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The Impact of Macroeconomic Factors on Non-Performing Loans of Commercial Banks: An Empirical Study Based on 2022 Provincial-level Data in China

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Abstract: The level of macroeconomic development varies, resulting in different non-performing loan ratios for commercial banks. Based on the relevant data of macroeconomic indicators from 31 provinces and cities in China in 2022, this paper empirically studies the relationship between regional gross domestic product (GDP), average urban employment salaries, the proportion of the tertiary industry, per capita consumer expenditure, the number of recipients of unemployment insurance, and the number of recipients of old-age insurance, and the non-performing loan ratio using a multiple regression model. A general model is established and tested to determine the final model. The empirical research results indicate that the proportion of the tertiary industry and the number of recipients of unemployment insurance have a positive impact on non-performing loans, while average urban employment salaries, regional GDP, and the non-performing loan ratio have a negative impact. Finally, based on the conclusions drawn from this study, relevant policy recommendations are proposed to provide guidance for commercial banks in China to mitigate the risks of non-performing loans.

Keywords: commercial banks, non-performing loan ratio, empirical research

1. Introduction

In recent years, with the increasing instability of the global economy, the scale of non-performing loans in commercial banks has received more and more attention. On March 10, 2023, Silicon Valley Bank, which had been named the best bank in the United States by Forbes for five consecutive years, declared bankruptcy, becoming the second-largest bank bankruptcy event in U.S. history. This event triggered a series of market chain reactions and led to a high level of concern from domestic and foreign banks regarding non-performing loans in commercial banks. Non-performing loans in banks are an important indicator for measuring the operating quality of commercial banks and the stability of a country's financial system. They reflect the efficiency of credit fund allocation in commercial

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banks, and a high level of non-performing loans will increase the risks of bank crises and financial crises. Macroeconomic factors are one of the important factors affecting non-performing loans in commercial banks. If a region is in good development, it indicates that residents or enterprises have strong debt repayment capabilities, and the possibility of non-performing loans will decrease. In China, according to data from the China Banking and Insurance Regulatory Commission, by the end of 2022, the balance of non-performing loans in the banking industry's financial institutions reached 3.8 trillion yuan, an increase of 169.9 billion yuan from the beginning of the year, and the non-performing loan ratio was 1.71%, which exceeded expectations in previous years. This indicates that there are risks in the credit asset quality of Chinese commercial banks, which poses hidden dangers to the smooth operation of the Chinese economy in the future. Therefore, based on provincial-level data in China in 2022, this paper conducts an empirical study to explore the impact of macroeconomic factors on non-performing loans in commercial banks and provides suggestions on how to prevent and respond to the risks brought by macroeconomic fluctuations to commercial banks.

2. Literature Review

(1) Macroeconomic Factors

Bing Xie studied the impact and contribution rate of macroeconomic factors on the non-performing loan ratio of commercial banks and found a negative correlation between macroeconomic factors and non-performing loans [1]. Fang Xiao, from the perspective of specific provinces, took Guangdong Province as an example to study the impact of economic downturn on the operations of commercial banks [2]. Hongbo Liang studied the relationship between macroeconomic uncertainty and credit risk and found that when macroeconomic uncertainty increases, the non-performing loan ratio significantly rises, causing banks to tighten credit supply and significantly increase credit risk [3].

Xueting Wang conducted an empirical study on the influence of leverage ratio and capital adequacy ratio on the non-performing loan ratio of commercial banks and the moderating effect of macroeconomic factors. The study found that macroeconomic factors have a moderating effect on the impact of leverage ratio and capital adequacy ratio on the non-performing loan ratio [4]. Zeyu Zhou used quarterly data on macroeconomics and financial markets to empirically study the significance of five influencing factors on the non-performing loan ratio of various types of commercial banks [5]. Tao Wu selected specific banks and researched the influence of macroeconomic factors on non-performing loans in a provincial branch of JS from the three dimensions of regional economic conditions, inflation level, and industry structure [6].

