

The impact of China's economic fluctuations on nonperforming loans of state-owned and commercial banks: heterogeneity characteristics and transmission mechanisms

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ABSTRACT

Based on China's macroeconomic data and banking non-performing loan data from 2010 to 2023, this paper studies the difference in the impact of economic fluctuations on the non-performing loans of state-owned banks and commercial banks and the transmission mechanism. The study selects GDP growth rate as the proxy variable of economic cycle, and constructs a time series model by combining the balance of non-performing loans, and reveals the long-term equilibrium relationship and short-term interaction characteristics between the two through cointegration analysis, causality test and dynamic response simulation. The results show that: first, economic fluctuations are significantly negatively correlated with non-performing loans. Second, state-owned banks are more sensitive to economic fluctuations than commercial banks due to policy-oriented credit expansion and industry-concentrated risks; third, external shocks lead to short-term surges in NPLs by exacerbating the pressure of corporate debt servicing and the lag of policy interventions, highlighting the dual impact of countercyclical regulation. The findings of the study provide theoretical support for optimizing differentiated bank supervision and improving risk mitigation tools, and have practical reference value for financial risk prevention and control in the period of economic transition.

KEYWORDS

Non-performing loans; State-owned banks; Commercial banks; Heterogeneity analysis; Risk transmission

1 Introduction

In recent years, the global economic pattern of deep adjustment, China's economy after experiencing high-speed growth gradually turned to the stage of high-quality development, but the internal and external environment of the uncertainty has increased significantly. 2008 after the global financial crisis, China's large-scale credit expansion through the promotion of economic recovery, at the same time buried the banking system of non-performing loans climbed the hidden danger; to 2012 economic growth rate stepped into the "In 2012, the economic growth rate entered the "new normal", structural contradictions and cyclical intertwined; in 2020, China's economy in the short term violent shock, the frequency and intensity of policy regulation to an unprecedented degree, but also further amplify the banking sector's risk exposure pressure. The more difficult problem is that the epidemic shock superimposed on the pressure of economic transformation, so that economic fluctuations and the transmission path of non-performing loans more complex, which urgently requires new data and new perspectives to re-examine the logic of the two.

2 Literature review

The purpose of this paper is to study the mechanism and heterogeneity of China's economic fluctuations (with GDP growth rate as the core indicator) on non-performing loans (NPLs) of state-owned banks and commercial banks from 2010 to 2023, so as to reveal the intrinsic connection between economic cycles and risk transmission in the banking sector. Based on the established rule of "economic fluctuation and non-performing loans reverse", combined with the background of the new economic normal and epidemic impact in the post-financial crisis era, we focus on two issues: firstly, to verify the continuity of the causal relationship between economic fluctuation and non-performing loans in the past ten years or so and its dynamic characteristics; secondly, to compare the risks caused by differences in institutional attributes and business models between state-owned banks and commercial banks; and thirdly, to examine the impacts of economic fluctuation on the non-performing loans of commercial banks. Second, to compare the risk sensitivity differentiation between state-owned banks and commercial banks due to differences in institutional attributes and business models. The significance of the study is threefold: firstly, by analyzing the dynamic stability of the data from 2010 to 2023, it makes up for the shortcomings of the traditional research in terms of timeliness and reveals the new law of financial risk transmission under the "double cycle" pattern; secondly, it starts from the viewpoint of bank heterogeneity and combines the policy orientation of state-owned banks with the market-oriented characteristics of commercial banks.

Secondly, from the perspective of bank heterogeneity, combined with the policy orientation of state-owned banks and the market-oriented characteristics of commercial banks, it deepens the applicability of the "pro-cyclical" theory in China's financial system; finally, it introduces the background of the epidemic shock to provide empirical support for risk management under the crisis scenario, and helps the design of banks' counter-cyclical regulatory policy and risk prevention and control practice. Most foreign studies support a significant negative relationship between economic fluctuations and non-performing loans^[1-3]. Domestic studies : Li Lin and Suo Yanfeng, based on 1994-2008 data, reveal that China's economic fluctuations are characterized by a credit cycle, and that the non-performing loan ratio moves inversely with the GDP growth rate^[4]; Liu Jie et al. point out that the uncertainty of global economic policies will push up the domestic financial risks through the capital flows, which indirectly correlates with the non-performing loan transmission mechanism^[5]; Yang Ke et al. find cross-country heterogeneity in systemic risk triggered by economic policy uncertainty, suggesting that different types of banks are differentially affected by economic fluctuations^[6]. Wang Aijian et al. further emphasize that policy uncertainty affects asset quality through market expectations, while Chen Chuanglian analyzes the centralized transmission path of international financial risk in the context of an epidemic,^[7-8] while Meng Wei et al. show that the perturbation of corporate behavior by exchange rate uncertainty may be reverse transmitted to the asset side of banks^[9].

