An Analysis of the Effectiveness of China's Monetary Policy Transmission Mechanism on GDP: Based on Vector Autoregression Model

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Abstract. How monetary policy affects the level of macroeconomic development is one of the issues that economists have studied deeply. Based on quarterly data from 2004 to 2023, this paper establishes a VAR model and studies the effectiveness of credit channel and money channel on monetary policy transmission through Johansen cointegration test and Granger causality test. The results show that both of them are beneficial to the role of monetary policy, but the correlation between them is small. In addition, the credit channel is the main channel of China's monetary policy transmission, although the role of the money channel is relatively stable but the influence is small. Based on the content of the study, the authors propose relevant policy implications to facilitate the effective functioning of China's monetary policy.

Keywords: monetary policy transmission mechanism; the amount of money supplied; credit channels; GDP; VAR model.

1 Introduction

Monetary policy is simply a fundamental instrument that each central bank can use to drive macro variables, such as GDP, inflation rate, and employment. Via mechanisms like interest rates, money supply, and credit availability, it achieves a goal. Economic research has elaborated a bit on the effectiveness of the monetary policy transmission mechanism, especially how these two channels—credit channel and money supply channel—execute their effects on economic activities. This paper focuses on the mechanism of transmission of monetary policy in China and tries to explore its effectiveness in influencing the GDP, using a vector autoregressive model based on quarterly data from 2004 to 2023.

For a fast-growing economy like China's, one needs an in-depth understanding of the nitty-gritty of monetary policy transmission. Over the last two decades, the Chinese financial system has undergone substantial reforms, becoming more market-oriented and integrated with the global economy. All these changes alter the dynamics of monetary policy transmission, therefore requiring continual updating of research and adjustment to economic models to capture the realities of today. The study is an attempt

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to update the insight available with regard to the effectiveness of China's monetary policy transmission mechanism as of Q4 2023. In a nutshell, this paper attempts to quantify, within the context of the VAR framework, precisely through the Johansen cointegration test and Granger causality test, the contribution of the credit channel and money supply channel towards GDP growth. Through this approach, it will be possible to provide a fully comprehensive survey of the dynamic interaction between these variables in order to capture any long-term equilibrium relationships, in addition to any short-term causal effects. This study is timely in view of the prevailing debates on the various relative potencies associated with different transmission channels. The findings shall, therefore, be relevant to policy recommendations for monetary authorities in the optimization of policy tools toward improved economic stability and growth. It also meets a need for robust, empirically-based models to underpin decision-making in an increasingly complex financial environment.

It is in this backdrop that the present paper attempts to elaborate the mechanisms through which Chinese monetary policy affects GDP and makes an empirical analysis based on the latest data. Contributing to a deeper understanding of these processes, this study has contributed to the wider discussion about the design and implementation of effective monetary policy in emerging market economies.

2 Literature Review

The existing literature shows that efficiency in price-based monetary policy transmission has much improved; quantitative monetary policy transmission efficiency [1], however, has been weakening by an important magnitude. Tiwari et al. (2019) found out that monetary policy of China significantly affects GDP, CPI, and the exchange rate in both the short and the long run [2]. Moreover, Liu and Liu (2018) that the fast-rising shadow banking will naturally affect the efficiency of monetary policy in the short term but is not obvious in the long term [3]. Comparative studies by international researchers also suggest that there are huge discrepancies in the performance of mechanisms for monetary policy transmission across different countries and regions. For instance, monetary policy transmission mechanisms of Pakistan, Kazakhstan, and Indonesia have their own features[4][5][6]. Relevant research reflects that though monetary policies have certain commonalities in various countries, specific economic environments and financial structures will significantly affect the effect of policy implementation.

