An Empirical Study on the Relationship between Money Supply, Economic Growth and Inflation

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Abstract: Inflation will have a great negative impact on the macro economy and the life of the residents in China.Since entering the 21st century, there has been a serious financial crisis and subprime crisis in the world. Therefore, inflation, money supply and economic growth have been widely concerned by the economists. This paper uses the method of financial time series analysis to establish a vector autoregressive (VAR) model. Empirical analysis shows that the increase of money supply will increase inflation and stimulate economic growth, and put forward corresponding countermeasures and suggestions.

Keywords: Inflation, Economic Growth, Money Supply, VAR Model

I. Introduction

The country's money supply, economic growth, and inflation are the two economic phenomena that are most closely related to people's livelihood. They are also the three eternal themes in macroeconomic research and are also the major goals pursued by governments of all countries. Facing the new situation, studying the interaction mechanism between economic growth, money supply, and inflation will not only help clarify the laws of mutual influence among the three parties, so as to judge the economic growth situation, but also to provide theoretical basis for the implementation of macroeconomic policies. Since 2003, China's inflation phenomenon has been increasingly intensified. Macroeconomic regulation and control generally achieve long-term stable economic growth and curb inflation by regulating the supply of money.After the financial crisis, in order to ensure rapid economic development, the Chinese government adopted a proactive fiscal policy and a moderately loose monetary policy. Large amounts of broad money have been put in place to ensure the rapid development of the economy and at the same time increase inflationary pressures. Therefore, the establishment of VAR model to study the impact of money supply and economic growth on inflation, in order to take appropriate countermeasures in time to reduce inflation to a certain extent is of great significance to China.

II. Literature Review

Wang Kai, Pang Zhen[1] on the basis of VAR model, this paper empirically analyzes the relationship between money supply, inflation uncertainty and China's economic growth. The study found that there is a two-way Granger causality between money supply and China's economic growth, and the uncertainty of inflation slows down the economic growth of China, At the same time, China's economic growth has exacerbated the uncertainty of inflation. Fang Fang[2] found that economic growth will cause price rises and also increase the money supply through cointegration tests and error correction models. Zhang Xu[3] analyzed the broad money supply in China based on the VAR model analysis and found that China's economic growth is rapid, demanding an increase in money supply, and the consumer price index has a certain guiding significance for China's short-term money supply. Liu Lin, Le Yunhui[4] used a vector autoregressive model to analyze the

money supply, economic growth, inflation and end-of-year loan balances of financial institutions. It was concluded that the expansion of money supply can stimulate economic growth in the short term, and monetary expansion can also promote economic growth in the long term. While inflation will hinder economic growth. YuanChun Yu found that in the current inflationary causes and policy recommendations in China, the worsening of inflation will shake the foundation of a country's economic growth. Yang Yi[6] believes that the impact of money supply cannot effectively explain the inflation phenomenon in China Therefore, adjusting the money supply to curb inflation is limited. LiuJinQuan, XieWeiDong[7] used the VAR model to confirm that inflation has a certain degree of promoting effect on economic growth, and found that economic growth has a counter effect on the development trend of inflation. MiYong Mei, Wang Xian Yong[8] research shows that China's inflation inertia is very strong. The previous period's inflation had the greatest impact on current inflation. The money supply has an impact on China's inflation but not obvious.

III. Model introduction

The promotion of the VAR model began with the famous literature published by the world famous economist Christopher Sims in 1980.Because economic and financial time series analysis often involves multiple variables, it is widely used in practice, especially in macro-finance such as monetary policy analysis. It is often used to predict the interconnected time series systems and to analyze the dynamic impact of stochastic disturbances on variable systems, thus explaining the impact of various economic shocks on the formation of economic variables. Based on multiple stationary time series variables, the lag values of all endogenous variables of the model are regressed to estimate the dynamic relationship among all endogenous variables.

IV. Empirical Analysis

4.1 Sample data selection and processing

This article selects the broad money supply M2, GDP, and consumer price index CPI as the economic indicators for measuring money supply, economic growth, and inflation. The article used 1990-2017 as a sample interval, using annual data, a total of 28 data. The data comes from the National Bureau of Statistics of China and the People's Bank of China.

