Journal of Economics and Management Sciences; Vol. 8, No. 2; 2025
ISSN 2576-3008 E-ISSN 2576-3016
https://doi.org/10.30560/jems.v8n2p218

# Impact of the Real Estate Climate Index on the Non-performing Loan Ratio of Commercial Banks

Siyu Liu[1]

[1] Liaoning University, China

Correspondence: Siyu Liu, Liaoning University, Shenyang, Liaoning, China.

Received: April 18, 2025; Accepted: April 28, 2025; Published: April 29, 2025

**Abstract**

The 20th National Congress of the Communist Party of China emphasized the imperative to enhance the financial stability safeguard system. Given the pivotal role of commercial banks in China's financial architecture, effectively managing their non-performing loan ratio proves crucial for sustaining financial and economic stability. This study uses panel data from 2007 to 2022 for empirical analysis. It explores the significant positive link between the real estate climate index and the non - performing loan ratio of commercial banks, showing that the real estate boom worsens systemic credit risk.Heterogeneity analysis reveals this effect manifests more prominently in state-owned commercial banks. Furthermore, capital regulation has a mitigating effect on the positive relationship between the index and the ratio of non-performing loans.These empirical findings highlight the importance of targeted regulatory measures and enhanced real estate market monitoring, providing theoretical and policy insights for optimizing financial risk governance frameworks.

**Keywords:** real estate climate index, non-performing loan ratio, commercial bank credit risk

## 1. Introduction

The report of the 20th National Congress of the Communist Party of China explicitly emphasizes the need to "deepen financial system reforms, strengthen and modernize financial regulation, enhance the financial stability safeguard system, and firmly hold the bottom line against systemic risks." As the dominant component of China's financial system, commercial banks' risk prevention capabilities directly determine the effectiveness of financial reforms. Notably, according to the Core Regulatory Indicators for Commercial Bank Risks (Provisional) issued by the China Banking Regulatory Commission, the non-performing loan ratio has been formally established as a pivotal regulatory metric for assessing commercial bank risks. Reducing NPL ratios has thus become a critical task in advancing financial reforms.From a comparative perspective, Western developed countries have accumulated mature regulatory practices in managing commercial banks' NPL ratio, whereas China's commercial banks continue to grapple with elevated NPL levels. Operating within an indirect financing-dominated system, Chinese commercial banks maintain a dominant position in credit allocation. As Cao Dongpo (2019)[1] revealed, by July 2020, commercial banks' total loan portfolio had reached 185.72 trillion yuan, accounting for 67.94% of aggregate social financing, demonstrating their pivotal role in national economic development. However, the substantial credit expansion masks structural vulnerabilities in risk management. As illustrated in Figure 1, the NPL ratio of commercial banks climbed persistently from 2014 to its peak of 1.92% in 2020. By the end of 2023, outstanding NPL balances remained at 3.4 trillion yuan—a decade-high level—with significant risk exposures observed in certain institutions, reflecting structural fragility in credit management practices.In 2021, the People's Bank of China emphasized the necessity to strengthen macroprudential policy coordination with national development plans, fiscal policies, industrial policies, and credit policies to enhance commercial banks' risk mitigation capacities. Effectively controlling NPL ratios carries dual strategic significance for safeguarding both financial market stability and macroeconomic performance. Therefore, reducing the non-performing loan ratio of commercial banks has become the core of maintaining the bottom line of systemic risk.

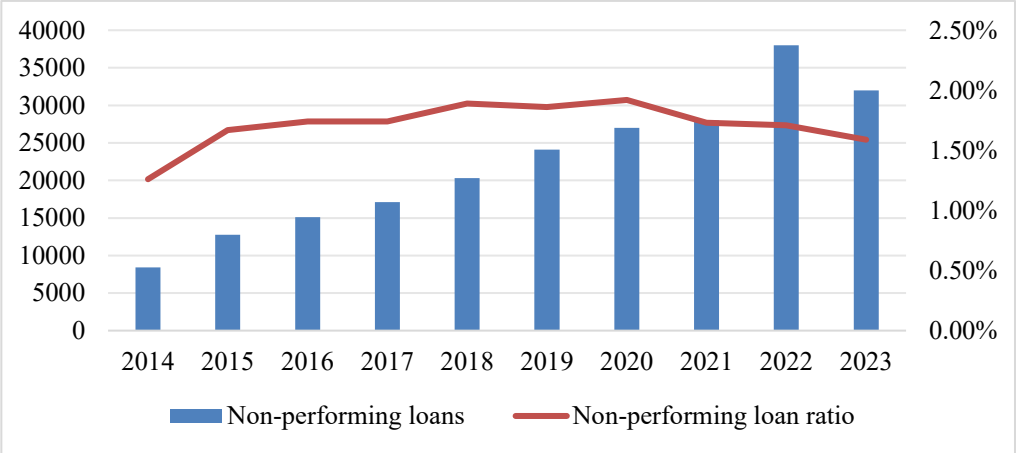


Figure 1. Non-performing loan amount and non-performing loan ratio of commercial banks

For an extended period, the governance of non-performing loan ratios in commercial banks has primarily relied on three approaches: government policy supervision (Barth et al., 1999)[2], internal financial institution controls (Wang Xi, 2011)[3], and market-driven regulatory mechanisms (Wu Qian, 2021)[4]. However, these traditional methods have gradually revealed multiple limitations in practice. On one hand, Tao Changgao (2005)[5] pointed out that risk transfer through credit asset securitization by financial institutions tends to breed financial bubbles and induce speculative behaviors. On the other hand, Ding Xin (2023)[6] demonstrated that while administrative intervention-dominated supervision can rapidly reduce NPL volumes, such rigid controls fail to address the structural imbalances in credit resource allocation.Existing research exhibits notable deficiencies, as most studies adopt fragmented single-perspective analyses. For instance, Zhang Hanbin (2010)[7] and Zhou Xia (2012)[8] separately examined the direct impacts of housing price fluctuations and policy interventions on NPL ratios, yet overlooked the comprehensive Real Estate Climate Index. Crucially, there remains an empirical research gap regarding RECI's influence on commercial banks' NPL ratios, which ultimately weakens the effectiveness of NPL governance frameworks. To address these limitations, this study proposes exploring more holistic solutions through capital market perspectives, particularly by incorporating RECI analysis to develop optimized NPL management strategies.

