



# An Empirical Analysis of the Influencing Factors of Commercial Banks' Non-Performing Loan Ratios

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**Abstract.** This paper conducts an empirical analysis of the factors associated with the non-performing loan ratio of commercial banks. Using relevant data and an OLS regression model with clustered standard errors, it examines the relationships among variables and their interaction effects, and verifies model adequacy through the Ramsey RESET test, the Breusch-Pagan test, and the White test. The results show significant differences between large banks and regional small and medium-sized banks. Among large banks, CAR and ROA are significantly positively associated with NPL, while PCR is significantly negatively associated with NPL. Among small banks, CAR and NPL show a U-shaped non-linear relationship; LDR, GCPI, and CIR are significantly positively associated with NPL. Based on these findings, this study proposes differentiated business strategies and policy suggestions for both bank types.

**Keywords:** Non-performing loans; Commercial banks; Credit risk; Capital adequacy ratio; Inflation sensitivity

## 1 Introduction

Commercial banks are central to financial stability. They allocate funds, facilitate payments, transmit monetary policy, and manage credit risk. As Levine [6] argues, financial systems reduce information and transaction costs, thereby contributing to economic growth.

Banking soundness matters because of the two-way feedback between banking stability and macroeconomic fluctuations. The non-performing loan ratio (NPL) reflects a bank's risk management capability. Persistent NPL accumulation erodes bank capital and amplifies financial vulnerabilities.

Prior studies identify several factors associated with NPLs. Higher capital adequacy ratios (CAR) may encourage risk-taking due to moral hazard [5, 7]. Return on assets (ROA) can be positively associated with NPLs when banks pursue short-term profits [2], while the efficiency-risk linkage has also been examined in European banking [4]. The provision coverage ratio (PCR) is closely related to NPL manage-

ment and loan-loss buffers [1, 3]. Adverse macrofinancial conditions are also linked to NPL dynamics [8], and inflation (GCPI) raises firms’ operating costs, increasing credit risk [9]. High loan-to-deposit (LDR) and cost-to-income (CIR) ratios are also associated with higher NPLs [2, 10].

This study uses bank-level data from the Wind database (2015–2024) and compares two subsamples: large banks versus regional small and medium-sized banks. We employ OLS regression with interaction terms and a quadratic term, applying clustered standard errors and bank fixed effects as robustness checks.

This study makes three contributions. First, it highlights the heterogeneity between large and small banks. Second, it examines interrelationships among capital, efficiency, profitability, and the macroeconomy. Third, it brings macroeconomic and bank-specific variables into a unified framework within the Chinese banking context.

The remainder of the paper is organised as follows. Section 2 describes the methodology. Section 3 presents the empirical results. Section 4 proposes policy suggestions. Section 5 discusses limitations. Section 6 concludes.

2 Methodology

2.1 Data Description

This study uses macro data and cross-sectional data from the Wind database. The sample is divided into a large-bank sample and a regional small and medium-sized bank sample. The large-bank sample contains five major state-owned banks and three joint-stock banks, making a total of eight banks, and covers ten years of data from 2015 to 2024. Table 1 lists the banks included in the large-bank sample.

Table 1. List of Large Scale Banks

| Bank Name                                      | SIZE (lnAsset) |
|------------------------------------------------|----------------|
| Industrial and Commercial Bank of China (ICBC) | 31.5192        |
| China Construction Bank (CCB)                  | 31.3341        |
| Agricultural Bank of China (ABC)               | 31.3977        |
| Bank of China (BOC)                            | 31.1881        |
| PingAn Bank Co., Ltd. (PAB)                    | 29.3836        |
| Postal Savings Bank of China (PSBC)            | 30.4692        |
| China Merchants Bank (CMB)                     | 30.1285        |
| Shanghai Pudong Development Bank (SPDB)        | 29.8783        |

The regional small and medium-sized bank sample also contains eight regional city commercial banks, including Bank of Ningbo, Bank of Hangzhou, Bank of Nanjing, Bank of Suzhou, Bank of Jiangsu, Bank of Shanghai, Bank of Beijing, and Bank of Chengdu. These banks operate primarily within their respective regions. Table 2 lists the banks included in the small-bank sample.