4.2 Unit Root Test

Before establishing the Var model, we should first test the stability of three time series variables. This article uses the ADF test of the unit root test. The results are shown in Table 1. As can be seen from Table 1, CPI, GDP, and M2 are all non-stationary at the 5% significance level, and the ADF statistics of the first-order difference are all less than the critical value at the 5% significance level, thus rejecting the original value. Assumptions show that there are no unit roots in the first-order differential sequences of RC, RG, and RM, which are stationary sequences, and it can be judged that RC, RD, and RM are all I(1) monosequences.

Table 1 ADF test results for RC, RG, and RM

variable	statistics	5% critical value	Prob.	result
CPI	-2.86501	-2.9918	0.064	Non-stationary
GDP	2.356186	-2.9810	0.999	Non-stationary
M2	0.399141	-2.9810	0.979	Non-stationary
RC	-3.17710	-2.9918	0.034	stationary
RG	-5.19319	-2.9980	0.000	stationary
RM	-5.40231	-2.9862	0.0002	stationary

4.3 Constructing a Vector Autoregressive (VAR) Model
4.3.1 Establish an Initial VAR(3) to Test the Stability of Difference Equations
    The characteristic equation of the general third-order difference equation:

$$\lambda^3 - \partial_1\lambda^2 - \partial_2\lambda^1 - \partial_3 = 0 \ (1)$$
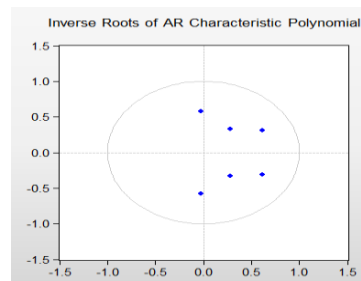

Figure 1 Root distribution of AR(3)

    It can be proved from Figure 1 that the root of the characteristic equation falls within the unit circle, and the difference equation system is stable.
4.3.2 Determining the Optimal Lag Period of the VAR Model

Table 2 Judgment Results of Lag Periods of VAR Models

Lag	LogL	LR	FPE	AIC	SC	HQ
0	136.2	NA	0	-12.117	-11.96	-12.0
1	166.9	50.1*	0*	-14.086	-13.4*	-13.9

2	174.8	10.78	0	-13.98	-12.94	-13
3	186	13.17	0	-14.26	-12.77	-13.9
4	198.5	9.48	0	-14.50	-12.56	-14.0
5	210.8	6.704	0	-14.8*	-12.4	-14.2*
* indicates lag order selected by the criterion						

From Table 2, it can be seen that LR, FPE, and SQ all point to the same first-order lag period, while the optimal number of periods given by AIC is 2, and HQ corresponds to five periods. According to the "majority principle", VAR should be selected. 1) Conduct subsequent analysis.

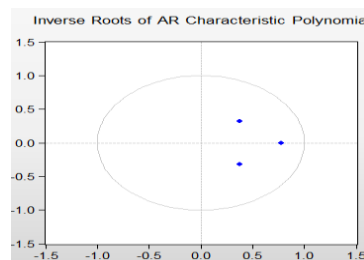**4.4 Establish VAR(1) to check system stability**

Figure 2 Root distribution of AR(1)

From Figure 2, it can be shown that when the lag period is 1, the roots of the VAR model's characteristic equations fall within the unit circle. When the point is close to 1, the Mudulus in the following Table 3 must be selected to judge, all less than 1, then the model Is stable.

4.5 Johansencointegration test

The ADF test shows that the three variables RC, RG, and RM are I(1) single integer sequences. Cointegration test is used to determine if there is a long-term equilibrium relationship between variables. The results are shown in Table 3 and Table 4:

Table 3 Johansen Cointegration Test Trace Statistics Test Results

| Hypothesized | | Trace | 0.05 | |
No. of CE(s)	Eigenvalue	Statistic	Critical Value	Prob.**
None *	0.697852	46.92937	29.79707	0.0002
At most 1 *	0.382577	17.00841	15.49471	0.0294
At most 2 *	0.179741	4.953375	3.841466	0.0260

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Table 4 Johansencointegration test feature root statistics

Hypothesized		Max-Eigen	0.05	
No. of CE(s)	Eigenvalue	Statistic	Critical Value	Prob.**
None *	0.697852	29.92096	21.13162	0.0023
At most 1	0.382577	12.05503	14.26460	0.1086
At most 2 *	0.179741	4.953375	3.841466	0.0260

According to trace statistic test results and feature root statistics output results, there is a cointegration relationship between sequence variables, that is, there is a long-term stable equilibrium relationship between inflation, economic growth and money supply.