This study empirically examines the impact of the Real Estate Climate Index on the non-performing loan ratios of commercial banks using panel data from 42 listed commercial banks spanning 2007 to 2022. The conclusions remain robust after conducting rigorous tests, including adjustments to fixed-effects model specifications and addressing endogeneity concerns. Furthermore, heterogeneity analysis based on bank ownership types and moderating effect tests on capital supervision were performed. The heterogeneity analysis reveals that the positive influence of RECI on NPL ratios is more pronounced in state-owned banks, while the moderating effect tests demonstrate that capital supervision significantly mitigates the positive relationship between RECI and NPL ratios. These findings contribute to refining regulatory mechanisms in capital markets and provide actionable policy insights and empirical evidence for more effective governance of commercial banks' NPL ratios.

## 2. Literature Review

Non-performing loans in commercial banks refer to loans where borrowers fail to repay principal and interest as agreed, or where proceeds from collateral liquidation under legal procedures remain insufficient to cover obligations (Gao He, 2009)[9] As defined, NPLs degrade banks' asset quality (Jin Yu, 2017)[10] and directly erode profitability. The non-performing loan ratio refers to the proportion of the total amount of non-performing loans in the total balance of loans of commercial banks. According to the latest core indicators of risk supervision of commercial banks issued by China Banking Regulatory Commission, the non-performing loan ratio has become an important regulatory indicator reflecting the safety status of bank assets.Existing research primarily employs financial ratio analysis (Ohlson, 1980)[11] and multivariate discriminant models (Altman, 1995)[12] to measure NPLs, with Guo Xiaoqun (2010)[13] demonstrating that elevated NPL ratios reduce bank profitability while Zhang Jiazhen (2018)[14] links them to heightened systemic financial risks.Key determinants of NPL ratios span macroeconomic conditions, credit structure characteristics, and bank governance. At the macro level, Berge and Boye (2007)[15] identified economic recessions as NPL amplifiers, corroborated by Dimitrios (2012)[16] who quantified unemployment rate correlations. Zou Ke and Cai Xiaochun (2017)[17] further warned that rapid credit

expansion exacerbates NPL accumulation. Micro-level solutions include Hwan Shin (2016)[18], who advocated loan portfolio diversification, and Zhang Le (2016)[19], who demonstrated private capital infusion's governance benefits. Sector-specific risks emerge in Liu Yan (2014)[20], who identified real estate lending and interest rate volatility as critical risk sources. Recent empirical work by Su Sheng'an (2024)[21] revealed regional employment levels and wage growth indirectly curb NPLs through enhanced borrower repayment capacity.While these studies collectively clarify NPLs' conceptual boundaries, measurement approaches, and influencing factors, they suffer from fragmented single-indicator analyses.However, it is a pity that the existing literature is mostly based on a single index, which discusses how to deal with the non-performing loans of commercial banks in a one-sided and fragmented way. Almost no research pays attention to the impact of the real estate climate index, a systematic indicator of the capital market, on the non-performing loan ratio of commercial banks, thus providing an opportunity for this paper.

The Real Estate Climate Index is a composite index synthesized from eight sub-indices, designed to comprehensively reflect the developmental trends and fluctuations in the real estate sector (Zhang Hua, 2012)[22].RECI incorporates statistical indicators such as real estate development investment, annual funding sources, and land development area, encompassing leading, coincident, and lagging indicators. Existing research primarily examines RECI's economic impacts through two lenses: macroeconomic effects and capital market linkages. Regarding macroeconomic consequences, Hu Tao (2016)[23] demonstrated that RECI significantly influences macroeconomic prosperity, while Li Hongjuan (2014)[24] identified its predictive relationship with the Consumer Price Index. In capital market studies, Liu Ying (2020)[25] explored RECI's association with real estate corporate capital structures. However, no prior research systematically investigates RECI's causal linkage with commercial banks' non-performing loan ratios from a banking risk perspective, let alone examines the moderating effects of capital supervision mechanisms on this relationship.

The marginal contributions of this study lie in three aspects: First, it expands the research perspective on driving factors of commercial banks' non-performing loan ratios. Previous studies predominantly explored commercial banks' non-performing loan ratios through macro indicators like rising unemployment rates and micro indicators such as bank credit structure characteristics. This paper innovatively investigates commercial banks' non-performing loan ratios from a capital market perspective using the more systematic Real Estate Climate Index, representing a valuable extension to existing literature. Second, it enriches research on the economic effects of the Real Estate Climate Index. While existing literature has conducted preliminary explorations on its economic benefits, confirming its roles in enhancing macroeconomic prosperity effects, few studies have examined its impact on commercial banks' non-performing loan ratios from a risk prevention perspective. This paper addresses this gap by specifically analyzing the influence of the Real Estate Climate Index on commercial banks' non-performing loan ratios through a risk control lens. Third, it deepens practical scenarios of how the Real Estate Climate Index affects commercial banks' non-performing loans. Beyond studying the direct impact, this research conducts in-depth analyses through heterogeneity tests and moderating effects. Diverging from previous singular and fragmented analytical approaches, this study innovatively integrates the capital market sentiment-reflecting Real Estate Climate Index with capital regulation. By examining their interactive effects, it systematically reveals how capital regulation suppresses the Real Estate Climate Index's effect on elevating commercial banks' non-performing loan ratios, thereby providing more targeted policy references for reducing commercial banks' non-performing loan ratios.

