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Research Article

A Study on the Relationship between Money Supply and Macroeconomic Variables in China

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Abstract

Many scholars have examined the importance of the money supply to the macroeconomics in developed countries. However, few studies have explored this proposition in developing countries. So, in this paper, annual series data from 2000 to 2016 is applied to analyze the relationship between the money supply (M_2) and the macroeconomic variables (the real GDP, the inflation rate & the interest rate) under the vector auto regression (VAR) model in China. The purpose of this paper is to verify the impact of these variables on the money supply in China. After performing an empirical analysis, conclusions can be obtained that an increase in the real GDP can result in an increase in the money supply; Also, an increase in the inflation rate can lead to an increase in the money supply; Conversely, an increase in the interest rate can cause a decrease in the money supply. Therefore, via adjusting the change of real GDP, inflation rate and interest rate, a better control of the money supply can be performed for the policy-makers in China.

Keywords: Money Supply, Macroeconomic Variables, VAR Model

1. Introduction

The western press' reports and national leaders' words have been full of prejudices against China's rapid development since China became the second-largest economic entity in the world. Especially, the president of the United States of America, Donald John Trump, took office shortly, he declared that China is a currency manipulator. As a matter of fact, the reason why China achieves remarkable success in economic field is that good macroeconomic policies has be taken into effect. In particular, the monetary policy deserves to be mentioned most.

Monetary policy is an important instrument with which objectives of macroeconomic policy can be achieved. In China, the function of monetary policy is to maintain the currency's value stabilization so as to accelerate economic growth. In this paper, the money supply is treated as the explanatory variable (a type of independent variable that changes how everything else operates even though it is just a small thing). M_1 (currency plus demand deposits, traveler's checks, and other check-able deposits) and M_2 [M_1 plus retail money market mutual fund balances, saving deposits (including money market deposit accounts), and small time deposits] are treated as explanatory variable. In China, the People's Bank of China publishes the target values of M_1 and M_2 every year. Usually, there is a gap between the growth rate of the actual value and the target value of M_1 & M_2. However, since 2007, the People's Bank of China has abolished the target growth rate of M_1. And only that of M_2 is published. Basically, as the explanatory variable of monetary policy, it should be equipped with the features such as the availability and the pertinence. Namely, the People's Bank of China is able to control the explanatory variable through the control of monetary policy. The reason is that the fluctuation of explanatory variable can influence the price and the

output.

The purpose of this study is to test the long-run relationship between the money supply and the macroeconomic variables (output, inflation rate, interest rate) to demonstrate the validity of money supply which is as an explanatory variable. Another purpose is to verify that M_2 is better to be the explanatory variable of monetary policy than that of M_1 in China.

The consequence of this study shows that the excess money supply (M_2) can result in a rise in the inflation in the short run. It certifies that the People's Bank of China sets the money supply as the explanatory variable which is valid and effective. M_1 is endogenous and determined by the economic development level and the holding of the liquidity costs of the money demand. M_2 is exogenous and determined by the monetary policy of the People's Bank of China because it is difficult for the People's Bank of China to regulate the aim controlling of M_1. When taking the availability and the pertinence into consideration, M_2 is better to be treated as the explanatory variable of monetary policy.

This paper includes five parts. Part 1 is the introduction; Part 2 provides the literature review which provides some findings from the previous studies; Part 3 provides the methodology which is a basis for conducting the empirical analysis; Part 4 presents the empirical analysis which verifies the relationship among variables; Part 5 provides some conclusions.

2. Literature Review

There are a large quantity of scholars who apply different kinds of multiple linear regression models to analyze the dynamic correlation between the money supply and the economic growth as well as inflation. Of course, their results are often different.