4.6 Granger causality test

From the following table, when the dependent variables are RG and RC, Chi-sp tested by LR is relatively large and the corresponding P value is less than 10% significance level; when the dependent variable is RM, Chi-sp tested by LR is relatively small, corresponding to The P value is greater than 10% of the significance level. It can be concluded that there is a two-way Granger causality between inflation (CPI) and economic growth (GDP); there is a one-way Granger causality between money supply and inflation; there is a one-way relationship between money supply and economic growth. Granger causality.

Table 5 Granger causality LR test results

Dependent variable	Excluded	Chi-sp	df	Prob.	result
RC	RG	13.5160	1	0.0002	refuse
	RM	9.74175	1	0.0018	refuse
	All	13.6405	2	0.0011	refuse
RG	RC	7.81531	1	0.0052	refuse
	RM	14.0712	1	0.0002	refuse
	All	16.1080	2	0.0003	refuse
RM	RC	1.02290	1	0.3118	accept
	RG	0.56446	1	0.4525	accept
	All	3.98665	2	0.1362	accept

4.7 Pulse Response Analysis

According to the impulse response function to obtain the dynamic impact path between variables and variables.To analyze the results of a variable after being impacted by another variable. Based on the vector autoregression VAR (1) model, an impulse response function is established for money supply, economic growth, and inflation. The results are shown in Figure 3-5.
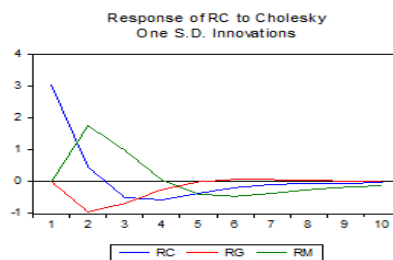
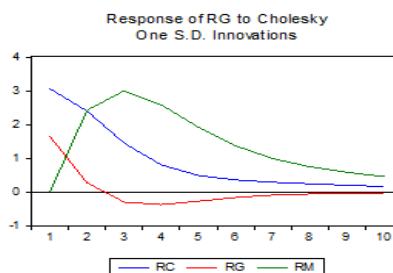Figure 3 Pulse effect of RC on RC, RG and RM
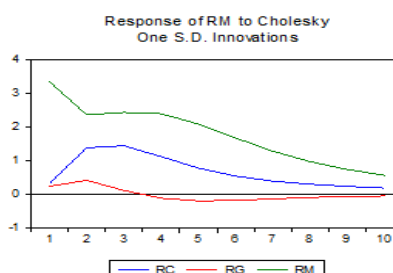

Figure 4 Pulse effect of RG on RC,.RG and RM

Figure 5 Pulse effect of RM on RC, RG and RM

As can be seen from Figure 3, the impact from CPI，The period from the first period to the fifth period of GDP was a negative effect, which basically disappeared from the sixth period, indicating that the impact of CPI in the short term has a lagging impact on GDP and has a minor impact;M2 is generally significant. The first four periods are positive, and then the negative effect gradually becomes stable. This indicates that the increase in the price level of the residents has led to an increase in the demand for money, which has increased the money supply; The positive effect on itself in the first two periods before the impact, and the negative effect in the third period gradually receded to a stable level, indicating that the CPI itself has a certain lasting effect and returns to the normal level due to its own changes.

As can be seen from Figure 4, the impact from GDP, the overall response of CPI is significant, indicating that economic growth has a positive impact on CPI; The impact of economic growth on the broad money supply M2 is still quite significant. The third period reached a peak of 3.0, and then gradually fell back, indicating that economic growth will cause rapid growth of money supply in the short term, and the speed of money supply will increase over time. Changes to oneself will eventually return to a normal level.

As can be seen from Figure 5, the impact from M2,The CPI rose slightly in the first three periods and continued to decline after the fourth period, indicating that the impact of the short-term M2 has a greater impact

on the CPI, and the impact gradually decreases with the extension of the term;GDP had a slight positive impact in the first three periods, with a positive impact maximum of 0.37 in the second period,There was also a slight negative impact between the 4th and the 8th period, and the impact was basically stable by the 10th and later periods. For the impact on itself, the overall response is significant, both positive impact, indicating that the random shock response to its own standard deviation is strong, and has a certain degree of continuity.