## 3. Research Hypotheses

1) Impact of the Real Estate Climate Index on commercial banks'non-performing loan ratios

First, from the perspective of bank self-interest, when the Real Estate Climate Index reaches historically high levels, indicating a prosperous phase in the real estate market, commercial banks tend to relax credit standards (Charles P. Kindleberger, 1978&Boris Hofmann, 2003)[26][27] and expand credit supply to the real estate sector. On one hand, banks may lower due diligence requirements for real estate development loans and mortgage loans to pursue higher returns (Hongwei Wang, 2013)[28]. On the other hand, they may overestimate the value of collateral, excessively relying on real estate as security while neglecting borrowers' actual repayment capacity (Ding Shao, 2005)[29]. Such loosening of credit standards could degrade loan quality, leading to a future rise in non-performing loan ratios (Lingling Mou, 2013)[30].Se-cond, from a risk identification perspective, the prosperity of the real estate market may obscure operational risks within real estate firms. During market booms, superficially robust financial performance and cash flow visibility can mask internal governance weaknesses and structural financial imbalances (Xiangyun Liu, 2018)[31], making it difficult for banks to identify latent risks during credit approval, thereby increasing NPLs.Finally, at the corporate level, a sustained high RECI may fuel market overheating and speculative demand, creating bubble-like conditions in the real estate sector (Yanyan Jia,

2024)[32]. In such scenarios, collateral values for development and mortgage loans could sharply depreciate, while borrowers'repayment capacities fail to adjust accordingly, driving up NPL ratios (Ruyong Chen, 2000)[33]. Over-optimism about market demand and financial resilience may incentivize developers to overleverage, exposing them to liquidity crises if financing conditions tighten and resulting in debt defaults that elevate banks'NPL ratios (Tingyang Sun, 2019)[34].To test whether the RECI exerts a positive influence on commercial banks' credit risk, this study proposes:

H1: The Real Estate Climate Index has a positive impact on commercial banks' non-performing loan ratios.

2) Differential effects of the Real Estate Climate Index on commercial banks'non-performing loan ratios across bank ownership types

State-owned banks and non-state-owned banks exhibit significant differences in real estate business exposure, risk preferences, and policy responsiveness. First, state-owned banks typically hold a larger share of real estate-related business. Due to their substantial capital reserves and lower financing costs, they exhibit significant advantages in sectors such as real estate development loans and residential mortgage lending (Fei Han, 2022)[35]. However, this concentrated exposure amplifies their vulnerability to non-performing loans in real estate.Second, state-owned banks prioritize policy-driven mandates over core financial objectives. Jun Xu (2025)[36] argues that an excessive focus on public policy functions may compromise their core responsibilities as financial institutions—profitability and risk management—leading to overreliance on government directives in loan allocation. Such policy-driven resource distribution could undermine financial health and capital returns, ultimately elevating NPL ratios. Additionally, state-owned banks often depend on implicit government bailouts during crises, fostering higher risk tolerance and preferential lending to strategically important sectors like real estate (Youchuan Xu, 2019)[37], further increasing their NPLs.Finally, state-owned banks demonstrate heightened policy responsiveness due to executive incentives. Senior executives in state-owned banks, typically appointed by government agencies, face greater political promotion pressures (Qi Wei, 2020)[38]. This dynamic incentivizes stronger alignment with policy signals during real estate market booms, driving excessive lending when the Real Estate Climate Index rises.In contrast, non-state-owned banks operate with greater market discipline, stronger risk diversification capabilities, and no expectations of government bailouts. Their lower sensitivity to real estate market fluctuations may insulate them from RECI-driven NPL risks.Based on these distinctions, this study proposes:

H2: The positive impact of the Real Estate Climate Index on non-performing loan ratios is more pronounced for state-owned banks compared to non-state-owned banks.

3) Moderating role of capital regulation in the RECI-NPL relationship

On one hand, from the perspective of the denominator effect of capital adequacy ratios, under the constraint of a fixed capital base, the expansion of risk-weighted assets reduces capital adequacy.Wang Zheqi(2025)[39] posits that capital regulation constrains commercial banks'credit supply through this denominator effect, thereby mitigating the impact of the Real Estate Climate Index on banks' non-performing loan ratios. Specifically, when a rising RECI incentivizes banks to expand real estate credit, regulatory capital requirements limit the growth of risk-weighted assets, reducing the likelihood of such loans deteriorating into NPLs.On the other hand, the deterrent effect of capital regulation reinforces this mechanism.Chen Tianxin (2021)[40] proposes the risk absorption hypothesis of capital buffers, suggesting that banks with higher capital buffers can absorb potential losses and reduce risk perception during economic policy uncertainty. However, when the RECI remains elevated, well-capitalized banks face stricter capital constraints, compelling them to adopt prudent lending practices—such as restricting credit to highly leveraged developers and tightening collateral valuation standards—which counteracts the RECI's upward pressure on NPL ratios.Thus, capital regulation may serve as a critical moderating factor in the relationship between real estate market conditions and bank risk. This study proposes:

H3: Capital regulation weakens the positive impact of the National Real Estate Climate Index on commercial banks' non-performing loan ratios

## 4. Research Design

### *4.1 Variable Description*

The dependent variable in this paper is the risk of commercial banks. In existing research literature, the risk of commercial banks is generally analyzed using two indicators: the non-performing loan ratio and Z-value. The Z-value reflects risk by measuring the probability of bank bankruptcy, but its calculation relies on data such as equity market value. Considering that Chinese commercial banks are influenced by implicit government guarantees, using the Z-value makes it difficult to measure the operational risk of commercial banks, and Z-value data at the regional and bank type levels are hard to obtain (Ma Li, 2021)[41]. In contrast, the non-performing loan ratio is simpler to

calculate and is widely used in practical research, so this paper adopts the non-performing loan ratio as the dependent variable. A higher non-performing loan ratio indicates a larger proportion of loans that may not be recovered out of the total loans; a lower non-performing loan ratio suggests that the proportion of loans that financial institutions cannot recover out of the total loans is smaller.

