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The Empirical Research about Monetary Policy and Stock Price Volatility based on Financial Crisis Environment in China

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Abstract: In recent years, the international economic environment is complex. The U.S. subprime mortgage crisis and Europe's sovereign-debt crisis have brought many adverse effects. The central bank has changed the reserve ratio and the interest rates many times in order to achieve the purpose of steady and health growth of economy. This paper investigates the impact of monetary policy on Shanghai stock index by using the VAR model, Granger causality test and co-integration test and impulse response function. The results show that monetary policy has the lagging effect on the Shanghai stock index. The results show that monetary policy has little effect on the Shanghai stock index in the financial crisis environment.

Keywords: Monetary policy; Shanghai stock index; Empirical Analysis; VAR; Financial crisis

1. Introduction

The financial crisis broke out in 2008 since the U.S. subprime mortgage crisis initially appeared in 2007. As an important part of the world economy, China's economy has suffered the severe impact brought by the financial crisis inevitably. Chinese government has taken a series of monetary policies, cutting the reserve ratio and the interest rates many times, in order to deal with the financial crisis and keep a steady growth. In the meantime, the government puts out a stimulus package worth 4,000 billion to stimulate the economic growth, which would inject the liquidity to the economy. In such a complex international financial environment, the easy monetary policies make China's economy better. What this research tries to analyze is the strength of influence and the lagging effect of the monetary policies on economy.

2. Related literature

2.1 The impact of monetary policy on stock prices

Ioannidis and Kontonika(2007) researched the impact of monetary policy on stock prices during 1972 to 2002 about 13 OECD countries, which showed the impact is significant and supported the transmission mechanism of the monetary policy to the stock market. Bjornland and Leitemo(2009) used the VAR model to find there was a significant relationship between real stock price and interest rate. The federal funds rate increased by 100 basis points, the actual stock price immediately fell by 7% to 9%. But Pearce and Roley(1985) found the unexpected money supply increase had a negative relationship with stock price. Chen xiaoli(2003) used the VECM model to find out the Shanghai stock index has a long balanced relationship with M1 and the response is positive. Alatiqi and Fazel(2008) discovered there was no negative significant causality of money supply to interest rate and interest rate to stock price. So there was no significant causality between money supply and stock price.

2.2 The impact of changes in the stock prices on the objectives of monetary policy regulation

Kunt and Levine (1996) consider the stock price rising will improve the liquidity, reducing the transaction cost. Lvine andzervos (1998) make a multinational empirical analysis about 42 countries and prove the fluctuation of stock price had a strong positive correlation with economic growth. The stock price has strong prediction ability about output growth and can respond to economic growth in advance. EI—wassa land Amin(2005) make a empirical analysis about the relationship between stock price and economic growth across 12 emerging market countries during 1988 to 2000. They verify the

stock price has bidirectional causality with economic growth in most countries. Kent (1997) and Bordo(2002) suggest using the interest rate to intervene at the beginning of asset prices rise.

3. Variables and Model

In this article, six variables are used. The selected time series data is the monthly data from March 2007 to July 2012. Shanghai stock index represent the fluctuation of stock price, choosing the closing price on the last day of each month. The interest rate in developed countries market is mature and perfect. On the contrary, the interest rate in China is not decided by the market. But the market of interbank lending interest rate which can reflect the supply-demand change about short-term funds in money market with timeliness and accuracy develop rapidly. And seven days interbank lending rate in all of the inter-bank lending interest rate gets the higher degree of marketization relatively. So the seven days interbank lending rate is chose to represent the fluctuation of interest rate. Broad money supply M1 and narrow money supply M2 are also chose to represent the fluctuation of money supply. Then add the exchange rate and the consumer price index as influencing factors into this model. In this article, VAR model, Granger causality test, ADF test, Johansen co-integration test and impulse response function to analyze.