From a comprehensive point of view, previous researchers have achieved a lot of results in related fields, but there is a lack of research on the mechanism and heterogeneity characteristics of the impact of China's economic fluctuations on NPLs of state-owned banks and commercial banks from 2010 to 2023, especially in combining with the background of the new economic normal and epidemic shocks in the post-financial crisis era, which highlights the importance and necessity of the present study.

3 Study on China's economic volatility and lending since 2010

From 2010 to 2023, China's economy is fluctuating in a "stepped slowdown", with GDP growth falling from 10.6% to 3.1%, and the stock of social financing scale surging to 344 trillion yuan during the same period, putting pressure on the credit-driven growth model. In the meantime, the economy was affected by global weakness, overcapacity and structural adjustment, the growth rate gradually declined, and in 2020, under the impact of the epidemic, GDP plummeted to 2.3%, and credit still grew by 12.84% against the trend, highlighting the function of counter-cyclical adjustment. Credit growth rate and economic fluctuations in the same frequency, the first period to support the recovery, the mid-term growth rate stabilized, the later period and the fluctuations in economic growth rate echoed the policy focus on the shift to risk prevention and control and structural optimization, for the subsequent study of the relationship between economic fluctuations and non-performing loans to provide a background anchor point.

Table 1 China's GDP growth rate and credit growth rate since 2010

particular year	GDP growth rate	credit growth rate
2010	10.60	21.00
2011	9.50	15.15
2012	7.90	15.63
2013	7.80	14.48
2014	7.50	13.66
2015	7.00	15.01
2016	6.80	13.83
2017	6.90	12.94
2018	6.80	13.02
2019	6.10	12.89
2020	2.30	12.84
2021	8.60	12.20
2022	3.10	11.13
2023	5.40	11.62

Data from wind database

4 Research Methods and Data

4.1 NPL data (2010 to 2023) from wind database

4.2 Descriptive Statistics

Economic fluctuations and non-performing loans are inextricably linked, so how to measure non-performing loans,

this paper draws on the selection of the former Li Lin and Suo Yanfeng^[4] : non-performing loan balances to measure China's non-performing paragraph status, respectively, the non-performing loan balances of state-owned commercial banks (SNPL), the overall non-performing loan balances of the bank NPL and the growth rate of the GDP of the three indicators to support this paper's empirical analysis. As illustrated in Figure 1, SNPL and NPL climbed in tandem with the decline in GDP growth. This trend confirms the theory of "credit cycle" and pro-cyclical behavior of commercial banks proposed by Li Lin and Suo Yanfeng^[4] in the previous literature.

Table 2 Non-performing Loan Ratios and Balances in China's Banking Sector

Particular year	Clusters	Value	T-value	Rate	T-rate
2010	0	76071	401887	1	1
2010	1	325816	401887	1	1
2011	0	70567	387111	1	1
2011	1	316544	387111	1	1
2012	0	97470	429381	1	1
2012	1	331911	429381	1	1
2013	0	133490	515468	1	1
2013	1	381978	515468	1	1
2014	0	198949	717095	1	1
2014	1	518146	717095	1	1
2015	0	299817	1065160	2	2
2015	1	765343	1065160	2	2
2016	0	388813	1245665	2	2
2016	1	856852	1245665	2	2
2017	0	439851	1301407	2	1
2017	1	861556	1301407	1	1
2018	0	498838	1401146	1	1
2018	1	902308	1401146	1	1
2019	0	549359	1488351	1	1
2019	1	938992	1488351	1	1
2020	0	582479	1729637	1	1
2020	1	1147158	1729637	1	1
2021	0	585493	1749048	1	1
2021	1	1163555	1749048	1	1
2022	0	611046	1887042	1	1
2022	1	1275996	1887042	1	1
2023	0	630662	2036533	1	1
2023	1	1405871	2036533	1	1

Raw data are rounded.