(2) Commercial Bank Factors

Changfeng Fang studied the factors influencing the performance of commercial banks and found that the macroeconomic environment has a significant impact on the average performance of Chinese commercial banks [7]. Chan Liu focused on the significant relationship between finance and economic fluctuations and, through constructing a micro-mechanism model, empirically studied the impact of commercial banks' pro-cyclicality on the macroeconomy. The study found a positive correlation between the growth rate of loan balance and GDP growth rate, indicating that large commercial banks have counter-cyclical effects on the macroeconomy [8]. Xihe Liu conducted research on the macroeconomic effects of commercial bank deleveraging based on commercial banks, government financing platforms, industrial and commercial enterprises, and household sectors. The study found that the greater the degree of deleveraging, the greater the impact on the macroeconomy [9].

Jia Li compared commercial banks in 16 different countries and found differences in the degree and direction of the impact of different macroeconomic factors on non-performing loans in commercial banks across countries [10]. Jijie Wei explored the main influencing factors of the non-

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performing loan ratio of commercial banks in four regions of China: Northeast, East, Central, and West. The study found that regional factors do not have a significant impact on the non-performing loans of commercial banks [11]. Huiyue Zhao combined micro-indicators of banks with macroeconomic indicators to analyze the relationship between bank management and economic operations [12].

The above literature provides a research foundation for this paper. Scholars have focused more on the cyclical fluctuations of macroeconomics, with fewer studies on the empirical research using macroeconomic indicators related to residents' production and daily activities. There is relatively little research literature on the factors influencing the non-performing loan ratio under the new economic situation. This paper conducts research on the non-performing loan ratio of commercial banks in 2022, analyzes the factors influencing the non-performing loan ratio of commercial banks, establishes a model, and draws corresponding conclusions to provide policy recommendations for the stable development of commercial banks.

3. Empirical Analysis of Non-performing Loans in Commercial Banks

(1) Sample Selection and Data Source

Macroeconomic indicators reflect the economic situation, including main indicators such as Gross Domestic Product (GDP), inflation and deflation, investment indicators, consumption, finance, fiscal indicators, etc. This paper studies the relationship between macroeconomic factors and non-performing loan ratio. The generation of non-performing loans is closely related to residents' production and living activities. Therefore, this paper selects 31 provinces and cities in China in 2022 as the sample. The dependent variable is the non-performing loan ratio. By reviewing relevant literature and combining with the innovative points of this paper, the initial control variables are determined as regional GDP, average urban employment salary, the proportion of the tertiary industry, per capita consumption expenditure of residents, the number of recipients of unemployment insurance for residents, and the number of recipients of old-age insurance for residents. These six variables will be tested and the final model will be determined in the subsequent empirical research.

The initial data analyzed in this paper comes from the "China Regional Financial Operation Report" published by the People's Bank of China and the National Bureau of Statistics. We selected data from 31 provinces and cities in China in 2022 for analysis, with a sample size of 31. To eliminate the dimensionality difference between different variables, this paper standardizes the data by taking the logarithm of both the independent and dependent variables.

(2) Model Specification

This paper selects 31 provinces and cities in China in 2022 as the sample to analyze the impact of macroeconomic factors on non-performing loans in commercial banks through data analysis. To reduce the absolute differences between data and avoid the influence of individual extreme values, so as to better explain the economic significance of the results, this paper takes the logarithm of all variables. To optimize the model, this paper conducts tests for multicollinearity, heteroscedasticity, and serial correlation for all variables. The preliminary multiple regression model in this paper is as follows:

$$lnBD = \beta_0 + \beta_1 lnGDP + \beta_2 lnAS + \beta_3 lnPTI + \beta_4 lnPCE + \beta_5 lnNUI + \beta_6 lnNEI$$

Where $lnBD$ represents the non-performing loan ratio, β_0 is the constant term, $lnGDP$ represents regional GDP, $lnAS$ represents average urban employment salary, $lnPTI$ represents the proportion of the tertiary industry, $lnPCE$ represents per capita consumption expenditure of residents, $lnNUI$ represents the number of recipients of unemployment insurance for residents, and

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$lnNEI$ represents the number of recipients of old-age insurance for residents.