4.8 Variance decomposition

The variance decomposition can know the extent to which the variance of a variable's variance is affected by random disturbance terms of other variables.Based on the VAR(1) model, the variance of money supply, economic growth, and inflation are decomposed, and the variance decomposition results of each variable are shown in Figure 6-8.
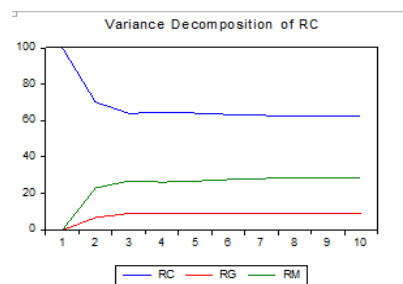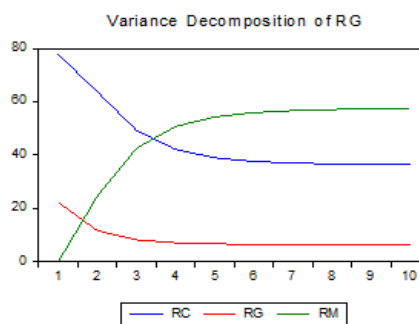

Figure 6 Variance decomposition of RC
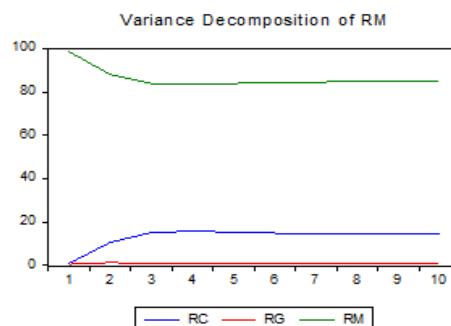

Figure 7 Variance decomposition of RG

Figure 8 Variance decomposition of RM

From Figure 6, we can see that CPI is affected by itself by 62.44%, 8.83% affected by GDP, 28.73% affected by M2, It shows that the growth of CPI itself is affected by its own systematic disturbance, and it is also

affected by the money supply. Economic growth has little effect on inflation, and its performance in the early period is negative, and then gradually stabilizes, but overall it seems that Economic growth and inflation are negatively correlated.

From Figure 7, we can see that GDP is affected by itself by 6.14%,36.35% affected by CPI ,57.51% affected by M2,It indicates that economic growth mainly depends on the level of household consumption and the amount of money supply, and that the self-system disturbance is relatively small

From Figure 8, we can see that M2 is affected by itself by 6.14%,affected by CPI 14.33%, affected by GDP 0.79%,It shows that the money supply is less affected by endogenous variables and the disturbance of its own system is greater.

V. Conclusion and Suggestion

Through the analysis of the cointegration analysis, Granger causality test, impulse response analysis and variance decomposition of RC, RG and RM three variables, the conclusions are as follows:

First, economic growth will increase the level of household consumption and will also increase the money supply. Relatively speaking, economic growth will have a greater impact on the level of household consumption.

Second, there is a certain lag in the two-way effects of inflation and economic growth. The impact of inflation on economic growth is mainly within the first five periods of lag. The positive impact of economic growth on inflation also has a certain lag, and the impact is almost zero after lagging 10 periods.

Third, in the long term, the contribution rate of the money supply to the variance of economic growth is 57.51%, and the contribution rate of money supply to inflation variance is 28.73%.Money supply can control consumption and investment, effectively stabilize market economic growth and curb inflation.Loose monetary policy will increase inflation and stimulate economic growth.

Based on the above conclusions, the following recommendations are given:

First, the Central Bank should strengthen its control over money supply. When the economy is in recession, we can expand the money supply by increasing the open market operations, reducing the deposit reserve ratio, or cutting interest rates, to stimulate investment and consumption and promote economic growth. Excessive money supply will also cause prices to rise, which in turn will lead to inflation. At this point, tightening monetary policies will be needed to reduce supply and ease inflation.

Second, strengthening the regulation of price regulation has great significance for stabilizing inflation. Concerned about important materials for the people's livelihood, actively adopting information guidance, supporting production and sales, promoting circulation, and necessary price intervention to stabilize prices. At the same time, it established a reserve system for key items and established price warnings. We must follow the economic laws to promote social welfare and gradually solve the current serious problem of price inequality.

Third, examine the two-way relationship between inflation and economic growth from a dynamic perspective. When there are relatively large fluctuations in the price level, the government should take corresponding measures and formulate relevant policies to stabilize the price level. With "low inflation and high economic growth" as a better combination. If the two have a positive correlation, then the government can stimulate output through moderate price inflation; If the two have a negative correlation, then the government will need to maintain output growth by driving down prices, and output growth will not bring about significant price increases.

VI. References

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