Babatunde and Shuaibu (2011) find a monetary growth model for Nigeria by examining the existence of a significant long-run relationship between money supply, inflation and growth as well as to identify the possible determinants of portfolio holdings to identify the main economic fundamentals that influence the relationship between 1975 and 2008. Their study makes use of error correction mechanism and the bounds testing approach to cointegration within an auto regressive distributed lag framework. Quantitative evidences reveal that there is a positive relationship between money supply, capital formation and economic growth in Nigeria while there is a negative relationship between inflation and growth. However, Sabade (2013) figures that monetary policy always has its own limitations and it's high time we understood them. The quantity theory of money gives the identity. Namely, $MV = PT$ which is true. But the functional relationship between M and P, that is, $P = f(M)$ does not hold in India since it's based on the constancy of V and T. So when inflation happens that it need not be attributed to money supply alone. In fact, even if a greater than required money supply has caused it, there is no guarantee that reduced money supply will bring inflation down. Also, Dragos, Mihaela and Stefan (2013) reveal that China directly controls the money supply through the uncontrolled printing of money. China has proved countless times that reaching economic growth is the main goal, and the means do not matter as long as the growth is present. Normally, according to the economic theory the growth of money supply will self-acting lead to inflation. This study proves that this theory is only available in the USA. Thus, for a growth of 1% in the money supply there will be a growth in inflation of 8%. For a growth of 1% in the interest rate, the inflation will grow by 0.6%. Chaudhry, Farooq and Murtaza (2015) publish a paper called "Monetary Policy and its Inflationary Pressure in Pakistan." Their findings go over the main points; interest rate and money supply are important policy variables for controlling inflation in the long run while it is the national output level which put downward pressure on inflation rate in the short run. Meanwhile, Jayasooriya (2015) also recaps that the expansion monetary policy causes to increase the inflation in Sri Lanka and one reason for the expansive monetary policy is the budget deficit. On the other hand inflation also causes to increase the budget deficit. Therefore, these relationships show a vicious cycle of inflation in Sri Lanka. Recently, Hung and Thompson (2016) explore that using data for 23 OECD countries from 1960 to 2009 demonstrates that workers' power has a larger effect on the inflation rate than money growth. Behera (2016) performs that the cointegration result shows that there is at least one linear combination in the long run and hence there is a long-run equilibrium relationship between variables in the model, which suggests that money supply and the exchange rate has a positive effect on the *GDP*

growth in the economy. The error correction results indicate that correct and negative sign for gross domestic product and exchange rate. Lastly, Srithilat and Sun (2017) write an article, named "The Impact of Monetary Policy on Economic Development: Evidence from Lao PDR". Their findings reveal that changing on the stock of money supply will have a negatively effect on the economic development in the long run. The relationship between money supply and gross domestic product per capita is negatively significant. Moreover, the crucial element of monetary policy instrument which driven the economic development of Lao PDR in the long run are interest rate and exchange, these two independent variables have a positive sign and their contribution to gross domestic product per capita are much more higher than money supply. However, the long-run relationship between inflation also confirms the negative relationship between money supply and real gross domestic product per capita, meaning that whenever the money supply has been rising would increase inflation and decreases in real output.

In this paper, the main aim is to verify the relationship between money supply and macroeconomic variables (real *GDP*, inflation rate, interest rate) in China. And the analysis results suggest that the inflation and the real *GDP* have a positive effect on money supply. Conversely, the interest rate has a negative effect on money supply.

3. Methodology

3.1 Suitability Test of M_1 & M_2

M_1 is the sum of the currency plus demand deposits, traveler's checks, and other check-able deposits. The purpose of holding M_1 is to treat it as a media exchange to purchase the commodity, labor services and securities. It is most liquid financial asset that is held by public. M_2 is sum of M_1 and the near money which is the sum of the resident savings deposits, time deposit of enterprises and other deposits. And it can not directly use as media exchange to buy commodity and labor services. If M_2 wants transacting, M_2 should need to be extracted from the bank and transferred into M_1. Therefore, M_1 can be treated as the money in circulation; M_2 is the money stock.
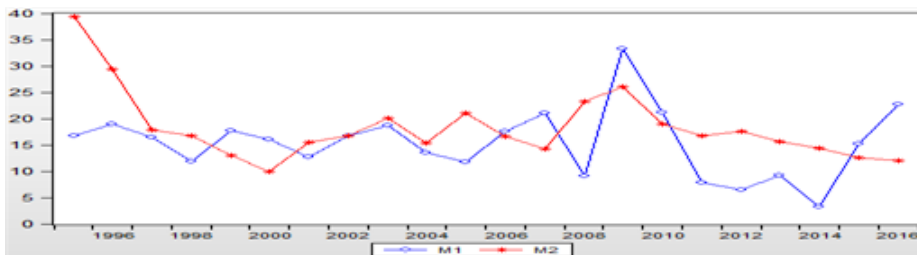