Recent research has confirmed the above conclusion. Kim (2021) applied the time-varying parameter VAR model for investigating changes in China's monetary policy transmission mechanism and found that changes in the structure have played a significant role in the transmission mechanism [7]. Feng (2022) examined the effect of monetary policies on house prices and drew a conclusion that monetary policies, in an effort to invigorate economic growth, should also be careful not to let housing prices increase too rapidly to the detriment of people's livelihood [8]. Park et al. (2023) studied the mechanism of monetary policy transmission in Laos and found M0 to have important positive impacts on real GDP growth and inflation [9]. Moreover, Song et al. (2021) show that during the period pertaining to Chinese high economic policy uncertainty,

there are more remarkable counter-cyclical effects of monetary policy on the output gap and inflation gap based on the LT-TVP-VAR model [10]. The research findings show the dynamic change of monetary policy in its transmission mechanism under different economic cycles and policy environments.

Also, it was discovered that the financial crisis that happened in other parts of the world predominantly affected China's economy through two broad channels relating to exchange rate and trade. It is similarly important to note that monetary and fiscal policies implemented by the government were equally instrumental in dealing with the crisis as they were in China, according to Sun in 2018 [11]. This has similarly resulted in vast diversities in the effects of China's monetary policies on different industries. Such industrial effect of monetary policy impact is almost ineffective, while its effectiveness is closely related to the expectations and the strength of the factors (Ouyang et al., 2020) [12]. Financial stability measures do have an important impact on monetary policy effects in inducing economies of emerging economies, as depicted by Ybrayev in 2022 [13]. He et al. (2021) determine that one of the major implications of this study is that policy uncertainty constrains industrial output and that policymakers should be more cautious [14]. In the future, research can be done more profoundly about different economic environments and policy tools to further optimize the formulation and execution of monetary policy. For example, how short-run stimulation to the economy could be reconciled with long-term financial stability during the process of policy execution, and the way to deal with the influence of global economic uncertainties on domestic policies, etc., are concerns that call for discursive elaboration.

The above research into the monetary policy transmission mechanism shall be the base of this paper, but studies on measuring the relative effectiveness of the credit channels and money channels in the monetary transmission mechanism to economic growth are still rather few. Considering monetary policy, its transmission mechanism and its effectiveness are highly related to time, with comparatively little research in this regard involving the recent years, this article updated the timeline up to the fourth quarter of 2023. Moreover, the paper intends to settle scholars' disputes over the effectiveness of money channels and credit channels; therefore, it has set out an in-depth study to draw a timely but comparatively comprehensive conclusion with the aid of quantitative empirical research.

3 Data and Methodology

3.1 Variable Selection

This paper selects data from the first quarter of 2004 to the fourth quarter of 2023, a total of 80 quarters, with a period of 20 years. The transmission mechanism of monetary policy means that monetary authorities use certain monetary policy tools to achieve the expected final goal through specific ways and processes. In terms of variable selection, this paper selects broad money supply (M2) as the money channel of China's monetary policy transmission, and the RMB loan balance (LB) of financial institutions as the credit channel of China's monetary policy transmission. Through the above two ways to measure the effect of China's monetary policy on economic development. Therefore,

gross domestic product (GDP) is chosen as the ultimate goal to measure the level of macroeconomic development. The data comes from the official websites of the National Bureau of Statistics of China and the People's Bank of China. Table 1 provides a brief description of the selected variables.

Table 1. Variable Declaration

Name	Type	Economic Indicator
GDP	Dependent Variable	Level of macroeconomic development
M2	Independent Variable	Money channel
LB	Independent Variable	Credit channel

Source: Author's Summary

3.2 Findings of Descriptive Statistics

In order to reduce the dimension of data and eliminate the influence of heteroscedasticity, this paper processed the data of all mobile phones logarithmically and conducted descriptive statistical analysis on this basis. The results are shown in Table 2. It can be seen from the table that the values of the three variables are not stable. In terms of LNGDP, the maximum value is 5.54, the minimum value is 4.54, and the average value is 5.133, which indicates that GDP growth fluctuates greatly, and the large standard deviation (0.276) can also indicate this. Correspondingly, the difference between the maximum and minimum values of LNLB and LNM2 is also large, indicating that this variable is also relatively unstable. But the values of all time series data are in the interval $\bar{X} \pm 3\sigma$.