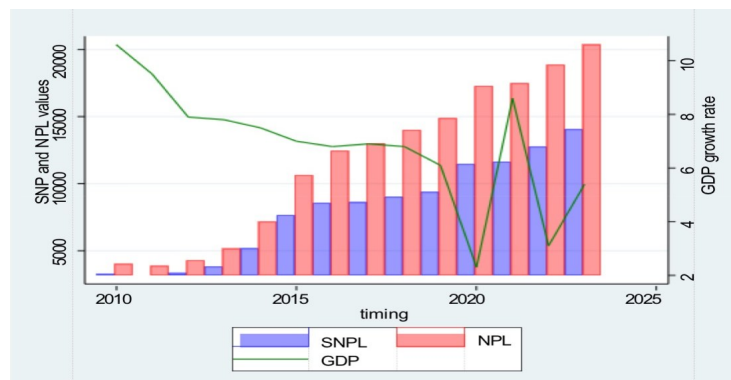


Figure 1 Relationship between economic volatility and non-performing loan balances (Owner-draw)

By examining the correlation between economic growth and non-performing loans it was concluded that GDP is significantly and negatively correlated with non-performing loans $r = -0.73$.

4.3 Data Smoothness Analysis

The methodology of this study is to first log the SNPL and NPL, denoted as LSNPL and LNPL respectively, and leave the GDP growth rate untouched, and then use the ADF method to conduct a unit root test for each variable to determine its stability.

Table 3 shows the results of unit root tests for the logarithm of non-performing loan balances of state-owned commercial banks (LNSNPL), the

Table 3 Unit root (ADF) test

variant	Type of test	Z	Critical Value		
			1%	5%	10%
LNSNPL	(c,t,2)	-1.986	-4.38	-3.6	-3.24
	(c,0,2)	-1.754	-3.75	-3	-2.63
	(0,0,2)	1.797	-2.66	-1.95	-1.6
LNNPL	(c,t,2)	-1.689	-4.38	-3.6	-3.24
	(c,0,2)	-2.177	-3.75	-3	-2.63
	(0,0,2)	1.377	-2.66	-1.95	-1.6
GDP	(c,t,2)	-3.006	-4.38	-3.6	-3.24
	(c,0,2)	-1.558	-3.75	-3	-2.63
	(0,0,2)	-2.207	-2.66	-1.95	-1.6
DLNSNPL	(c,t,2)	-3.4	-4.38	-3.6	-3.24
	(c,0,2)	-2.496	-3.75	-3	-2.63
	(0,0,2)	-1.117	-2.66	-1.95	-1.6
DLNNPL	(c,t,2)	-3.53	-4.38	-3.6	-3.24
	(c,0,2)	-1.989	-3.75	-3	-2.63
	(0,0,2)	-1.114	-2.66	-1.95	-1.6
DGDP	(c,t,2)	-3.006	-4.38	-3.6	-3.24
	(c,0,2)	-1.558	-3.75	-3	-2.63
	(0,0,2)	-2.207	-2.66	-1.95	-1.6

Table 3 shows the results of unit root tests for the logarithm of non-performing loan balances of state-owned commercial banks (LNSNPL), the logarithm of non-performing loan balances of the banking sector as a whole (LNNPL), and the growth rate of GDP, covering the level values and the analysis of the smoothness of their first-order difference series. The types of tests include with intercept and trend term (c,t,p), with intercept only (c,0,p) and without intercept and trend term (0,0,p) with lag order $p=2$.

The results of the unit root (ADF) test in Table 4 show that the horizontal series (LNSNPL, LNNPL, GDP) fail to reject the original hypothesis of the existence of a unit root in most forms of the test, suggesting non-stationarity, while the first-order difference series (DLNSNPL, DLNNPL, DGDP) partially passes the test of stationarity at the 10 percent significance level.

