shifts in the market environment [7].

Therefore, this paper will conduct regression analysis on the two stress resilience respectively, and analyze how different management strategies affect the two stress resilience respectively.

3 Descriptive Analysis of Risk Management Strategies

The following figures show the changes in the financial indicators of the four major banks, which reflect the risk control strategies and preferences of the major banks before and after the crisis from the side. This paper will make a specific analysis on these financial data.

3.1 Loans

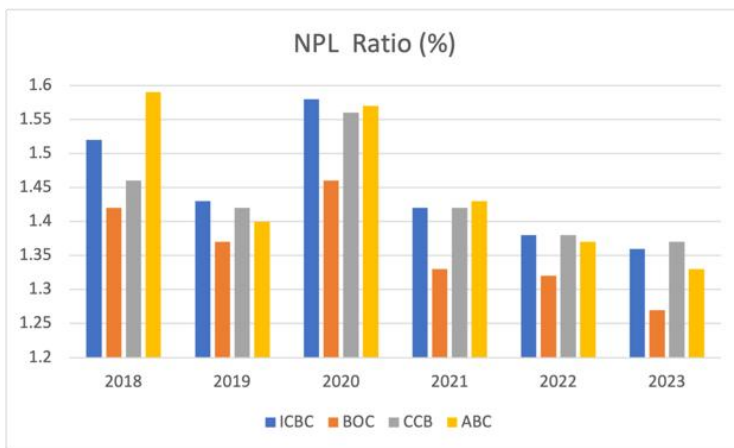


Fig. 3. Non-performing loan ratio.

In a stable economic environment, the four major banks worked to dispose of non-performing loans and improve asset quality [8]. This results in a general decrease in the NPL ratio, as shown in Figure 3. The ABC saw the largest decline, reflecting its more proactive risk management approach during favorable economic conditions. The

loan loss provision adequacy ratio of various banks increased, especially the significant increase of CCB and ABC, reflecting more prudent risk prevention and control.

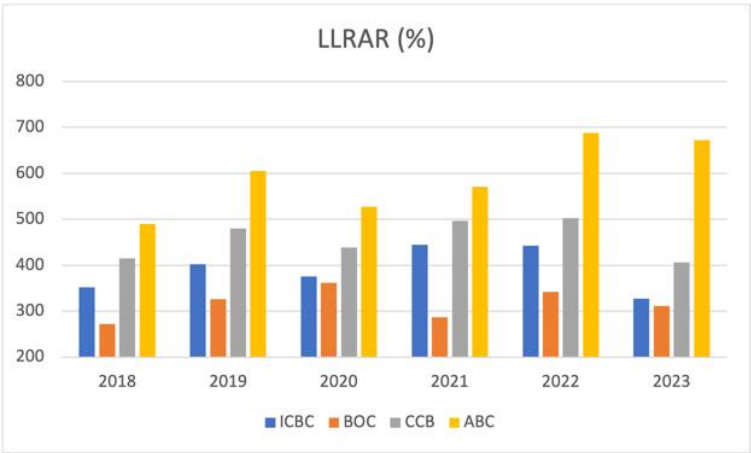


Fig. 4. Loan loss provision adequacy ratio.

The NPL ratio rose in the early stage of the pandemic, but banks quickly took measures to gradually reduce it in 2021 and 2022, showing effective risk management capabilities [9]. ICBC and BOC stood out, with their NPL ratio declining year on year. The loan loss provision adequacy ratio fluctuated during the pandemic, and the changes of ICBC and BOC showed differences in adjustment strategies, while CCB maintained a relatively high level as a whole, highlighting its conservative risk resistance strategy.

After the crisis, the NPL ratio of the Big Four banks continued to decline, with BOC falling to the lowest level, reflecting strict risk control measures. As Figure 4 shown, banks' loan loss provision adequacy ratio decreased, indicating optimism about economic recovery and paying more attention to capital efficiency and optimal asset management.