Table 2. Descriptive Statistics

Statistics	LNGDP	LNLB	LNM2
Mean	5.133499	6.305721	6.460096
Median	5.181893	6.338467	6.523101
Maximum	5.541442	6.850855	6.940367
Minimum	4.538380	5.692833	5.834934
Standard Deviation	0.276250	0.357139	0.333579
Skewness	-0.451150	-0.196805	-0.370257
Kurtosis	2.085119	1.782893	1.873726
Jarque-Bera	5.503843	5.454264	6.056179
Jarque-Bera test Probability	0.063805	0.065407	0.048408
Observations	80	80	80

Sources: Author's Calculations

3.3 Unit Root Test

The stationarity of time series data is a prerequisite for establishing the Vector Autoregression Model (VAR), on which the stability and accuracy of VAR model can be improved. Therefore, the unit root test should be performed. In this paper, Augmented

Dickey-Fuller (ADF) will be conducted to test its stationarity, and KPSS will be further used to improve persuasiveness and robustness.

The results of ADF test are shown in Table 3. It can be seen that only after the second-order difference can LNGDP and LNM2 be significant at the significance level of 1% in Intercept and Intercept & Trend, and the null hypothesis of the existence of unit root is rejected. Therefore, it is considered that these two variables do not exist unit root after the second-order difference. However, for LNLB, it is significant at the 5% significance level after the first-order difference, while the second-order difference is strongly significant. At this time, it is preliminarily determined that LNLB does not have unit roots after both the first-order and second-order differences.

Table 3. Results of ADF Unit Root Test

Variables	Level		First Difference		Second Difference		Difference Order
	Intercept	Intercept & Trend	Intercept	Intercept & Trend	Intercept	Intercept & Trend	
LNGDP	-4.441	-1.784	-2.423	-3.606	-59.577	-59.148	2
	(0.0006)	(0.7023)	(0.1390)	(0.0360)	(0.0001)	(0.0001)	
LNM2	-2.967	-1.409	-1.549	-2.822	-14.382	-14.300	2
	(0.0428)	(0.8504)	(0.5037)	(0.1943)	(0.0001)	(0.0001)	
LNLB	-2.515	-0.705	-3.111	-3.959	-5.260	-5.298	1 or 2
	(0.1160)	(0.9687)	(0.0300)	(0.0143)	(0.0000)	(0.0002)	

Sources: Author's Calculations

Notes: P-Value in parentheses

At this time, the KPSS test is performed again to ensure the correctness of the decision based on ADF test on the one hand, and to determine the final difference order of LNLB on the other hand [15]. Table 4 shows the results of the KPSS test. The decisions of LNGDP and LNM2 are consistent with the results of ADF test, but LNLB is not significant only after the second-order difference, indicating that the null hypothesis that the data is stationary cannot be rejected at this time. Therefore, it is finally determined that all three variables are stationary after the second-order difference.

Table 4. Results of KPSS Unit Root Test

Variables	Level		First Difference		Second Difference		Difference Order
	Intercept	Intercept & Trend	Intercept	Intercept & Trend	Intercept	Intercept & Trend	
LNGDP	1.2222***	0.3025***	0.3875*	0.0955	0.0780	0.0600	2
LNM2	1.2284***	0.3131***	1.0439***	0.1114	0.1300	0.0947	2
LNLB	1.2391***	0.2799***	0.4889**	0.1475**	0.1458	0.1095	2

Sources: Author's Calculations

Notes: * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

3.4 Cointegration Test

After the data is processed smoothly by difference, the lag order is determined to be 2 according to AIC and SC criteria. In order to verify the different influences of different channels of monetary policy on the level of economic development, we will divide the discussion into the following three groups: LNGDP, LNM2, LNLB; LNGDP, LNLB and LNGDP, LNM2. Johansen cointegration test was conducted for these three groups of variables.