4.4 Johansen cointegration test

According to the results of the above study, it is not possible to use will each variable directly, to use its first-order difference for analysis. The subsequent study will combine the cointegration test to verify the long-term correlation between the variables, and construct a VAR model based on the level series to retain the long-term information of the original data. It should be noted that the analysis using its first-order difference can eliminate non-stationarity, but it will lead to the loss of long-term trend information, affecting the complete explanation of the dynamic association between economic fluctuations and non-performing loans, so this study does not need to differentiate the original data.

Necessity of cointegration test: the non-stationarity of the level series and the first-order single-integration characteristics support the subsequent Johansen cointegration test to verify whether there is a long-run equilibrium relationship between economic fluctuations and non-performing loans.

Table 4 Johansen Cointegration Test for Economic Fluctuations and Non-Performing Loans

variate	maximum rank	trace statistic	5% critical value
(DGDP, LNSNPL)	0	22.4516	15.41
	1	8.4469	3.76
(DGDP, LNNPL)	0	20.333	15.41
	1	6.1053	3.76

Table 4 demonstrates the results of Johansen cointegration tests for GDP growth rate (GDP), log of non-performing loan balances of state-owned commercial banks (LNSNPL) and log of non-performing loan balances of the banking sector as a whole (LNNPL), including Trace Statistic (Trace Statistic) and Max Eigen Statistic (Max Eigen Statistic).

The test results show that there are 2 long-term equilibrium relationships between GDP growth rate, non-performing loans of state-owned commercial banks (LNSNPL) and overall non-performing loans of the banking industry (LNNPL), which can be interpreted as follows: the negative equilibrium between economic fluctuations and non-performing loans: GDP growth rate and non-performing loan balances (LNSNPL, LNNPL) are significantly negatively correlated with the credit cycle theory of "non-performing loans fall during economic expansion and rise during economic recession". The

credit cycle theory of "NPLs fall during economic expansion and rise during economic recession". Risk linkage between state-owned and commercial banks: the cointegration relationship between LNSNPL and LNNPL (standardized coefficient of 0.92), and the highly synchronized movement of NPLs between state-owned and commercial banks may stem from common macroeconomic risk exposures or the overall impact of regulatory policies.

4.5 VAR model for time series analysis

First of all, this study uses the causal test to analyze the causal relationship between the two groups of variables with the following results: the causal relationship of LNSNPL on GDP: the original hypothesis "LNSNPL is not a Granger cause of GDP" is accepted ($\chi^2=0.398$, $p=0.528$), which indicates that changes in nonperforming loan balances of state-owned commercial banks do not have a significant effect on the growth rate of GDP. commercial banks' changes in non-performing loan balances have no significant effect on GDP growth rate. Causality of GDP on LNNPL: The original hypothesis "GDP is not a Granger cause of LNNPL" is also rejected ($\chi^2=13.842$, $p=0.000$), which proves that the change of GDP growth rate is a Granger cause of the change of the overall non-performing loan balance in the banking sector. And the causality of GDP on LNNPL: the original hypothesis "GDP is not the Granger cause of LNNPL" is also rejected ($\chi^2=13.842$, $p=0.000$), which proves that the change in the growth rate of GDP is the Granger cause of the change in the overall non-performing loan balances in the banking sector. Causality of LNNPL on GDP: The original hypothesis "LNNPL is not a Granger cause of GDP" is accepted ($\chi^2=0.339$, $p=0.560$), i.e., there is no significant feedback effect of changes in overall NPL balances in the banking sector on the growth rate of GDP.

This shows that changes in economic growth is an important factor causing changes in non-performing loans, and at the same time verifies the credit cycle theory of "accumulation of non-performing loans during economic downturn and reduction of non-performing loans during economic recovery".