Fig. 1: Year-on-Year Growth Rate of M_1 & M_2
Source: People's Bank of China

Fig.1. shows the volatility of M_1 & M_2's growth. M_1 is relatively steady and M_2 is in a great fluctuation. In different periods of economic activities, M_1 & M_2 often perform differently. For example, when the economy locates in the low point, the growth rate of M_1 is usually lower than that of M_2. Meanwhile, the commodity and labor service's demand is also in the lower level. Conversely, when the growth rate of M_1 exceeds that of M_2, enterprises often transfer their time deposits into demand deposits in a large amount so as to pay for outgoings. Meanwhile, enterprise's will to invest and the economy boom will turn better.

M_1 has a stronger endophytism than that of M_2. Therefore, when the People's Bank of China is ready to loosen monetary, a stimulation needs to be attached into M_2's growth. However, if the total demand does not reach a active degree, M_1 still keeps in a low growth rate. Only when a rise in active degree of economic operation of itself, M_1 will increase quickly. So, M_2 will be adopted to analyze in this paper.

3.2 Long-run Market Equilibrium

In the long run, the money market equilibrium will be shocked by the price level, nominal interest rate. When the real money supply (determined by the central bank) equals the demand for real money balances (determined by the nominal interest rate and real income), the money market will be in equilibrium. Thus, a general model in which money demand is proportional to nominal income, and a deceasing function of the nominal interest rate:

$$M = L(i) \times PY \qquad (1)$$

M is the demand for money; $L(i)$ is a decreasing function of the nominal interest rate; P is the price level; Y is the real income. Dividing by , the money market equilibrium can be derived:

$$\frac{M}{Y} = L(i) \times Y \qquad (2)$$

$\frac{M}{P}$ is the supply of real money; $L(i) \times Y$ is the demand for real money.

An economist, called Juselius, proposes an idea on this proposition. His results show that the real total money can not always determine the money demand, unless backing to equilibrium can be completely performed in the instant. In general, the total money observed probably is determined by money supply, money demand and a combination of them. If the Central Bank can control the money supply effectively, the money supply will be adjusted to the money demand. the total money observed pretty probably is determined by the money supply.

Assuming that the total money, M_2 is determined by the money demand, in the money demand theory, the total money is determined by the transaction demand, wealth demand and opportunity cost. Also the transaction demand of M_2 can be measured by the real *GDP*. A scholar, called Qin, has performed a empirical study on money wealth demand in China. Her findings show that the real income and real interest rate are the main factors that determine the money wealth demand. This finding will be used in this paper.

The real money demand of M_2 gives:

$$M_{2t} = \alpha_1 + \alpha_2 y_t + \alpha_3 p_t + \alpha_4 R_t + \varepsilon_t \qquad (3)$$

Where $\alpha_2 \geq 0, \quad \alpha_3 \geq 0, \quad \alpha_4 \leq 0$; y_t stands for the real; p_t stands for the inflation; R_t stands for the deposit rate.

4. Empirical Analysis

4.1 Data Description

In this paper, four variables are involved. The real total money (M_2) is the ratio of nominal total money to *CPI*; The real *GDP* （y_t）is the ratio of nominal *GDP* to *CPI*; The inflation rate ($\hat{p}_t$) is the ratio of CPI_t to CPI_{t-1}; The deposit interest rate for one year is R_t. The definition, meaning and the source of the variables are shown in table.1.