The cointegration test results of the first group (LNGDP, LNLB, LNM2) are shown in Table 5. At the significance level of 1%, the Trace statistic rejects the null hypothesis that there is no co-integration relationship or at most one co-integration relationship. Of course, the null hypothesis that there are at most two co-integration relationships is also rejected, so it is considered that there are at least two co-integration relationships. It reveals that monetary policy can have an effect on economic development through the common transmission of money channel and credit channel.

Table 5. Johansen Cointegration Test of the First Group

Hypothesis	Eigenvalue	Trace Statistic	5% Critical Value	P-Value
None *	0.973270	391.2369	35.01090	0.0000
At most 1 *	0.601560	119.5887	18.39771	0.0000
At most 2 *	0.490496	50.57387	3.841465	0.0000

Source: Author's Calculations

Table 6 shows the co-integration test results of the second group (LNGDP and LNLB). Trace statistics both reject the null hypothesis at the level of 1%, which means that there is at least one co-integration relationship, so there is a long-term equilibrium relationship between time series, reflecting that monetary policy can affect macroeconomic development through credit channels.

Table 6. Johansen Cointegration Test of the Second Group

Hypothesis	Eigenvalue	Trace Statistic	5% Critical Value	P-Value
None *	0.972656	323.0553	18.39771	0.0000
At most 1 *	0.507445	53.11123	3.841465	0.0000

Source: Author's Calculations

Table 7 shows the co-integration test results of the second group (LNGDP and LNM2). Trace statistics both reject the null hypothesis at the level of 1%, which means that there is at least one co-integration relationship, so there is a long-term equilibrium relationship between time series, reflecting that monetary policy can affect macroeconomic development through money channels.

Table 7. Johansen Cointegration Test of the Third Group

Hypothesis	Eigenvalue	Trace Statistic	5% Critical Value	P-Value
None *	0.976647	337.7089	18.39771	0.0000
At most 1 *	0.525634	55.93320	3.841465	0.0000

Source: Author's Calculations

The results of using the Maximum Eigenvalue test are consistent with the above findings.

3.5 Model Stability Test

AR Eigenvalues Test aims at verifying the stability of the VAR model and requires that all AR unit roots are less than 1, that is, all test points are distributed in the unit circle, which proves that the established VAR is not only stable but also effective, and reflects the long-term equilibrium relationship between variables. Figure 1 shows the distribution of test points in the unit circle. It is obvious that all points are in the circle, indicating that the model is relatively stable.

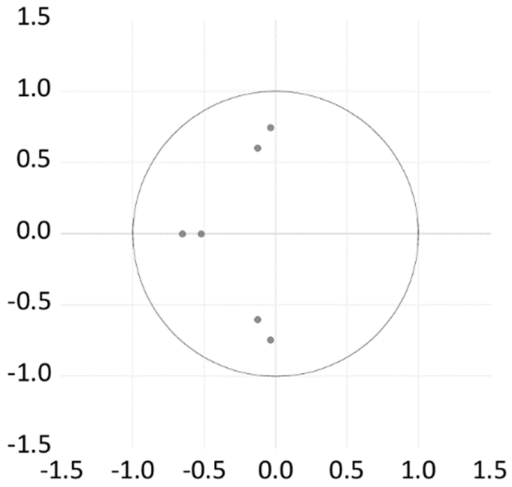

Fig. 1. Inverse Roots of AR Characteristic Polynomial.
Source: Author's Calculations

In addition, the White test was conducted on VAR model to verify whether there is heteroscedasticity in the model. The result showed that Chi-square statistic was 80.6346 and corresponding P-value was 0.2273, which could not significantly reject the null hypothesis of homoscedasticity. Therefore, it was believed that there was no heteroscedasticity problem in the model.

3.6 Granger Causality Test

The original hypothesis of Granger causality test is that there is no causality. If the P-value is less than 5%, the original hypothesis is significantly rejected, which means that there is a significant causality between the two variables. Table 8 shows the final results of the Granger causality test.