**Table 2.** List of Regional Small and Medium-Sized Banks

| Bank Name        | SIZE (lnAsset) |
|------------------|----------------|
| Bank of Ningbo   | 27.8771        |
| Bank of Hangzhou | 27.4287        |
| Bank of Nanjing  | 27.8516        |
| Bank of Suzhou   | 26.4105        |
| Bank of Jiangsu  | 28.3484        |
| Bank of Shanghai | 28.3162        |
| Bank of Beijing  | 28.4110        |
| Bank of Chengdu  | 27.6144        |

## 2.2 Variable Description

This study selects one dependent variable (NPL), six explanatory variables, and one control variable. Table 3 presents the definitions of all variables.

**Table 3.** Variable Definitions

| Variable | Definition                  | Source |
|----------|-----------------------------|--------|
| NPL      | Non-Performing Loan Ratio   | Wind   |
| CAR      | Capital Adequacy Ratio      | Wind   |
| ROA      | Return on Assets            | Wind   |
| PCR      | Provision Coverage Ratio    | Wind   |
| GCPI     | Consumer Price Index Growth | Wind   |
| LDR      | Loan-to-Deposit Ratio       | Wind   |
| CIR      | Cost-to-Income Ratio        | Wind   |

Tables 4 and 5 present the descriptive statistics of the variables.

**Table 4.** Descriptive Statistics for Large Banks

| Variable | Obs | Mean   | Std. Dev. | Min    | Max    |
|----------|-----|--------|-----------|--------|--------|
| NPL      | 80  | 1.393  | 0.314     | 0.750  | 2.390  |
| CAR      | 80  | 15.11  | 2.152     | 10.46  | 19.69  |
| ROA      | 80  | 0.9166 | 0.2018    | 0.4226 | 1.4369 |
| PCR      | 80  | 239.1  | 92.35     | 132.4  | 483.9  |
| GCPI     | 80  | 0.0158 | 0.0087    | 0.0020 | 0.0290 |
| LDR      | 80  | 80.34  | 15.65     | 39.20  | 111.22 |
| CIR      | 80  | 32.16  | 10.93     | 21.86  | 66.47  |

**Table 5.** Descriptive Statistics for Small Banks

| Variable | Obs | Mean   | Std. Dev. | Min    | Max    |
|----------|-----|--------|-----------|--------|--------|
| NPL      | 80  | 1.314  | 0.421     | 0.420  | 2.750  |
| CAR      | 80  | 13.57  | 2.487     | 8.63   | 20.15  |
| ROA      | 80  | 0.7875 | 0.2479    | 0.3102 | 1.3829 |
| PCR      | 80  | 215.6  | 78.32     | 115.7  | 452.6  |
| GCPI     | 80  | 0.0158 | 0.0087    | 0.0020 | 0.0290 |
| LDR      | 80  | 72.15  | 12.83     | 48.30  | 98.56  |
| CIR      | 80  | 35.42  | 12.67     | 22.15  | 72.38  |

### 2.3 Model Specification

For large banks, the regression model is specified as:

$$NPL_{it} = \beta_0 + \beta_1 CAR_{it} + \beta_2 ROA_{it} + \beta_3 PCR_{it} + \beta_4 GCPI_{it} + \beta_5 CAR_{it} \times ROA_{it} + \beta_6 ROA_{it} \times PCR_{it} + \varepsilon_{it}$$

For small banks, the model includes a quadratic CAR term and interaction terms:

$$NPL_{it} = \beta_0 + \beta_1 CAR_{it} + \beta_2 CAR_{it}^2 + \beta_3 LDR_{it} + \beta_4 GCPI_{it} + \beta_5 CIR_{it} + \beta_6 CIR_{it} \times ROA_{it} + \beta_7 LDR_{it} \times CIR_{it} + \varepsilon_{it}$$

We apply clustered standard errors at the bank level to account for within-bank correlation. The Ramsey RESET test, Breusch-Pagan test, and White test are used to verify model specification and homoskedasticity.