The VAR model is the main tool in the present research, since it allows examining the dynamic interaction between economic variables. Because the VAR Model are used to analyze lagged terms of all variables' influence over current terms, in other word, to analyze that how X_{t-1} affect X_t. The sample equation VAR (p) that has no exogenous variable and intercept constant is as follows:

$$Y_t=A_1Y_{t-1}+A_2Y_{t-2}+\ldots+A_kY_{t-p}+ut \quad (1)$$

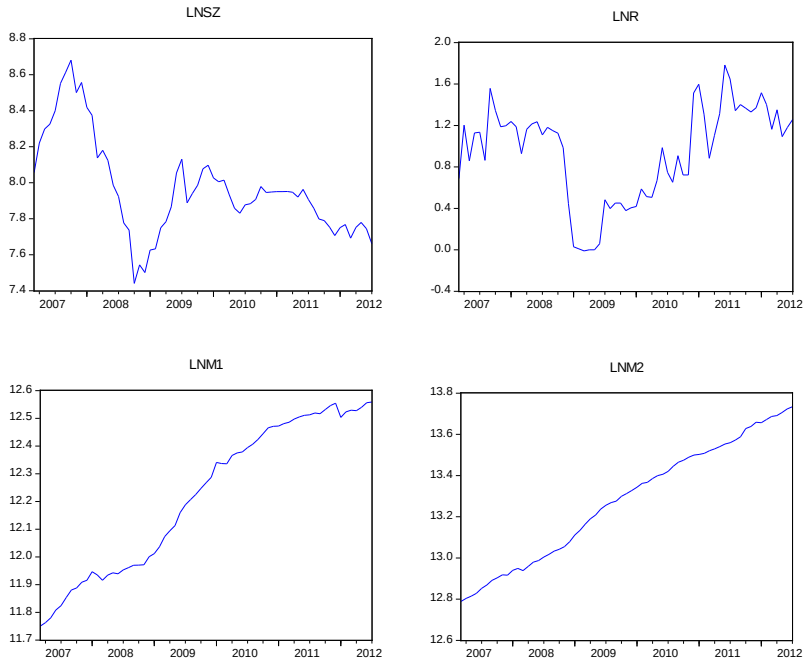
Y_t is the K-dimensional endogenous variables, ut is the k-dimensional random disturbance term.

The paper estimates parameters in the VAR model with the help of software Eviews6.0. The representative symbol of variable is as followed: Shanghai stock index-SZ, narrow money supply- M1, broad money supply-M2, seven days interbank lending rate-R, exchange rate – E and consumer price index- CPI.

4. Empirical Analysis

The high frequency date like monthly data usually exist seasonal variation, making no comparability between each other. So, the date should be seasonally adjusted. All the variables except seven days interbank lending rate are adjusted by Census X11 with Eviews 6.0. Then take logarithm to the all variables, in order to eliminate the impact on measurement results of heteroscedasticity between different variables. The variables are represented as the symbol after logarithm: LNSZ, LNM1, LNM2, LNR, LNE, LNCPI.

Those graphs below show the variables after seasonally adjustment and logarithm.



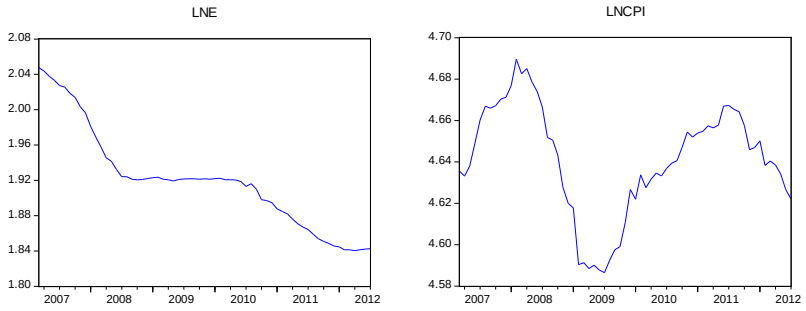


Figure 1. Variables after Seasonally Adjustment and Logarithm
Put all variables into one graph.

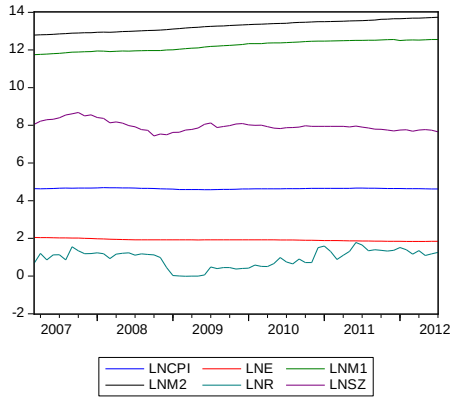


Figure 2. All Variables

4.1 ADF stationary test

All the time series date needs to do the stationary test before modeling in order to make sure if they are stationary. Choose ADF stationary test and determine the minimum lag order number based on SIC criterion. The stationary test results are as below.