3.2 Risky Assets

Before the crisis, the risk-weighted asset ratio (see Figure 5) and loan delinquency rate (see Figure 6) of the Big Four banks were relatively stable, reflecting good risk management and capital adequacy ratio [10]. Risk-weighted assets at ICBC and BOC edged down to less than 1 per cent. CCB and ABC increased slightly, while the proportion of overdue loans both decreased significantly, indicating strict credit review and effective risk control.

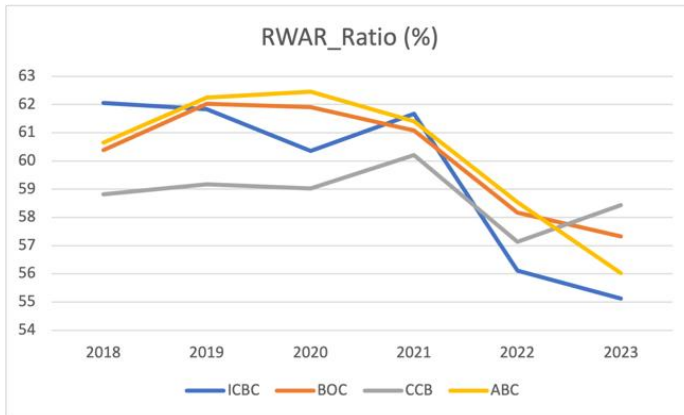


Fig. 5. Risk-weighted assets ratio.

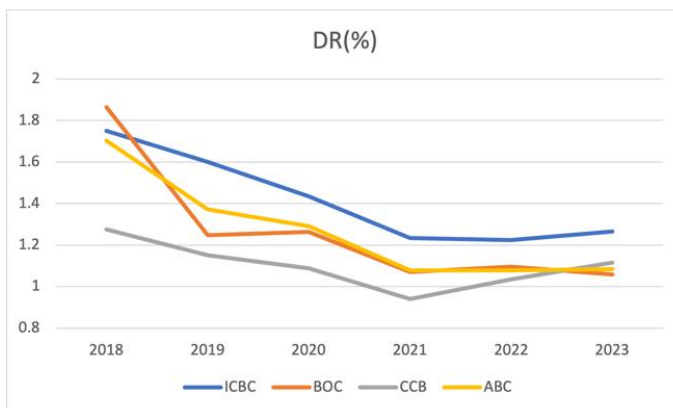


Fig. 6. Loan delinquency ratio.

In the middle of the crisis, the risk-weighted asset share fluctuates greatly, indicating that banks adjust their risky assets in response to economic uncertainty [11]. The proportion of ICBC and CCB decreased after adjustment at the beginning of the epidemic, while BOC and ABC reduced their risky assets year by year. In terms of the proportion of overdue payments, the ICBC and the CCB declined slightly after the initial period of the epidemic, while the BOC and the ABC continued to decline, reflecting effective risk control.

The share of risk-weighted assets of the four major banks generally declined after the crisis, indicating a greater focus on optimizing asset structure and risk management in the post-pandemic period [12]. ICBC and ABC fell more, to 55.13 percent and 56.02 percent, respectively, while BOC and CCB fell less. In terms of the proportion of overdue loans, ICBC and CCB increased slightly, while BOC and ABC decreased slightly or remained stable, indicating that banks still need to strengthen

risk management to cope with potential economic fluctuations while optimizing assets.

3.3 Leverage Ratio

The Big Four banks generally increased their leverage ratios before the crisis, especially ICBC and BOC, showing that they strengthened their capital buffers by increasing their core capital, as Figure 7 shown.