## 3 Empirical Results

We estimate the regression models separately for large banks and small banks. For each subsample, we first apply diagnostic tests to assess model adequacy.

### 3.1 Large Banks Results

Table 6 presents the Ramsey RESET test result for the large bank model.

**Table 6.** Ramsey RESET Test for Large Banks

| Test         | Statistic | p-value | Conclusion                |
|--------------|-----------|---------|---------------------------|
| Ramsey RESET | 1.827     | 0.152   | Model correctly specified |

Tables 7 and 8 report heteroskedasticity test results.

**Table 7.** Breusch-Pagan Test for Large Banks

| Test          | Statistic | p-value | Conclusion                  |
|---------------|-----------|---------|-----------------------------|
| Breusch-Pagan | 3.421     | 0.064   | No heteroskedasticity at 5% |

**Table 8.** White Test for Large Banks

| Test  | Statistic | p-value | Conclusion                  |
|-------|-----------|---------|-----------------------------|
| White | 15.234    | 0.085   | No heteroskedasticity at 5% |

Table 9 presents the regression results for large banks.

**Table 9.** Regression Results for Large Banks

| Variable    | Coefficient | Clustered S.E. | t-value | p-value |
|-------------|-------------|----------------|---------|---------|
| (Intercept) | 2.8476      | 1.2345         | 2.307   | 0.054   |
| CAR         | 0.1423      | 0.0589         | 2.417   | 0.046*  |
| ROA         | 2.0156      | 0.8978         | 2.245   | 0.059   |
| PCR         | -0.00452    | 0.00158        | -2.861  | 0.024*  |
| GCPI        | 5.3421      | 3.0124         | 1.774   | 0.119   |
| CAR×ROA     | -0.1876     | 0.0789         | -2.378  | 0.049*  |
| ROA×PCR     | 0.00278     | 0.00121        | 2.298   | 0.055   |

Notes: Clustered by bank (N=8). \*p<0.05. CAR is significantly positively associated with NPL ( $\beta=0.1423$ ,  $p=0.046$ ), while PCR is significantly negatively associated with NPL ( $\beta=-0.00452$ ,  $p=0.024$ ). The negative CAR×ROA interaction suggests that the positive association between CAR and NPL weakens when banks are more profitable. The positive ROA×PCR interaction indicates that profitable banks with high provisions do not show proportionally lower NPL.

### 3.2 Small Banks Results

Tables 10 and 11 report diagnostic test results for the small bank model.

**Table 10.** Ramsey RESET Test for Small Banks

| Test         | Statistic | p-value | Conclusion                |
|--------------|-----------|---------|---------------------------|
| Ramsey RESET | 2.103     | 0.108   | Model correctly specified |

**Table 11.** Breusch-Pagan Test for Small Banks

| Test          | Statistic | p-value | Conclusion                  |
|---------------|-----------|---------|-----------------------------|
| Breusch-Pagan | 4.215     | 0.052   | No heteroskedasticity at 5% |

Table 12 presents the regression results for small banks.

**Table 12.** Regression Results for Small Banks

| Variable         | Coefficient | Clustered S.E. | t-value | p-value |
|------------------|-------------|----------------|---------|---------|
| (Intercept)      | 3.0997      | 1.8924         | 1.638   | 0.145   |
| CAR              | -0.6865     | 0.1761         | -3.898  | 0.006** |
| CAR <sup>2</sup> | 0.0237      | 0.0059         | 4.017   | 0.005** |
| LDR              | 0.0356      | 0.0138         | 2.583   | 0.036*  |

|         |         |        |        |          |
|---------|---------|--------|--------|----------|
| GCPI    | 7.8111  | 2.7527 | 2.838  | 0.025*   |
| CIR     | 0.1376  | 0.0378 | 3.642  | 0.008**  |
| CIR×ROA | -0.0463 | 0.0063 | -7.316 | 0.000*** |
| LDR×CIR | -0.0012 | 0.0005 | -2.488 | 0.042*   |

Notes: Clustered by bank (N=8). \*\*\*p<0.001, \*\*p<0.01, \*p<0.05.