Table 8. Results of Granger Causality Test

Null Hypothesis:	F-Statistic	P-value	Decision
LNLB does not Granger Cause LNGDP	12.3234	0.0000	Granger Causality
LNGDP does not Granger Cause LNLB	7.66678	0.0010	Granger Causality
LNM2 does not Granger Cause LNGDP	9.86940	0.0002	Granger Causality
LNGDP does not Granger Cause LNM2	5.02862	0.0091	Granger Causality
LNM2 does not Granger Cause LNLB	1.07377	0.3472	No Granger Causality
LNLB does not Granger Cause LNM2	1.59943	0.2092	No Granger Causality

Source: Author's Calculations

The P-value of the first four groups of tests is less than 0.05, rejecting the null hypothesis at the significance level of 5%. Therefore, it can be believed that LNLB and LNM2 have a causal relationship to LNGDP, and LNGDP also has a causal relationship to LNLB and LNM2. However, the latter two sets of results do not significantly reject the null hypothesis. Therefore, it can be concluded that there is no causal relationship between LNLB and LNM2, which further indicates that the correlation between credit channel and money channel is small.

3.7 Impulse Response and Variance Decomposition

Through the graph of impulse response function, we can intuitively see the mutual influence of each variable. Figure 2 shows the impact of monetary policy transmission on economic development through credit channels. At the beginning of the phase, the impact is positive, and reaches its peak in the second phase, and negative impact appears in the fourth phase, and then positive and negative impact alternately appears. Moreover, the impact amplitude of the impact shows a gradually decreasing trend in general, and the impact of the tenth phase is close to 0. Figure 3 shows the impact response of monetary policy to economic development through money channel transmission. The overall trend of its impact is roughly the same as FIG. 2, and the impact ability weakens with the increase of the number of phases. Finally, the impact of LNM2 in the tenth phase is basically 0, but the impact of LNM2 on LNGDP is smaller. In other words, the impact of monetary policy on the economy through the money channel will be softer.

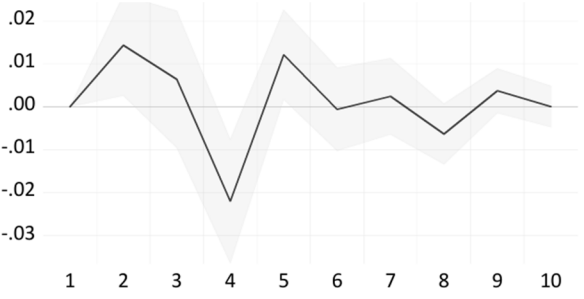

Fig. 2. Response of LNGDP of LNLB.
Source: Author's Calculations

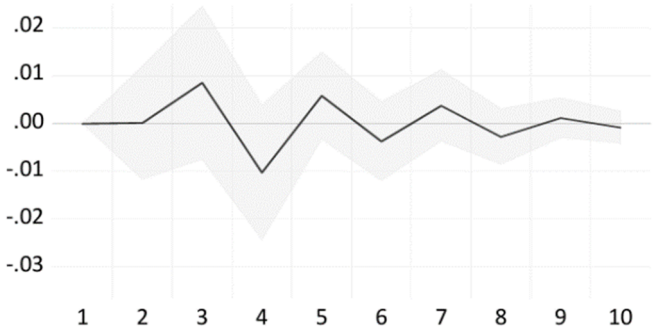

Fig. 3. Response of LNGDP of LNM2.
Source: Author's Calculations

Variance decomposition was performed on LNGDP (i.e. the level of economic development, which is also a key variable for evaluating the effectiveness of monetary policy), and the results are shown in Table 9.