The fluctuations in the real estate market significantly impact bank risks. This paper selects the National Housing Prosperity Index as the core explanatory variable for analyzing the trend of real estate economic volatility. This approach not only addresses the issue of one-sidedness associated with a single indicator but also avoids factors such as per capita income levels that can cause economic volatility, thus sidestepping the problem of uncorrelated causality in certain composite indicators (Qiu Zhaoxiang, 2009)[42]. The real estate climate index reflects the supply and demand dynamics and price fluctuations in the real estate market, making it an important indicator for analyzing the impact of the real estate sector on the financial system.

To eliminate the influence of other factors, this paper selects control variables from two aspects: individual bank factors and macro-environmental factors. At the individual bank level, based on the research of Cui Ruiwen (2023)[43] and other scholars, this paper selects four indicators from the perspectives of profitability, liquidity, and safety: loan-to-deposit ratio (LDR), return on equity (ROE), asset size (ASSETSIZE), and capital adequacy ratio (CAR). At the macro-environmental level, based on the research of Ma Li (2021) and other scholars, this paper selects two indicators: economic development level (GDPR) and money supply (M2). The measurement dimensions and definitions of each variable are shown in Table 1.

Table 1. Variable description

| VARIABLE CLASSES | MEASURE DIMENSIONS | QUANTITATIVE INDEX | VARIABLE-DEFINITION | VARIABLE SYMBOL |
|---|---|---|---|---|
| DEPENDENT VARIABLE | risk level | non-performing loan ratio | (substandard loans + doubtful loans + loss loans)/total loans | NP |
| EXPLANATORY VARIABLE | real estate industry boom | real estate climate index | reflect the real estate market prosperity | RECI |
| CONTROL VARIABLES | liquidity management ability | loan-to-deposit ratio | total loans/deposits | LDR |
| | profitability | return on equity | net profit of the current period ÷ [(net assets at the beginning of the period + net assets at the end of the period) / 2 + new net assets added by new shares issued or rights offering in the current period × (number of months from the end of the payment to the end of the reporting period-6) / 12] | ROE |
| | capital strength and anti-risk ability | asset size | take the logarithm of total assets | ASSETSIZE |
| | capital adequacy and financial soundness | capital adequacy ratio | net capital / total risk-weighted assets | CAR |
| | level of economic development | GDP growth rate by region | annual GDP growth rate of the province where the bank is registered | GDPR |
| | monetary policy | m2 | the monthly arithmetic average of money supply growth is used as a measure | M2 |

### *4.2 Sample Selection and Data Processing*

This study utilizes panel data from 42 listed commercial banks under the banking industry classification of the China Securities Regulatory Commission (CSMAR) from 2007 to 2022. After excluding one financial leasing company, the sample comprises 6 state-owned commercial banks, 9 national joint-stock banks, and 27 regional

commercial banks. Data for the Real Estate Climate Index and bank-level variables are sourced from the China Stock Market & Accounting Research Database (CSMAR).

To ensure regression accuracy and sample integrity, the following steps were applied:(1) Missing bank-specific data were manually supplemented by retrieving periodic reports from the official websites of the respective commercial banks.(2) Observations with irrecoverable missing data.(3) All continuous variables were winsorized at the top and bottom 1% to mitigate the influence of outliers.

*4.3 Model Constructions*

In order to test the impact of national housing prosperity on the risk of commercial banks, this paper constructs the following benchmark model:

$$NP_{i,t} = \alpha + \beta_1 \times RECI_{i,t} + \beta_2 \times LDR_{i,t} + \beta_3 \times ROE_{i,t} + \beta_4 \times ASSETSIZE_{i,t} + \beta_5 \times CAR_{i,t} + \beta_6 \times GDPR_{i,t} + \beta_7 \times M2_{i,t} + \mu_i + \delta_t + \varepsilon_{i,t} \quad (1)$$

Among them, NPi,t represents the credit risk level of bank i in the year t,RECIi,t represents the degree of national economic conditions,Xi,t represents the impact ofexcluding other factors on the actual results, introducing loan-to-deposit ratio (LDR), return on equity (ROE), asset size (ASSETSIZE), capital adequacy ratio (CAR), and other bank-level control variables, as well as GDP growth rate (GDPR), money supply (M2), and other macro-level control variables.

## 5. Empirical Analysis

*5.1 Descriptive Stats*

First, descriptive statistical analysis is conducted on each variable. From the perspective of non-performing loan ratios in commercial banks, the mean is 1.391%, indicating a relatively low overall non-performing loan ratio. However, the standard deviation of 0.809 suggests significant differences among banks. The maximum non-performing loan ratio reaches 6.06%, indicating severe credit risk in some banks. The gap in non-performing loan ratios among different banks is considerable, with fluctuations in credit risk levels. It is necessary to be vigilant about high-risk exposures in individual banks and promote further reduction in their non-performing loan ratios. The National Housing Prosperity Index has a minimum value of 93.34, a maximum value of 106.4, a mean of 99.16, and a standard deviation of 3.563. This indicates significant volatility in the National Housing Prosperity Index, suggesting room for improvement. The loan-to-deposit ratio has a mean of 70.98%, close to the liquidity regulatory ceiling (typically ≤75%). Some banks have a loan-to-deposit ratio as high as 109.5%, clearly indicating a liquidity crisis. The return on equity has a mean of 15.39% and a standard deviation of 5.515, indicating strong overall profitability in the industry but significant individual differences. After logarithmic processing, the asset scale ranges from 5.77 to 12.62, reflecting a sample covering large, medium, and small banks. Although the capital adequacy ratio meets regulatory requirements, the minimum value of 8.12% indicates severe capital shortages in some banks, which could exacerbate credit risks. The GDP growth rate ranges from 0.7% to 15.9%, covering both economic downturns and periods of rapid growth, with significant economic volatility. The money supply (M2) has a mean of 13.05% and a maximum value of 27. 68%, reflecting the degree of monetary policy easing, which may affect bank risk through liquidity.