Table 1. Estimation Variables

Variable	Meaning	Definition	Source
m_{2t}	Real total money M_2	$m_{2t} = \log(\frac{M_{2t}}{CPI_t})$	National Bureau of statistics of the People's Republic of China
y_t	real *GDP*	$y_t = \frac{GDP_t}{CPI_t}$	National Bureau of statistics of the People's Republic of China
$\hat{p}_t$	Year-on-year inflation rate	$\hat{p}_t = \log(\frac{CPI_t}{CPI_{t-1}})$	National Bureau of statistics of the People's Republic of China
R_t	Deposit interest rate for one year	R_t	National Bureau of statistics of the People's Republic of China

4.2 Unit Root Test

When a time-series regression approach is used to study the relationship among time series, it is important to test the stationary of the original sequence first. The reason is that, even though the sequence is non-stationary, the result of the regression test finds that the relationship among the sequences may be notable. In fact, this kind of regression is spurious regression. Therefore, it is necessary to test the stationary of the logarithm sequence of variables.

The ADF test is completed by the following three models:

Model 1:
$$\Delta X_t = \delta X_{t-1} + \sum_{i=1}^{m} \beta_i \Delta X_{t-1} + \varepsilon_t \qquad (4)$$

Model 2:
$$\Delta X_t = \alpha + \delta X_{t-1} + \sum_{i=1}^{m} \beta_i \Delta X_{t-1} + \varepsilon_t \qquad (5)$$

Model 3:
$$\Delta X_t = \alpha + \beta t + \delta X_{t-1} + \sum_{i=1}^{m} \beta_i \Delta X_{t-1} + \varepsilon_t \qquad (6)$$

The null hypothesis, $H_0 : \delta = 0$, one unit root exists; An alternative hypothesis, $H_1 : \delta \neq 0$, a unit root does not exist.

The difference between model 1 and the other two models is that the other two models have constant and trend term. Actually, the proper order to test the sequence is from the model 3 to model 1. Any test that rejects the null hypothesis means that its original sequence does not have a unit root. As long as one of the results from any of the models rejects the null hypothesis, the original hypothesis can be considered to be stationary. When all of the testing results of the three models do not reject the null hypothesis, the original sequence can be considered to be non-stationary. And then, the first difference of the original sequence should be tested, and the procedures above should be repeated until becoming stationary.

Table. 2 shows the unit root test of the original sequence and its first difference.

Table 2. Result of unit root test

Variable	ADF Test Statistic	P-value	Test critical value 5%
m_{2t}	0.011	0.946	-3.081
y_t	-0.577	0.844	-3.120
$\hat{p}_t$	-0.082	0.711	-3.145
R_t	-1.961	0.298	-3.099
Δm_{2t}	-3.822	0.014	-3.099
Δy_t	-4.192	0.008	-3.112
$\Delta \hat{p}_t$	-5.875	0.000	-3.099
ΔR_t	-3.983	0.041	-3.099

Δ stands for the first difference.

Table. 2 shows all variables are non-stationary under the 5% significance level. However, after first difference, all of them become stationary under the 5% significance level.

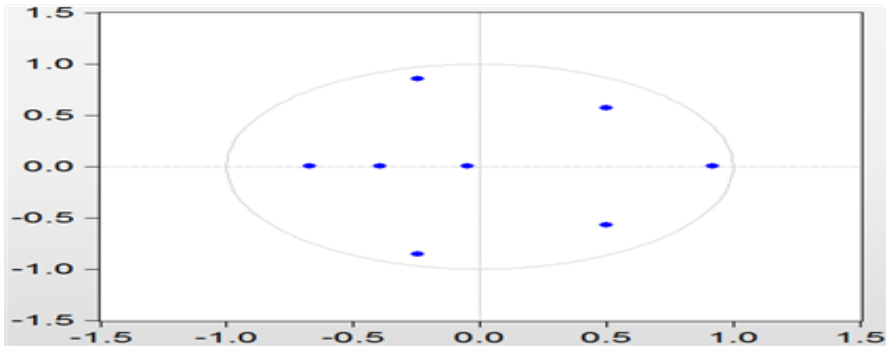### 4.2.1 Choice of lag difference on the model

Fig. 2: Inverse Roots of AR Characteristic Polynomial

Unless roots of VAR model' reciprocal is less than 1. Namely, all points are located in the unit cycle, the model will be stationary. Fig. 1 indicates that this model is stationary because all points are in the unit sycle.