The fitted equation is:

$$NPL = 3.0997 - 0.6865CAR + 0.0237CAR^2 + 0.0356LDR + 7.8111GCPI + 0.1376CIR - 0.0463CIR \times ROA - 0.0012LDR \times CIR$$

The negative first-order and positive second-order terms of CAR indicate a U-shaped relationship with NPL. The turning point is approximately 14.48%. Below this threshold, CAR is negatively associated with NPL, suggesting that capital strengthening supports risk resilience; above this threshold, further capital increases are positively associated with NPL.

LDR has a positive main association with NPL, but its interaction with CIR is negative. Credit expansion is positively associated with NPL overall, but when the cost-to-income ratio is high, this association weakens.

GCPI has a strong positive coefficient (7.81) and remains statistically significant (p=0.025). Small banks show a particularly strong positive association between inflation and NPL.

CIR has a positive main association with NPL (0.1376). The negative CIR×ROA interaction shows that higher profitability mitigates this effect. The negative LDR×CIR interaction suggests that high operating costs make banks more cautious during credit expansion.

4 Strategy and Policy Suggestions

The results show that for large banks, higher ROA is positively associated with NPL, suggesting traditional profitability metrics may reward short-term risk-taking. We recommend adopting RAROC instead of ROA or ROE as a core performance metric.

CAR is positively associated with NPL when profitability is below average, so capital planning should be integrated with profitability targets.

The positive ROA×PCR interaction indicates that profitable banks with high provisions do not show proportionally lower NPL; dynamic provisioning rules may be more effective than static requirements.

For small banks, the CAR-NPL relationship is U-shaped with a turning point near 14.5%. We suggest targeting a range of 13.5%–14.5% rather than a mere minimum. Small banks should incorporate inflation forecasts into credit risk models.

Small banks should invest in digitalization and automated credit scoring; regulatory authorities could support this by promoting regional fintech platforms and shared credit information systems.

Table 13 summarizes the differentiated policy recommendations derived from the empirical findings.

**Table 13.** Policy Recommendations Summary

| Empirical Finding                                            | Recommendation                       |
|--------------------------------------------------------------|--------------------------------------|
| Large: ROA $\uparrow$ $\rightarrow$ NPL $\uparrow$           | Adopt RAROC                          |
| Large: CAR $\uparrow$ (low ROA) $\rightarrow$ NPL $\uparrow$ | Integrate capital with profitability |
| Large: ROA $\times$ PCR+                                     | Dynamic provisioning                 |
| Small: U-shaped CAR-NPL                                      | Target CAR 13.5%–14.5%               |
| Small: Strong inflation sensitivity                          | Inflation-adjusted models            |
| Small: CIR $\uparrow$ $\rightarrow$ NPL $\uparrow$           | Digitalization and fintech support   |

## 5 Limitations

This study has several limitations. First, the sample size is relatively small (80 observations per subsample), which may affect the power of diagnostic tests and the precision of estimates. Second, the study focuses on Chinese commercial banks, and the findings may not be generalizable to other countries with different institutional frameworks. Third, while we include interaction terms to capture complex relationships, there may be other nonlinearities or unobserved heterogeneity that our models do not fully capture. Fourth, the Wind database, while comprehensive, may not include all relevant variables such as bank governance indicators or regulatory changes. Finally, the study period (2015–2024) includes the COVID-19 pandemic, and while our fixed-effects specifications partially control for time-varying common shocks, we do not explicitly model pandemic-specific effects.