(3) Empirical Analysis of the Model

1. Multicollinearity Test

Using the Klein discriminant method, the correlation analysis between the six selected variables is conducted to exclude the problem of multicollinearity in the model. The results are shown in Table 1, indicating the presence of multicollinearity in the model.

Table 1: Klein Discriminant Method Results.

	GDP	AS	PTI	PCE	NUI	NEI
GDP	1.000000	0.004034	0.070474	0.500766	**0.880460**	**0.796755**
AS	0.004034	1.000000	**0.811488**	0.734880	0.117770	-0.529865
PTI	0.070474	**0.811488**	1.000000	0.693932	0.238682	-0.371497
PCE	0.500766	0.734880	0.693932	1.000000	0.619650	-0.076697
NUI	**0.880460**	0.117770	0.238682	0.619650	1.000000	0.584300
NEI	**0.796755**	-0.529865	-0.371497	-0.076697	0.584300	1.000000

Multicollinearity issues can lead to ineffective model results. Below, we will address the issue of multicollinearity by conducting linear regressions of each explanatory variable on the dependent variable. This will provide the coefficient of determination R2 for different models, as shown in Table 2.

Table 2: Linear Regression Results of Explanatory Variables on Dependent Variable.

Variable	R^2
GDP	0.095563
AS	0.257123
PTI	0.024302
PCE	0.108195
NUI	0.015320
NEI	0.000010

Based on the coefficient of determination results in Table 2, the variables will be gradually added to the regression model. Following the criterion of minimizing the AIC, the final model includes the explanatory variables: average urban employment salary (AS), regional GDP (GDP), the proportion of the tertiary industry (PTI), and the number of recipients of unemployment insurance for residents (NUI). The regression results of the corrected model are shown in Table 3.

Therefore, the corrected multiple regression model is as follows:

$$lnBD = 32.707 - 3.410lnAS - 0.672lnGDP + 3.272lnPTI + 0.366lnNUI$$

Table 3: Regression Results of the Corrected Model.

Variable	Coefficient	Prob.
C	32.70687	0.000000

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Table 3: (continued).

AS	-3.410106	0.000000
GDP	-0.672077	0.000500
PTI	3.272313	0.003900
NUI	0.365527	0.009100

2. Heteroscedasticity Test

The White test is used to determine whether there is heteroscedasticity in the model. Partial results are shown in Table 4.

Based on the results of the White test in Table 4, $nR2 = 22.852$. According to the White test, at the $\alpha = 0.05$ level, the critical value from the chi-square distribution table is $X^2_{0.05}(14)= 23.685$. By comparing the calculated X^2 test statistic with the critical value, we accept the null hypothesis and reject the alternative hypothesis. Additionally, since the p-value corresponding to nR^2 is greater than 0.05, it can also be concluded that there is no heteroscedasticity in the model.

Table 4: White Test Results.

F-statistic	3.205068	Prob. F (14,41)	0.0141
Obs*R-squared	22.85161	Prob. Chi-Square (14)	0.0627
Scaled explained SS	15.85290	Prob. Chi-Square (14)	0.3224

3. Serial Correlation Test

The coefficient of determination R^2 for this regression equation is 0.677, indicating a good model fit. Furthermore, all four variables have passed the T-test, indicating their significance in the regression. For a sample size of 31 and a significance level of 5%, and considering a model with 4 explanatory variables, consulting the DW statistic table, it is found that d_L=1.160 and d_U=1.735. The DW value for the model is 1.829. Based on the analysis, the DW value falls within the range of (dU, 4-dU), which is between 1.735 and 2.265. Therefore, the null hypothesis H0 is accepted, indicating that the equation is not autocorrelated. This indicates that the model results are valid and further analysis can be conducted.