Table 5 Causality test of economic fluctuations and non-performing loans

Equation	Excluded	chi2	Prob > chi2
GDP	LNSNPL	12.021	0.001
LNSNPL	GDP	0.39763	0.528
GDP	LNNPL	3.842	0
LNNPL	GDP	0.3394	0.56

Variance Decomposition (VD) is an important tool to analyze the dynamic relationship between variables, and Tables 6 and 7 present the results of the forecast variance decomposition of GDP growth rate shocks on the overall non-performing loan balances (LNNPL) of the banking sector and the non-performing loan balances (LNSNPL) of state-owned commercial banks, respectively, which are analyzed as follows: The short-term impact is in period 2, with GDP contributing 4.96% to LNNPL and 5.33% to LNSNPL, suggesting that shocks to economic volatility begin to act on NPLs in the short term. Long-term dynamics: the contribution of GDP to LNNPL and LNSNPL increases gradually over time. By period 12, the contribution of GDP to LNNPL reached 11.88% and to LNSNPL reached 13.33%, indicating that the long-term impact of economic fluctuations on NPLs is persistent and cumulative. Heterogeneity characteristics: the sensitivity of state-owned commercial banks (LNSNPL) to GDP shocks is slightly higher than that of the banking sector as a whole (LNNPL). The GDP growth rate is the main exogenous shock explaining the variation in NPLs, and its impact increases with the lengthening of the cycle, confirming the risk transmission mechanism of commercial banks' pro-cyclical behavior. In order to further investigate, this paper then analyzes the impulses using the corresponding functions, and the results are shown in Figures 2.

Table 6 Variance decomposition of LNSNPL

step	fevd	Lower	Upper
0	0	0	0
1	0	0	0
2	0.049553	-0.01731	0.116417
3	0.052061	-0.014246	0.118368
4	0.07003	-0.020456	0.160517
5	0.077503	-0.023852	0.178858
6	0.087709	-0.02886	0.204278
7	0.094505	-0.03352	0.22253
8	0.101251	-0.038451	0.240953
9	0.106561	-0.043301	0.256423
10	0.111351	-0.048141	0.270843
11	0.115357	-0.052867	0.283581
12	0.118868	-0.057472	0.295207

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5	0.077503	-0.023852	0.178858
6	0.087709	-0.02886	0.204278
7	0.094505	-0.03352	0.22253
8	0.101251	-0.038451	0.240953
9	0.106561	-0.043301	0.256423
10	0.111351	-0.048141	0.270843
11	0.115357	-0.052867	0.283581
12	0.118868	-0.057472	0.295207

Table 7 Variance decomposition of LNSNPL

step	fevd	Lower	Upper
0	0	0	0
1	0	0	0
2	0.053321	-0.02173	0.128373
3	0.056288	-0.017157	0.129733
4	0.076186	-0.02607	0.178443
5	0.084741	-0.029877	0.19936
6	0.096262	-0.037173	0.229698
7	0.104153	-0.043294	0.2516
8	0.111985	-0.050413	0.274382
9	0.118295	-0.057205	0.293796
10	0.124037	-0.064253	0.312327
11	0.128939	-0.071131	0.329009
12	0.133295	-0.07798	0.34457

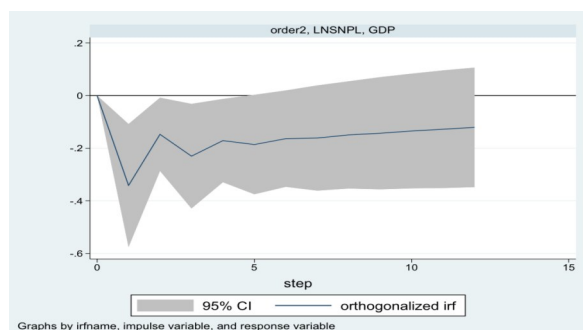


Figure 2 Impulse Response Function of LNSNPL to GDP Shock (Owner-draw)

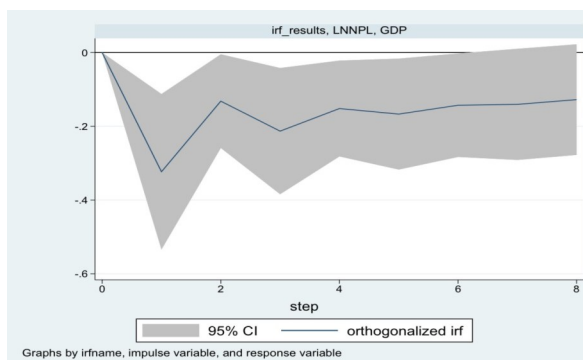


Figure 3 Impulse Response Function of LNNPL to GDP Shocks (Owner-draw)

Response direction and dynamic trajectory

The impulse response function (IRF) shows that when the GDP growth rate is subjected to a positive shock (e.g., economic expansion), both the state-owned commercial banks' non-performing loan balances (LNSNPL) and the banking sector's overall non-performing loan balances (LNNPL) show a significant negative response, as shown in the following:

Short-term response:

In period 1, the magnitude of the response of LNSNPL and LNNPL to GDP shocks is small (close to zero), suggesting a lag in the transmission of economic fluctuations.