Table 2. Descriptive statistics of each variable

| VARIABLES | (1)<br>N | (2)<br>MEAN | (3)<br>SD | (4)<br>MIN | (5)<br>MAX |
|---|---|---|---|---|---|
| NP | 624 | 1.3910 | 0.8090 | 0.3300 | 6.0600 |
| RECI | 624 | 99.1600 | 3.5630 | 93.3400 | 106.4000 |
| LDR | 624 | 70.9800 | 13.6200 | 32.3200 | 109.5000 |
| ROE | 624 | 15.3900 | 5.5150 | 5.7480 | 33.4700 |
| ASSETSIZE | 624 | 8.9470 | 1.8140 | 5.7700 | 12.6200 |
| CAR | 624 | 13.1500 | 2.0640 | 8.1200 | 19.7100 |
| GDPR | 624 | 8.2470 | 3.3030 | 0.7000 | 15.9000 |
| M2 | 624 | 13.0500 | 4.6770 | 8.1000 | 27.6800 |

*5.2 Benchmark Results*

Table 3. Benchmark regression results

| VARIABLES | (1)<br>NP |
|---|---|
| RECI | 0.0829** |
| | (0.0349) |
| LDR | 0.0209*** |
| | (0.0039) |
| ROE | -0.0197** |
| | (0.0079) |
| ASSETSIZE | -0.0043 |
| | (0.1350) |
| CAR | -0.0908*** |
| | (0.0178) |
| GDPR | 0.0027 |
| | (0.0272) |
| M2 | 0.1640*** |
| | (0.0407) |
| CONSTANT | -8.7910* |
| | (4.5100) |
| INDIVIDUAL FIXED EFFECTS | Yes |
| TIME FIXED EFFECTS | Yes |
| N | 624 |
| $R^2$ | 0.4020 |

Note: *, ** and *** indicate significance at the 10%,5% and 1% levels, respectively. Unless otherwise specified, the following tables are the same.

Column (1) of Table 3 reports the baseline regression results incorporating both entity and time fixed effects. The coefficient estimate for the core explanatory variable, the Real Estate Climate Index , is positive and statistically significant at the 5% level. Specifically, the RECI coefficient is 0.0829, indicating that a one-unit increase in the RECI corresponds to an average rise of 0.0829 percentage points in commercial banks'non-performing loan ratios, holding other factors constant. This validates Hypothesis H1, confirming that rising real estate market prosperity significantly amplifies credit risks for commercial banks. Elevated RECI levels reflect overheated market sentiment, which may spur reckless expansion of real estate investments, weaken banks'credit approval rigor and oversight, and ultimately increase risks in real estate-related lending, driving up NPL ratios.

In terms of controlling variables, from the bank level perspective, the coefficient estimate of the loan-to-deposit ratio (LDR) is positive at the 1% significance level, indicating that the higher the loan-to-deposit ratio, the weaker the liquidity management capability of commercial banks and the higher their risk levels. The coefficient estimate of the capital adequacy ratio (CAR) is negative at the 1% significance level, suggesting that banks with more adequate capital have lower non-performing loan ratios. The coefficient estimate of return on equity (ROE) is negative at the 5% significance level, indicating that an increase in return on equity significantly helps reduce the non-performing loan ratio of commercial banks. The relationship between asset size and non-performing loan ratio is not significant, indicating that changes in asset size do not affect the non-performing loan ratio. At the macroeconomic level, the coefficient estimate of money supply (M2) is positive at the 1% significance level, indicating that loose monetary policy will increase the non-performing loan ratio of commercial banks. The relationship between regional GDP growth rate and non-performing loan ratio is not significant, indicating that regional GDP growth rates do not impact the non-performing loan ratio.

*5.3 Robustness Test*

In order to verify the reliability of the research results, a number of robustness tests were carried out.First, replacing the dependent variable—bank non-performing loan ratios—with the absolute value of non-performing loans (NPL amounts) yielded a statistically significant RECI coefficient of 0.0438 at the 5% level (Column 1, Table 4), confirming the persistent positive impact of the National Real Estate Climate Index on credit risk. Second,

switching to a pooled OLS model produced a RECI coefficient of 0.0829, significant at the 5% level (Column 2, Table 4), consistent with the baseline results and further supporting their robustness. Third, adopting region-time interaction fixed effects instead of the original model specification resulted in a RECI coefficient of 0.5140, significant at the 5% level (Column 3, Table 4), reinforcing the conclusion that rising real estate market prosperity amplifies commercial banks' NPL ratios. Collectively, these tests confirm the stability and generalizability of the baseline findings under alternative specifications.