(4) Model Empirical Results

According to the regression results of the model, the coefficients between the proportion of the tertiary industry and the number of recipients of unemployment insurance benefits and the non-performing loan ratio are positive, indicating that both factors have a positive impact on non-performing loans. According to the dimensionless regression results, for every one unit increase in the proportion of the tertiary industry, the non-performing loan ratio of commercial banks will increase by 3.272 units. For every one unit increase in the number of recipients of unemployment insurance benefits, the non-performing loan ratio of commercial banks will increase by 0.366 units. In 2022, due to the impact of the COVID-19 pandemic, regions with a higher proportion of the tertiary industry will be more strongly affected by the pandemic, leading to higher non-performing loan ratios in regions with a higher proportion of the tertiary industry. The number of recipients of unemployment insurance benefits reflects the living conditions of local residents. When their lives are affected, their ability to repay debts naturally decreases, resulting in an increase in the non-performing loan ratio.

The coefficients between the average salary of urban employees, the regional GDP, and the non-performing loan ratio are negative, indicating that both factors have a negative impact on non-performing loans. For every one unit increase in regional GDP, the non-performing loan ratio of

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commercial banks will decrease by 3.410 units. For every one unit increase in the average salary of urban employees, the non-performing loan ratio of commercial banks will decrease by 0.672 units. Both indicators reflect the development of the regional economy. In regions with better development, the living standards of residents improve, naturally reducing the possibility of non-performing loans.

In conclusion, all four variables are consistent with their practical significance. Overall, the average salary of urban employees has the greatest impact on the non-performing loan ratio, followed by the proportion of the tertiary industry, regional GDP, and the number of recipients of unemployment insurance benefits.

4. Conclusion and Recommendations

(1) Conclusion

1. The proportion of the tertiary industry has a positive impact on the non-performing loan ratio of commercial banks. Generally, the higher the proportion of the tertiary industry, the higher the non-performing loan ratio of commercial banks.

2. The number of recipients of unemployment insurance benefits has a positive impact on the non-performing loan ratio of commercial banks. Generally, the higher the number of recipients of unemployment insurance benefits, the higher the non-performing loan ratio of commercial banks.

3. The average salary of urban employees has a negative impact on the non-performing loan ratio of commercial banks. Generally, the higher the average salary of urban employees, the lower the non-performing loan ratio of commercial banks.

4. Regional GDP has a negative impact on the non-performing loan ratio of commercial banks. Generally, the higher the regional GDP, the lower the non-performing loan ratio of commercial banks.

(2) Recommendations

1. Optimize industrial structure and improve loan structure

Local governments should accelerate the upgrading of the industrial structure in their regions, optimize the industrial structure, promote the transformation and upgrading of traditional industries and manufacturing industries, support the development of local emerging industries and industries with local characteristics, attract high-tech industries, and control the proportion of the tertiary industry reasonably. Play a regulatory role, establish a platform for enterprise experience exchange, and provide financial support to enterprises. While complying with macroeconomic policies, commercial banks should optimize their loan approval system, actively provide financial support to small and medium-sized enterprises, optimize the structure of fund allocation, and reduce the possibility of non-performing loans.

2. Promote coordinated economic development and increase regional GDP

The level of regional economic development is an important factor affecting the development of the banking industry. Provincial governments in economically backward regions should learn from the development paths of developed regions, adapt measures to local conditions, attract investment, stimulate consumption, broaden import and export trade, and vigorously develop the regional economy. Improve the income distribution system, ensure the reasonableness of income levels in various industries, and thereby increase the local employment rate and per capita salary level. Pay attention to macroeconomic indicators in the local area, formulate corresponding financial regulatory policies, and ensure the standardized and efficient development of the banking industry.

3. Improve the financial regulatory system and establish risk prevention mechanisms

Different levels of regional economic development require different regulatory goals. Local governments should formulate reasonable financial regulatory goals based on actual conditions, reduce stock and control increment. Commercial banks should adapt to the trend of interest rate marketization, accelerate business transformation, increase investment in financial technology, improve service efficiency and quality, reduce dependence on loans as the main source of profit,

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develop diversified sources of profit, and reduce the risk of non-performing loans caused by the pressure of loan profitability.

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