After confirming the stationary of this model, using the VAR model's Lag Order Selection Criteria can determine the lagged difference between the money supply and others from 2000 to 2016 in China. And the results show in table. 2.

Table 2. VAR Model Lag Order Selection Criteria

Lag	LogL	LR	EPE	AIC	SC	HQ
0	94.426	NA	2.891	-12.918	-12.735	-12.935
1	119.577	32.337	8.900	-14.225*	-13.312*	-14.310
2	140.672	15.068	9.852	-14.953	-13.310	-15.105

* indicates lag order selected by the criterion

Table. 2 indicates that according to AIC and SC, the lagged difference is lag 1. Based on this, VAR(1) model whose variables are m_{2t}, y_t, $\hat{p}_t$ and R_t can be established. The estimated results gives:

$$m_{2t} = -0.134m_{2t}(-1) + 0.262\hat{p}_t(-1) - 0.055R_t(-1) + 1.340y_t(-1) - 0.506 \tag{7}$$

$$p_t = 0.686m_{2t}(-1) - 0.268\hat{p}_t(-1) + 0.010R_t(-1) - 0.809y_t(-1) + 1.514 \tag{8}$$

$$R_t = 4.049m_{2t}(-1) + 0.264\hat{p}_t(-1) + 0.897R_t(-1) - 5.258y_t(-1) + 3.245 \tag{9}$$

$$y_t = -0.192m_{2t}(-1) + 0.188\hat{p}_t(-1) + 0.003R_t(-1) + 1.191y_t(-1) - 0.094 \tag{10}$$

$$R^2 = 0.998; AIC = -5.037; SC = -4.801$$

Estimating equation models demonstrate that the fitting degree of models is better. And the value of AIC and SC are small, which illustrates the model structure is steady. Also, it shows that auto correlation and heteroscedasticity does not exist.

4.3 Model Test

4.3.1 Granger Causality test

After establishing model, the causality among all variables should be confirmed.

Table 3. Granger Causality test

Null Hypothesis	F-statistic	P-value	Result
$\hat{p}_t$ does not Granger Cause m_{2t}	5.877	0.031	Rejected
m_{2t} does not Granger Cause $\hat{p}_t$	0.864	0.454	Non-rejected
R_t does not Granger Cause m_{2t}	6.065	0.022	Rejected
m_{2t} does not Granger Cause R_t	0.753	0.498	Non-rejected
y_t does not Granger Cause m_{2t}	4.486	0.045	Rejected
m_{2t} does not Granger Cause y_t	2.834	0.111	Non-rejected

Table.3 shows the hypothesis that $\hat{p}_t$ does not Granger Cause m_{2t} is rejected and m_{2t} does not Granger Cause $\hat{p}_t$ is non-rejected. It means that it is a unidirectional causality from $\hat{p}_t$ to m_{2t} under 5% significance level. Moreover, the conclusion that $\hat{p}_t$ does not Granger Cause m_{2t} is rejected is in accordance with this paper discussed. It indicates the fact that in the long run the inflation can result in an increase in money supply in China, which is significant; Taking the long-run relationship between money supply and interest rate into account, a unidirectional causality between money supply and interest rate exists under 5% significance level. Namely, the money supply and interest rate have an unilateral effects. And Granger causality test result is in keeping with this paper addressed. It also indicates that in the long run an increase in the interest rate can lead to a decrease in money supply in China; In addition, table.3 also implies that there is a long-run relationship between money supply and real *GDP*, and a unidirectional causality from real *GDP* to money supply. The hypothesis that m_{2t} does not Granger Cause y_t is non-rejected and y_t does not Granger Cause *GDP* is rejected under 5% significance level. It demonstrates that in the long run the real *GDP* can promote and expansion of money supply in China.
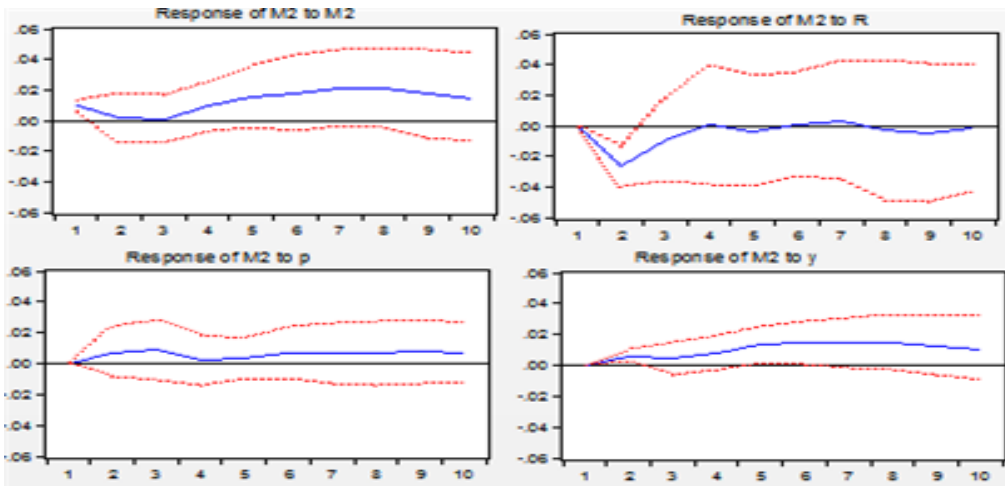
4.3.2 Impulse Response Function