Table 4. Robustness test

| VARIABLES | (1) REPLACE THE EXPLAINED VARIABLE MODEL1 | (2) REPLACE THE MIXED OLS MODEL MODEL2 | (3) REPLACE THE FIXED EFFECT MODEL3 |
|---|---|---|---|
| RECI | 0.0438** | 0.0829** | 0.5140** |
| | (0.0205) | (0.0421) | (0.1910) |
| LDR | 0.0209*** | 0.0209*** | 0.0262*** |
| | (0.0025) | (0.0051) | (0.0071) |
| ROE | -0.0172** | -0.0197 | -0.0251 |
| | (0.0078) | (0.0164) | (0.0214) |
| ASSETSIZE | 0.9560*** | -0.0043 | 0.0297 |
| | (0.1120) | (0.2140) | (0.3720) |
| CAR | -0.0410*** | -0.0908*** | -0.0628** |
| | (0.0153) | (0.0278) | (0.0309) |
| GDPR | 0.0008 | 0.0027 | 0.4650** |
| | (0.0178) | (0.0359) | (0.1810) |
| M2 | 0.0882*** | 0.1640*** | 1.5030** |
| | (0.0287) | (0.0542) | (0.5930) |
| CONSTANT | -11.0100*** | -9.1980 | -69.3500*** |
| | (2.9900) | (5.8990) | (23.9000) |
| INDIVIDUAL FIXED EFFECTS | YES | YES | YES |
| TIME FIXED EFFECTS | YES | YES | YES |
| REGIONAL AND TEMPORAL EFFECTS | NO | NO | YES |
| N | 616 | 624 | 624 |
| $R^2$ | 0.9730 | 0.5010 | 0.7560 |

To address potential endogeneity concerns, this study employs an instrumental variable (IV) approach following Wang Hongqian(2017)[44], utilizing the lagged National Real Estate Climate Index (lag_RECI) as an instrument. The lagged RECI satisfies the relevance requirement as it is strongly correlated with the contemporary RECI (F-statistic = 32.8039 in the first-stage regression), exceeding the Stock-Yogo 10% critical threshold (16.38), thereby ruling out weak instrument issues. Theoretically, lagged RECI reflects historical market conditions and is unlikely to be directly influenced by current bank risk or correlated with contemporaneous error terms, fulfilling the exogeneity assumption. In the second-stage regression, the RECI coefficient remains positive and statistically significant at the 5% level, corroborating the robustness of the baseline findings even after mitigating endogeneity.

Table 5. Endogeneity test

| VARIABLES | (1) THE FIRST STAGE RECI | (2) THE SECOND STAGE NP |
|---|---|---|
| RECI | | 0.0905** |
| | | (0.0407) |
| LAG_RECI | 0.2140*** | |
| | (0.0373) | |
| LDR | 0.0063 | 0.0024 |
| | (0.0111) | (0.0027) |
| ROE | -0.2440*** | -0.0133 |

| | | |
|---|---|---|
| | (0.0326) | (0.0121) |
| ASSETSIZE | 0.2810*** | -0.0566*** |
| | (0.0816) | (0.0215) |
| CAR | 0.0492 | -0.0507*** |
| | (0.0725) | (0.0173) |
| GDPR | 0.3850*** | -0.0093 |
| | (0.0606) | (0.0222) |
| M2 | 0.0731** | -0.0049 |
| | (0.0323) | (0.0079) |
| CONSTANT | 73.5900*** | -6.2720* |
| | (3.7660) | (3.8040) |
| N | 582 | 582 |
| $R^2$ | 0.1780 | 0.0024 |

*5.4 Heterogeneity Analysis Based on Property Rights Nature*

Commercial banks with different ownership types exhibit divergent risk exposures to the National Real Estate Climate Index. Following the methodology of He Guosheng(2024) and Ding Jingwen(2024), the sample is stratified into state-owned and non-state-owned banks. Columns (1) and (2) of Table 6 report regression results for these subgroups. For state-owned banks, the RECI coefficient is positive and statistically significant at the 1% level, indicating that rising real estate market prosperity significantly elevates their non-performing loan ratios. In contrast, RECI has no statistically significant impact on NPL ratios for non-state-owned banks. This disparity arises because state-owned banks prioritize policy-driven mandates, concentrate credit exposure in the real estate sector, and face heightened risk accumulation due to implicit government guarantees. During real estate market booms, their risk controls may relax in alignment with policy directives, leading to excessive credit expansion. These findings confirm that state-owned banks, with their concentrated credit portfolios and policy sensitivity, are more vulnerable to real estate market fluctuations than non-state-owned banks, thereby validating Hypothesis H2.

Table 6. Heterogeneity test

| VARIABLES | (1)<br>STATE-OWNED BANK | (2)<br>NON-STATE BANKS |
|---|---|---|
| RECI | 0.1190*** | -0.1430 |
| | (0.0379) | (0.0889) |
| LDR | 0.0282*** | 0.0187*** |
| | (0.0050) | (0.0062) |
| ROE | -0.0132 | 0.0013 |
| | (0.0095) | (0.0147) |
| ASSETSIZE | -0.1360 | -0.1710 |
| | (0.1640) | (0.2490) |
| CAR | -0.0903*** | -0.0866*** |
| | (0.0205) | (0.0317) |
| GDPR | -0.0328 | 0.1830** |
| | (0.0275) | (0.0776) |
| M2 | 0.1790*** | 0.0089 |
| | (0.0480) | (0.0788) |
| CONSTANT | -11.5800** | 15.1800 |
| | (5.2440) | (10.3300) |
| INDIVIDUAL FIXED EFFECTS | Yes | Yes |
| TIME FIXED EFFECTS | Yes | Yes |
| N | 397 | 227 |
| $R^2$ | 0.5650 | 0.2390 |

*5.5 Analysis of the Regulatory Effect of Capital Supervision*

Drawing on the methodology of Zheqi Wang (2025), Table 7 demonstrates the moderating role of capital regulation. The coefficient estimate for the moderating variable, capital adequacy ratio (CAR), is negative and

statistically significant at the 1% level, indicating that higher capital adequacy reduces commercial banks' credit risk exposure. Critically, the interaction term RECI×CAR also exhibits a negative coefficient significant at the 1% level, confirming that capital regulation attenuates the amplifying effect of elevated National Real Estate Climate Index (RECI) on bank credit risk. Specifically, banks with higher CAR exhibit weaker positive correlations between RECI and NPL ratios. These results align with Hypothesis H3.The rationale is that capital regulation mandates banks to maintain minimum capital adequacy ratios, preventing unchecked credit expansion. Even during real estate market upswings, well-capitalized banks prioritize prudent lending practices—such as rigorous loan standards and collateral valuation—over short-term profit chasing, thereby mitigating NPL risks. By imposing capital constraints, regulatory frameworks curb irrational credit growth during market overheating, validating the effectiveness of capital regulation in countercyclical risk management.