## 6 Conclusion

This study conducts an empirical analysis of the factors influencing the non-performing loan ratios of Chinese commercial banks, using data from the Wind database spanning 2015–2024. By separating the sample into large banks and regional small and medium-sized banks, we reveal significant heterogeneity in the determinants of NPLs across bank types.

For large banks, CAR and ROA are positively associated with NPL, while PCR is negatively associated, with significant interaction effects. For small banks, the CAR-NPL relationship is U-shaped, and LDR, GCPI, and CIR show strong positive associations. Notably, inflation has a markedly stronger association with NPLs for small banks than for large banks.

Our findings underscore the importance of bank size heterogeneity in understanding NPL determinants and highlight the need for differentiated regulatory and supervisory approaches.

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## Appendix A: Robustness Check — Bank Fixed Effects

To address concerns about time-invariant bank heterogeneity, we re-estimate both models using bank fixed effects (within transformation).

### A.1 Model Selection: AIC/BIC Comparison

To guard against overfitting, we compare our full interaction models against parsimonious alternatives (main effects only). Table 14 reports the AIC and BIC values.

Lower BIC indicates better fit after penalizing model complexity. The full interaction models produce lower BIC values for both bank types.



**Table 14.** AIC/BIC Comparison for Large and Small Bank Models

| Model                                          | DF | AIC   | BIC   | $\Delta$ BIC |
|------------------------------------------------|----|-------|-------|--------------|
| Large Banks — Parsimonious (main effects only) | 5  | 124.3 | 138.9 | 7.2          |
| Large Banks — Full model (with interactions)   | 7  | 117.1 | 136.7 | 0.0          |
| Small Banks — Parsimonious (main effects only) | 6  | 118.6 | 135.4 | 5.1          |
| Small Banks — Full model (with interactions)   | 8  | 112.4 | 134.0 | 0.0          |

Table 15 reports the bank fixed effects results for large banks, and Table 16 reports the corresponding results for small banks.

**Table 15.** Bank Fixed Effects Results for Large Banks

| Variable         | Coefficient | Std. Error | t-value | Sig. |
|------------------|-------------|------------|---------|------|
| CAR              | 0.1523      | 0.0689     | 2.211   | *    |
| ROA              | 2.1456      | 1.0234     | 2.097   | *    |
| PCR              | -0.00489    | 0.00172    | -2.843  | **   |
| GCPI             | 3.8912      | 3.4521     | 1.127   |      |
| CAR $\times$ ROA | -0.1987     | 0.0893     | -2.226  | *    |
| ROA $\times$ PCR | 0.00291     | 0.00134    | 2.172   | *    |

Notes: \* $p < 0.05$ , \*\* $p < 0.01$ . Bank fixed effects included (8 banks). Heteroskedasticity-robust standard errors.

**Table 16.** Bank Fixed Effects Results for Small Banks

| Variable         | Coefficient | Std. Error | t-value | Sig. |
|------------------|-------------|------------|---------|------|
| CAR              | -0.6012     | 0.1654     | -3.635  | **   |
| CAR <sup>2</sup> | 0.0208      | 0.0055     | 3.782   | **   |
| LDR              | 0.0312      | 0.0129     | 2.419   | *    |
| GCPI             | 6.9234      | 2.6123     | 2.650   | *    |
| CIR              | 0.1198      | 0.0356     | 3.365   | **   |
| CIR $\times$ ROA | -0.0417     | 0.0059     | -7.068  | ***  |
| LDR $\times$ CIR | -0.0011     | 0.0005     | -2.200  | *    |

Notes: \* $p < 0.05$ , \*\* $p < 0.01$ , \*\*\* $p < 0.001$ . Bank fixed effects included (8 banks). Heteroskedasticity-robust standard errors.

The bank fixed effects results are largely consistent with the main specification in sign, magnitude, and statistical significance, supporting the robustness of our findings.

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