Fig. 3: Impulse response function

The impulse response functions show the reaction of the different variables' impulses to the dependent variable. As for response of m_{2t} to m_{2t}, the money supply performs a rise on itself response; As for response of m_{2t} to R_t, the interest rate has a negative effect on the money supply. At lag 2, its effect arrives at minimum. However, its effect always keeps under the negative area. As for response of m_{2t} to $\hat{p}_t$, the inflation rate has a positive effect on the money supply. After lag 10, its effect on the money supply will keep constant. As for response of m_{2t} to y_t, the real *GDP* also

has a positive effect on the money supply. And in the short run, its effect on the money supply keeps growing. But in the long run, its effect will fall to zero.

4.3.3 Variance Decomposition

Table 4. Variance Decomposition of m_{2t}

Period	S.E	m_{2t}	$\hat{p}_t$	R_t	y_t
1	0.009	100.000	0.000	0.000	0.000
2	0.030	9.531	5.715	81.128	3.627
3	0.033	7.988	11.504	75.731	4.777
4	0.035	13.873	10.307	66.315	9.505
5	0.041	23.807	8.170	50.293	17.728
6	0.047	32.074	8.116	37.668	22.142
7	0.054	39.451	7.535	29.173	23.841
8	0.600	43.806	7.710	23.920	25.105
9	0.064	45.157	7.629	21.492	25.722
10	0.067	46.132	8.013	19.801	26.054

Variance Decomposition measures the contribution of each explanatory variable to the expected change of explained variable. It is useful in assessing how changes to economic variables reverberate through a system.

Table. 4 indicates that in the trend of Chinese money supply growth, the expected variance of Chinese money supply growth is determined by the disturbance from itself in the lag 1. However, in the lag 2, 9.531% of Chinese money supply growth is from itself; 5.715% of Chinese supply money growth is from the inflation; 81.128% of Chinese money supply growth is from interest rate; 3.627% of Chinese money supply growth is from the real *GDP*. Then, if taking the long-run effect into consideration, Chinese money supply growth is mainly determined by itself up to 50%, of course, still 8% from inflation, 14% from interest rate and 28% from real *GDP*.

5. Conclusion

In this paper, most emphasis has been put on the relationship between the money supply, m_{2t}, and macroeconomic variables (real *GDP*, inflation rate, interest rate) in China. Then VAR model is established and the data is gotten from National Bureau of statistics of the People' s Republic of China with the year from 2000 to 2016. Based on two of them, an empirical analysis is conducted and the empirical analysis findings reveal that in China an increase in the real *GDP* can result in an increase in the money supply; Meanwhile, an increase in the inflation rate can lead to an increase in the money supply; Oppositely, an increase in the interest rate can cause a decrease in the money supply. So, the results of this paper provide a better reference for the policy-makers controlling the money supply in China.

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