Table 7. Analysis of moderating effects

| VARIABLES | (1)<br>NP |
|---|---|
| RECI×CAR | -0.0719*** |
| | (0.0247) |
| RECI | 0.2870** |
| | (0.1240) |
| LDR | 0.0198*** |
| | (0.0039) |
| ROE | -0.0194** |
| | (0.0078) |
| ASSETSIZE | 0.0255 |
| | (0.1350) |
| CAR | -0.1590*** |
| | (0.0378) |
| GDPR | 0.0094 |
| | (0.0271) |
| M2 | 0.1510*** |
| | (0.0406) |
| CONSTANT | -2.3040 |
| | (1.9100) |
| INDIVIDUAL FIXED EFFECTS | YES |
| TIME FIXED EFFECTS | YES |
| N | 624 |
| $R^2$ | 0.5080 |

## 6. Conclusion and Policy Implications

In Through the above analysis, this study draws the following conclusions:(1) Excessive prosperity in the real estate market significantly elevates bank credit risks, and this effect varies substantially across different banks.(2) Due to high credit concentration and strong policy orientation, state-owned banks are more vulnerable to real estate market fluctuations. The sensitivity of non-performing loan ratios in state-owned banks to the Real Estate Climate Index is significantly higher than that in non-state-owned banks.(3) Capital regulation can mitigate the positive impact of an overheated Real Estate Climate Index on bank credit risks.

Based on these conclusions, this study proposes the following policy implications:First, establish a dynamic monitoring and response mechanism for real estate credit risks.Commercial banks should develop a "Real Estate Climate Index (RECI) – Bank Credit" dynamic response system. When the RECI remains in the overheated zone (>100) for three consecutive months, real estate loan approval standards should be tightened. Additionally, commercial banks should implement differentiated credit quota management for real estate enterprises, creating a tiered credit management framework of "safe-warning-restricted" with hierarchical and differentiated evaluation criteria. Concurrently, a list-based control mechanism should be applied to highly leveraged real estate enterprises to avoid "one-size-fits-all" policies harming high-quality firms. Financial regulators should enhance data platform construction for credit supervision by developing a "Dynamic Monitoring Platform for Financial Real Estate Credit Risks." Commercial banks should be mandated to upload core indicators quarterly and integrate these with the

central bank's credit reporting system and judicial enforcement databases. A visualized regulatory interface should be developed to display regional credit concentration, industry risk heatmaps, and other functions in real time, enabling regulators to generate risk warning reports efficiently.

Second, improve risk constraint mechanisms for banks of different ownership types.For state-owned banks with high credit concentration, annual stress tests simulating extreme scenarios of non-performing loan ratio fluctuations should be required. Risk prevention indicators such as NPL ratios and loan-to-deposit ratios should be incorporated into the performance evaluations of state-owned bank executives, reducing pressures from policy-driven tasks and incentivizing enhanced risk management capabilities. For non-state-owned banks, they should be encouraged to develop low-capital-consumption, high-return businesses, such as expanding retail credit operations to improve profitability. Efficiency should be promoted through fintech tools like AI-powered risk control models to streamline loan approval processes for low-risk real estate developers, reducing information asymmetry risks.

Third, strengthen the countercyclical adjustment function of capital regulation.First, differentiated capital regulation should be implemented based on bank characteristics. For state-owned banks with high credit concentration and policy sensitivity, stricter capital adequacy ratio thresholds should be set for real estate-related loans. Meanwhile, small and medium-sized banks should be encouraged to supplement capital by issuing high-quality capital instruments to enhance risk resilience. Additionally, synergy between capital regulation and macroprudential policies should be reinforced. Real estate credit growth should be integrated into the capital regulatory framework, with punitive capital provisions imposed on loan growth exceeding regional economic capacity. Dynamic adjustments to risk weights should guide banks to optimize asset structures and curb irrational expansion.

**References**

[1] Cao, D. (2019). The impact of industrial structure upgrading on bank risk bearing. *Southern Finance, 1*(6), 39–47.

[2] Barthet. (1999). Banking systems around the globe: Do regulation and ownership affect performance and stability? *Brookings-Wharton Papers on Financial Services, 6*(1), 1–67.

[3] Wang, X. (2011). Research on corporate governance structure and operating performance of commercial banks. *Business Research, 12*(416), 95–99.

[4] Wu, Q. (2021). Analysis on the disposal methods of non-performing loans in commercial banks. *Commercial Banks, 37*(6), 54–58.

[5] Tao, C. (2005). Banking crisis: Analysis from the perspective of financial bubble. *Financial Forum, 10*(6), 66–73.

[6] Ding, X. (2023). Government supervision, market constraints and bank risk taking. *Financial Economics Research, 38*(4), 143–160.

[7] Zhang, H. (2010). Real estate credit and real estate price changes. *Productivity Research, 26*(8), 71–72.

[8] Zhou, X. (2012). Research on real estate economic fluctuations based on national housing prosperity index and its impact on credit risk. *Construction Economy, 33*(4), 76–78.

[9] Gao, H., & Zhao, J. (2009). Formation and development of non-performing loans in China's banking industry: An applied study based on economic transformation. Jilin: Jilin Publishing Group Co., Ltd.

[10] Jin, Y. (2017). Analysis of changes in loan quality of commercial banks in China based on major listed banks. *Commercial Banks, 33*(10), 82–85. https://doi.org/10.1016/j.cjar.2016.12.001

[11] Ohlson, J. (1980). Financial ratios and the probabilistic prediction of bankruptcy. *Journal of Accounting Research, 18*(1), 109–131. https://doi.org/10.2307/2490395

[12] Altman, E. I. (1995). Predicting financial distress of companies: Revisiting the Z-score and ZETA models. *Journal of Credit Risk Management, 19*(2), 1–25.