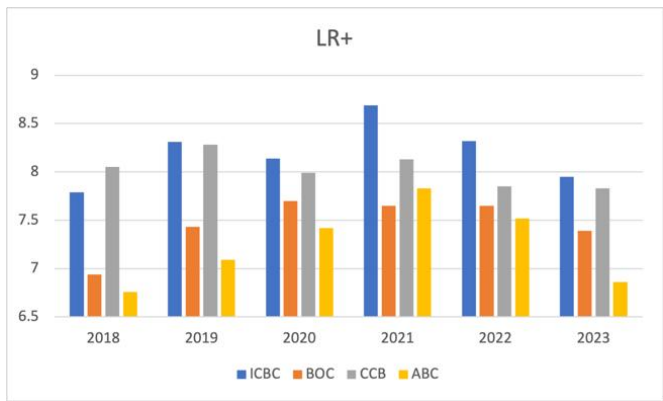


Fig. 7. Leverage ratio.

In the early days of the pandemic, economic uncertainty led to a decline in the leverage ratio of ICBC and CCB, which may have been due to the balance sheet expansion caused by the pandemic and the failure to fully keep up with the pace of capital replenishment. But ICBC and ABC raised their leverage ratios in 2021 to bolster their capital adequacy against risks.

After the end of the epidemic, the leverage ratio of the four major banks generally declined, especially the ABC, reflecting that banks pay more attention to optimizing the asset structure and improving the efficiency of capital use in the post-epidemic period, rather than merely increasing the capital buffer.

4 Comprehensive Analysis and Difference Analysis of Risk Management Strategies

4.1 Comprehensive Analysis

Before the crisis, the NPL ratio of the banks decreased slightly and the risk management was good. Most banks increased loan-loss provisions and increased leverage in 2019, reflecting responses to potential risks, especially ICBC and CCB.

The pandemic negatively affected the asset quality of banks, leading to an increase in the NPL ratio in 2020. However, since 2021, banks have implemented proactive

risk management strategies, resulting in a decrease in the NPL ratio. ABC, in particular, significantly boosted its loan loss provisions. The leverage ratio across all banks remained relatively stable, with ICBC and CCB demonstrating strong risk resilience in response to their high leverage ratios.

After the crisis, the NPL ratio fell back to close to the pre-epidemic level, loan loss provisions decreased, and bank asset quality improved significantly. The leverage ratio was stable, and the proportion of overdue loans decreased, reflecting the improvement of loan recovery rate and the effect of risk control.

4.2 Difference Analysis

By comparing the data of the Big Four banks, it can be found that AgBank adopts a more aggressive strategy in risk management, while CCB is relatively conservative.

ABC is more aggressive in the selection of assets, and the NPL ratio and overdue proportion are significantly higher than other banks, so it has to prepare a large number of reserves to deal with potential non-performing loans. It can be seen that the loan loss reserve adequacy ratio of ABC is significantly higher than that of other banks, especially exceeding 570% in 2020 and 2021. At the same time, Agbank's leverage ratio was significantly lower than that of the other three banks from 2018 to 2023, indicating that it was more aggressive in capital operation.

CCB's loan loss provision adequacy ratio during and after the pandemic was higher than that of other banks. CCB's relatively low NPL ratio and overdue ratio in 2023 suggest it is more effective in credit quality management and more conservative in asset quality screening. At the same time, CCB's leverage ratio was relatively high during and after the pandemic, especially in 2021 and 2022, which shows its sound strategy in capital operation.

5 Descriptive Analysis of Compressive Capacity and Stability

The figures below show the stability of the Big Four banks from 2018 to 2023. Before the pandemic, the capital adequacy ratio of the Big Four banks increased, especially ICBC and ABC, showing capital accumulation and enhanced ability to resist risks during good economic times. The share price volatility of all the four major banks decreased and the volatility decreased significantly (see Figure 8), and the capital adequacy ratios of BOC and ABC also showed similar robustness, indicating the increased market confidence in the stability and resilience of the banks.

Despite the economic shock, the capital adequacy ratios of the Big four banks have continued to rise amid the pandemic, as Figure 9 shown. The volatility of the four major banks (see Figure 10) increased in the early stage of the pandemic, but decreased in 2021 and 2022 with the adjustment of the bank's risk management, indicating the high market recognition of their ability to withstand pressure and the gradual recovery of confidence.