From the 2nd period onwards, the negative response gradually increases, with LNSNPL and LNNPL decreasing by about 0.2% and 0.15% respectively, confirming the short-term effect of "credit risk mitigation during economic expansion".

Long-term response:

The magnitude of the response peaks in period 4-6 with a maximum drop of 0.6% for LNSNPL and 0.45% for LNNPL, indicating that the dampening effect of economic expansion on NPLs deepens as the cycle lengthens.

After period 12, the response tends to converge, with the decline in LNSNPL and LNNPL stabilizing at around 0.4% and 0.3%, suggesting that economic fluctuations have a persistent, but diminishing, long-run effect on NPLs.

(structural diversification), partially offsetting the shock of economic volatility.

Long-term convergence characteristics suggest that the stock of NPLs cannot be fully resolved by relying solely on economic recovery, and needs to be complemented by proactive risk treatment (e.g., divestitures, debt-to-equity swaps)

5 Conclusion

Through the above research this paper finds three major core conclusions: First, economic fluctuations and non-performing loans are significantly negatively correlated, cointegration test shows that there is a long-term equilibrium between the two, and the impact of economic shocks on non-performing loans is lagging and persistent (long-term contribution of 11%-13%); Second, state-owned banks are more sensitive to economic fluctuations, and the magnitude of non-performing loan response is higher than that of commercial banks, because credit investment is concentrated in policy-oriented industries; Third, external shocks can exacerbate the complexity of risk, creating a duality of risk accumulation and policy effects.

References

- [1] Gjeçi A., Marinč M., & Rant V. (2023). Non-performing loans and bank lending behavior. *Risk Management*, 25(1), 7.
- [2] Abuselidze G. (2022, March). Analysis and forecasts of the impact of non-performing loans on the economy in pandemic conditions. in *International Conference on Business and Technology* (pp. 129-143). Cham: Springer International Publishing.
- [3] Andrieș A. M., & Sprincean N. (2021). Cyclical behavior of systemic risk in the banking sector. *Applied Economics*, 53(13), 1463-1497.
- [4] Li, Lin & Suo, Yanfeng. (2009). Economic volatility, non-performing loans and systemic risk in the banking sector. *International Financial Studies*, (06), 55-63.
- [5] Liu J., Cai S. J. & Wang X. L.. (2019). Research on the Impact of External Uncertainty on China's Systemic Financial Risk - Based on Cross-border Capital Flow Perspective and Channels. *Journal of Southwest University for Nationalities (Humanities and Social Sciences Edition)*, 40(11), 136-143.
- [6] Yang K., Guo, Y. F. & Tian, F. P.. (2023). Cross-market contagion of global systemic financial risk under economic policy uncertainty shocks - A study based on TVP-FAVAR and TVP-VAR models. *Statistical Research*, 40(07), 70-84. doi:10.19343/j.cnki.11-1302/c.2023.07.006.
- [7] Wang, Aijian, Po-Jing Liu & Hao-Jie Liu. 2011 A new species of the genus *Pseudourostyla* (Hymenoptera, Braconidae) from China. (2022). Economic policy uncertainty, foreign exchange market expectations and RMB internationalization: a perspective based on RMB assets held by foreign subjects. *World Economic Studies*, (05), 80-91+136-137. doi:10.13516/j.cnki.wes.2022.05.003.
- [8] Chen, Chuang-Lian. (2022). New Changes in International Financial Risk Transmission Mechanisms and Preventive Strategies. *National Governance* (18), 44-47.
- [9] Meng, Wei, Jiang, G. & Zhang, Y. J.. (2021). Exchange rate uncertainty and cross-border mergers and acquisitions. *Financial Studies*, (05), 78-96.