[13] Guo, X. (2010). Factors influencing the sustainability of profitability of listed banking companies. *Financial Forum, 15*(9), 31–37.

[14] Zhang, J. (2018). Measurement and influencing factors of systemic risk in China's banking sector. *Economic Review, 35*(5), 143–150.

[15] Berge, T. O., & Boye, K. G. (2007). An analysis of bank's problem loans. *Norges Bank Economic Bulletin, 78*(3), 65–76.

[16] Louzis, D. P., Vouldis, A. T., & Metaxas, V. L. (2012). Macroeconomic and bank-specific determinants of non-performing loans in Greece: A comparative study of mortgage, business and consumer loan portfolios. *Journal of Banking and Finance, 36*(4), 1012–1027. https://doi.org/10.1016/j.jbankfin.2011.10.012

[17] Zou, K. (2017). Empirical analysis of factors affecting non-performing loan ratio: Based on provincial panel data from 2005 to 2014. *Financial Theory and Practice, 39*(2), 10–18.

[18] Shin, H., & Kolari, J. W. (2016). Efficiency in Japanese banking: An empirical analysis. *Journal of Banking & Finance, 68*(8), 11–14.

[19] Zhang, L., & Han, L. (2016). The impact of mixed ownership on the non-performing loan ratio of Chinese listed banks. *International Finance Research, 32*(7), 50–61.

[20] Liu, Y. (2014). Analysis of causes and related factors of non-performing loans of commercial banks in China. *Systems Engineering, 32*(5), 65–74.

[21] Su, S. (2024). Empirical analysis of the influencing factors of non-performing loan ratio of China's commercial banks. *Business Exhibition Economy, 6*(20), 109–113.

[22] Zhang, H. (2012). Analysis of the dynamic relationship between economic leading index and China's macroeconomic growth. *Economic Issues, 34*(11), 9–12.

[23] Hu, T., Wang, H., & Qiu, W. (2016). The linkage between China's national housing prosperity index and macroeconomic prosperity index: An empirical study based on VAR model. *Journal of Hubei University of Science and Technology, 36*(12), 30–34.

[24] Xiao, Q. (2025). A study on the bidirectional risk spillover effect between China's stock market and housing market: Analysis based on time-varying Copula-CoVaR model. *Journal of Shandong University of Finance and Economics, 37*(1), 58–101.

[25] Liu, Y. (2020). The impact of real estate market fluctuations on the capital layout of real estate enterprises: Based on the perspective of financial analysis. *Economic Forum, 62*(6), 120–126.

[26] Hofmann, B. (2003). Bank lending and property prices: Some international evidence. *HKIMR Working Paper, 12*(1), 1–38. https://doi.org/10.2139/ssrn.1009079

[27] Kindleberger, C. P. (1978). *Manias, panics and crashes: A history of financial crises*. New York: Basic Books. https://doi.org/10.1007/978-1-349-04338-5

[28] Wang, H., & Gao, G. (2013). Evaluation of the dependence of commercial banks on real estate industry. *The Banker, 14*(2), 74–76.

[29] Shao, D. (2005). Closely monitor the guarantee risk in commercial bank loan business. *China Finance, 55*(21), 69.

[30] Mou, L. (2013). Research on the correlation between credit growth and real estate market risk. *Accounting Friends, 29*(1), 78–80.

[31] Liu, X., & Wang, Y. (2018). The impact of excessive real estate market prosperity on financial expansion. *Southern Finance, 40*(2), 3–11.

[32] Jia, Y., Liu, Y., & Peng, J. (2024). A review of research on identification, causes, prevention and resolution of real estate financial risks. *Real Estate Economy, 45*(3), 1–15.

[33] Chen, R. (2000). Risk assessment and avoidance strategies of personal housing mortgage loans in commercial banks. *Economic Management, 22*(6), 45–52.

[34] Sun, T. (2019). Real estate financial risks are concentrated in which areas? Leverage model, illegal loans of property speculators. *China Economic Weekly, 19*(5), 18–22.

[35] Han, F. (2022). Characteristics, potential risks and development direction of China's real estate finance system. *Future and Development, 1*(1), 11–15.

[36] Xu, J. (2025). Dominant role and risk analysis of state-owned commercial banks in serving the real economy. *Investment and Entrepreneurship, 2*(1), 176–178.

[37] Xu, Y., & Liu, H. (2019). Government's risk tolerance to the state-owned banking system and its implicit rescue pressure. *Economic Research, 54*(1), 64–75.

[38] Wei, Q. (2020). Research on the influence of bank property rights structure on loan efficiency. *Economic Forum, 38*(8), 42–52.

[39] Wang, Z. (2025). Will digital transformation expand the credit risk of commercial banks? *Jianghan Forum, 67*(1), 37–44.

[40] Chen, T. (2021). Economic policy uncertainty, asset prices and bank credit risk: The moderating effect of capital regulation. *Journal of Yunnan University of Finance and Economics, 37*(10), 37–54.

[41] Ma, L., Chen, R., Li, J., & Jiang, N. (2021). Research on the impact of real estate loans on the risk of commercial banks. *Financial Supervision Research, 9*(1), 12–28.

[42] Qiu, Z., & Wang, T. (2009). Research on China's real estate economic cycle 1950–2008. *Economic Research Reference, 39*(71), 1–12.

[43] Cui, R., Chen, W., & Liu, M. (2023). The impact of housing price fluctuation on commercial banks' risk exposure. *Financial Theory and Practice, 45*(3), 88–95.

[44] Wang, H. (2017). Financialization of real enterprises promotes or inhibits enterprise innovation. *Economic and Trade Practice, 18*(23), 45–55.