After the pandemic, the capital adequacy ratio of the Big Four banks declined slightly but remained high, demonstrating the robustness of their capital base and the

continued resilience to risks. Stock price volatility has rebounded in 2023, reflecting the market's concern about the uncertainties in the economic recovery. However, the volatility of ICBC and CCB has rebounded relatively moderately, and the market still maintains high stability expectations for them.

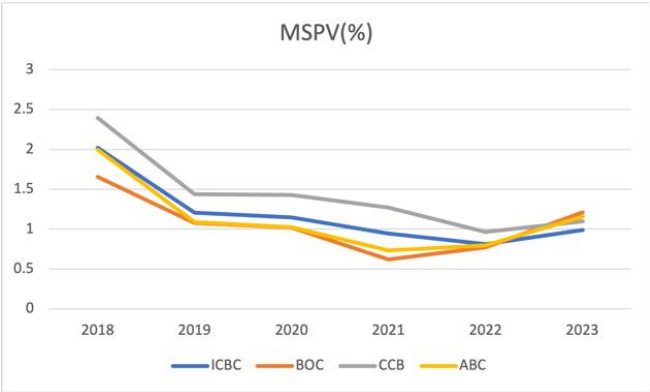


Fig. 8. Five-day average stock price volatility.

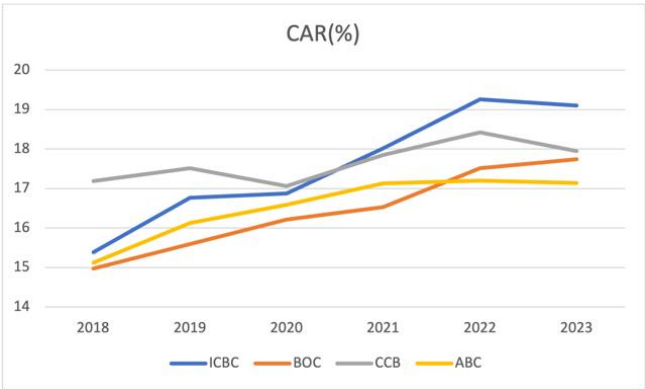


Fig. 9. Capital adequacy ratio.



Fig. 10. Closing share price of four banks.

6 Regression Results

Through the construction of multiple regression models, quantitative analysis of different risk management strategies on different aspects of the bank's ability to withstand stress. The results of regression analysis, including regression coefficient, significance level, degree of fit and other indicators, are presented to assess the impact of various risk management strategies on the bank's stress resilience. The regression analysis model constructed is as follows:

$$y_i = \beta_1 \text{NPL_Ratio} + \beta_2 \text{LLRAR} + \beta_3 \text{RWAR_Ratio} + \beta_4 \text{LR}_+ + \beta_5 \text{DR} + \beta_6 \text{LCR} + \beta_7 \text{ROE} + \varepsilon_i \quad (1)$$

In this model, the relationship of corresponding variables is as follows: the index of stress resilience is y_i , which corresponds to the stress resilience of the market dimension (MSPY) and the bank dimension (CAR) respectively; The variables related to risk management strategy are NPL_Ratio, LLRAR, RWAR_Ratio, LR+, DR, LCR, and ROE.

Regressions on the bank level are run for capital adequacy, that is, $y = \text{CAR}$.

Table 1. OLS regression results for CAR.

	Coef.	std err	t	P> t	[0.025	0.975]
NPL Ratio	-0.0290	0.087	-0.333	0.744	-0.214	0.156
LLRAR	0.0617	0.087	0.706	0.490	-0.124	0.247
RWAR Ratio	-0.5894	0.074	-7.930	0.000	-0.747	-0.432
LR+	-0.5091	0.089	-5.728	0.000	-0.698	-0.321
DR	-0.2831	0.124	-2.285	0.036	-0.546	-0.020
LCR	-0.2231	0.085	-2.625	0.018	-0.403	-0.043
ROE	-0.0018	0.106	-0.017	0.987	-0.227	0.224
Const.	-7.633e-16	0.062	-1.23e-14	1.000	-0.132	0.132