Table 9. Variance Decomposition

Period	S.E.	LNGDP	LNLB	LNM2
1	0.054826	100.0000	0.000000	0.000000
		(0.00000)	(0.00000)	(0.00000)
2	0.074515	96.31934	3.680245	0.000419
		(3.82457)	(3.78410)	(0.96550)
3	0.078588	94.84378	3.962167	1.194050
		(4.60110)	(3.32193)	(3.12296)
4	0.083937	87.10714	10.35925	2.533605
		(6.92231)	(5.41432)	(4.27470)
5	0.087400	85.74481	11.47325	2.781943
		(7.36557)	(5.87979)	(4.16578)
6	0.088807	86.01358	11.11725	2.869170
		(7.30301)	(5.80103)	(4.12211)
7	0.089159	85.87123	11.10286	3.025909
		(7.47305)	(5.86210)	(4.26866)
8	0.089506	85.38185	11.52253	3.095626
		(7.68696)	(5.98806)	(4.41393)
9	0.089712	85.25795	11.64307	3.098985
		(7.85934)	(6.09960)	(4.44826)
10	0.089789	85.27490	11.62328	3.101818
		(7.87599)	(6.12305)	(4.44983)

Source: Author's Calculations

Note: Monte Carlo (100 repetitions) standard deviation in parentheses

As can be seen from the results in the above table, the contribution of LNLB and LNM2 in the first stage was 0, and LNGDP was completely affected by its own

variables. However, as time went on, the influence of LNGDP's own variables showed a decreasing trend, while the influence of LNLB continued to increase and reached the maximum in the 9th stage, which was about 11.64%. Correspondingly, the influence of LNM2 is also gradually increasing. Even though the influence still shows an increasing trend in the tenth phase, its influence is always smaller than that of LNLB on LNGDP, which is stable at about 3.1% in the long run.

In summary, the impact of monetary policy on economic growth through credit channels is significantly greater than that of money channels, but the impact of GDP itself is strongly endogenous, followed by LNLB and the weakest endogenous of LNM2.

4 Conclusion and Policy Implications

In this paper, quarterly macroeconomic data from 2004 to 2023 are used for research, and the VAR model is established by econometric methods, including unit root test, Johansen cointegration test, AR feature root test of VAR model, heteroscedasticity White test, Granger causality test, impulse response, and variance decomposition. The results show that there are two channels in China's monetary policy transmission mechanism. Both credit channel (LB) and money channel (M2) can effectively explain the impact of monetary policy on GDP, but LB's explanation of GDP is stronger, reflecting the dominant and priority position of credit channel in China's monetary policy transmission. In addition, the impact of monetary policy on GDP through credit channels has a large fluctuation. It not only improves the timeliness of the research but also provides a reference for the implementation of China's monetary policy.

Based on the above research and analysis, the authors propose the following policy implications:

1. Strengthen the role of credit channel: Research finds that credit channel (LB) has a more profound impact on GDP; hence, the decision-makers at the helm of affairs should take an interest in how to use credit expansion to stimulate economic growth. This can be done through measures aimed at optimizing credit allocation, lowering lending rates, and easing credit conditions to improve credit availability and liquidity.

2. Changes in the Money Supply Should Enjoy Constant Attention: While the credit channel enjoys a more salient role, the effect of the money channel, M2, on GDP is not anything to sneeze at. As such, policymakers should constantly pay attention to the changes in the money supply and regulate from that the money supply to the market through monetary policy tools—open market operations, and adjustment of the reserve requirement ratio, among others—with a view toward the attainment of macroeconomic stability and sustainable growth.

3. Dynamic readjustment of policy tools: It is specified that, according to research, the impact of monetary policy on GDP both through credit and money channels involves huge volatility. Thereby, policymakers should be empowered to modify policy tools so that they will have to be more time-apt to be aligned with changes in the economic situation for fighting economic fluctuations and uncertainties and making policies effective and timely without any ambiguity.

4. Strengthen financial market stability: For the transmission mechanism of credit and money channels to be effective, there needs to be stability in the financial markets. Policymakers should take measures to prevent financial risks, strengthen financial supervision, and ensure the healthy operation of the banking system, thus promoting financial market stability and development.

5. Deepen financial reform: Further, promote the comprehensive reform in the system of finance to perfect the allocation of financial resources and raise the efficiency and competitiveness of financial organizations to support economic restructuring and upgrading. We should provide strong support for economic restructuring at a higher level and promote interest rate liberalization, strengthen price discovery functions of the financial market, and improve the transmission efficiency of monetary policy.

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