The results in Table 1 show that RWAR_Ratio and LR+ are significant at the significance level of 1%, and DR And LCR are significant at the significance level of 5%. It indicates that the impact of these four variables on bank capital adequacy ratio is significant. It can be seen from the observation of coefficients that the coefficients of RWAR_Ratio, LR+ and DR Variables are all significantly less than 0, indicating that aggressive risk management strategies with high proportion of risky assets, high leverage ratio and high overdue ratio will obviously lead to a decline in the capital adequacy ratio of banks, and then lead to a decline in the ability of banks to resist pressure. For LCR, banks will reduce or adjust their allocation of risky assets in order to increase liquidity. In terms of specific data, the regression coefficients of RWAR_Ratio and LR+ are both < 0; The regression coefficients of DR And LCR are

around -0.25 , which is enough to show that the former two have more obvious effects on the bank's capital adequacy ratio.

The regression on the market level is performed against the mean of stock price volatility, that is, $y = MSPV$.

Table 2. OLS regression results for MSPV.

	Coef.	std err	t	P> t	[0.025	0.975]
NPL Ratio	0.1868	0.163	1.147	0.268	-0.159	0.532
LLRAR	-0.2545	0.163	-1.560	0.138	-0.600	0.091
RWAR Ratio	-0.2542	0.139	-1.831	0.086	-0.549	0.040
LR+	0.3871	0.166	2.331	0.033	0.035	0.739
DR	-0.0103	0.231	-0.044	0.965	-0.501	0.480
LCR	0.0159	0.159	0.100	0.922	-0.321	0.352
ROE	0.8156	0.199	4.101	0.001	0.394	1.237
Const.	2.22e-16	0.116	1.91e-15	1.000	-0.247	0.247

According to Table 2, only ROE is significant at the 1% significance level; At 5% significance level, only LR+ is significant; RWAR_Ratio is significant at the 10% significance level. By comparing the regression coefficients, it is found that the most important influence on the stock price fluctuation is the return on equity, and the regression coefficient is 0.8156, indicating that the higher the return on equity is, the more obvious the stock price fluctuation is. At the same time, the increase of leverage ratio also significantly increases the volatility level of stock prices, and the regression coefficient reaches 0.3871, which indicates that high leverage and high returns do affect the stability of the market to a large extent. In addition, the coefficient of RWAR_Ratio < 0 , which indicates that the market does not have a special preference for stocks with a high proportion of risky assets, thus reducing the volatility of stock prices to a certain extent.

7 Conclusion

Through regression analysis at the market level and the bank level, this paper finds that leverage ratio has a significant impact on both. A decrease in leverage leads to a decrease in bank capital adequacy and an increase in stock price volatility, indicating that aggressive leverage strategies weaken the resilience of banks and markets. Fluctuations at the market level are mainly affected by ROE and have nothing to do with risk management strategies, indicating high independence of the market. At the bank level, the increase in the proportion of risky assets, the proportion of overdue and the liquidity coverage ratio will all reduce the capital coverage ratio of banks, which further proves that the aggressive risk management strategy will significantly weaken the resilience of banks.

In view of the findings of this paper, banks need to strictly control the leverage ratio and optimize the management of non-performing loans and overdue loans to

ensure that banks maintain a sound capital base and improve the quality of bank assets, thus enhancing the resilience to stress.

This paper still has the following shortcomings: the time span is only six years, so it is difficult to capture the long-term effect; The sample scope is limited to the four major banks, and the universality is limited; The model variables are not fully selected, and the macroeconomic and external market environment are not fully considered. The analysis method focuses on static data and ignores the dynamic adjustment and lag effect of risk management strategy. In addition, the applicability of the findings to other countries and different bank types needs to be verified. Future research should extend the time, expand the sample, introduce more variables, and adopt dynamic models to improve the comprehensiveness and practicability of research.

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