Table 1. ADF Test of variables

Variables	Type (c,t,k)	T	Prob.	Test critical values	
LNM1	(c,t,0)	-0.16596	0.9925	1%	-4.107947
				5%	-3.481595
				10%	-3.168695
LNM2	(c,t,0)	-1.0185	0.9338	1%	-4.107947
				5%	-3.481595
				10%	-3.168695
LNR	(c,0,0)	-2.13936	0.2304	1%	-3.536587
				5%	-2.90766
				10%	-2.591396
LNSZ	(c,0,0)	-1.15242	0.6897	1%	-3.536587
				5%	-2.90766
				10%	-2.591396
LNE	(c,t,3)	-3.8379	0.021	1%	-4.115684
				5%	-3.485218
				10%	-3.170793
LNCPI	(c,0,3)	-2.55077	0.1089	1%	-3.542097
				5%	-2.910019
				10%	-2.592645

(C,T,N)represent intercept ,trend and lag order; MAXLAG=10.

From the test results, we can see that T statistics of five variables is greater than the critical value at different level. The hypothesis can't be rejected that the five variables have a unit root. So they are not stationary. But exchange rate is stationary at the 5% critical value. So there is no cointegration relationship between the exchange rate and other five variables during the period chose. The exchange rate is excluded in the following analysis. Still use the ADF stationary test to exam the first order difference of the five variables. Letter D means the first order difference of the variable. Test results are as below.

Table 2. ADF Test of First Order Difference of Variables

Variables	Type (c,t,k)	T	Prob.	Test critical values	
DLNM1	(c,t,0)	-7.27651	0	1%	-4.110440
				5%	-3.482763
				10%	-3.169372
DLNM2	(c,t,0)	-7.15558	0	1%	-4.11044
				5%	-3.482763
				10%	-3.169372
DLNR	(c,0,0)	-8.83649	0	1%	-3.538362
				5%	-2.90842
				10%	-2.591799
DLNSZ	(c,0,0)	-7.42562	0	1%	-3.538362
				5%	-2.90842
				10%	-2.591799
DLNCPI	(0,0,2)	-2.29856	0.0219	1%	-2.603423
				5%	-1.946253
				10%	-1.613346

(C,T,N)represent intercept ,trend and lag order; MAXLAG=10.

It can be seen from the table 2, all the T statistics of the first order difference of five variables is less than the critical value at 5% level. The test results can reject the hypothesis that they have a unit root, which shows a great stationarity. The first order difference of the five variables is stationary and they are integrated of order 1.

4.2 Granger causality test

In this article, the Granger causality test has been taken to estimate the causality between M1, M2, R and SZ. Take the VAR model to estimate the lag order before the Granger causality test. Choose 8 lag order to analyze.

4.2.1 Granger causality test of R, CPI and SZ.

First of all, the optimal lag order need to be determined. The parameters given by different criterions at different lag orders are as below.

Table 3. Parameters of R, CPI and SZ at Different Lag Orders.

Lag	LogL	LR	FPE	AIC	SC	HQ
0	127.3802	NA	2.55e-06	-4.364219	-4.256690	-4.322430
1	288.2835	299.2237*	1.24e-08*	-9.694159*	-9.264043*	-9.527002*
2	292.6700	7.695568	1.46e-08	-9.532281	-8.779578	-9.239755
3	298.9105	10.29130	1.62e-08	-9.435456	-8.360166	-9.017561
4	308.0590	14.12407	1.63e-08	-9.440668	-8.042791	-8.897405
5	315.9986	11.42188	1.73e-08	-9.403461	-7.682997	-8.734830
6	319.7533	5.006287	2.15e-08	-9.219416	-7.176364	-8.425416
7	326.5033	8.289385	2.44e-08	-9.140466	-6.774827	-8.221098
8	336.8340	11.59936	2.49e-08	-9.187156	-6.498931	-8.142420

It can be seen from the date LR, FPE, AIC, SC and HQ criterions all select the lag order 1 as optimal. The five criterions achieved very good consistency. So the lag order 1 has been chosen. Then it needs to be verified if the VAR model with lag order 1 is stationary. Use the AR roots graph to verify.

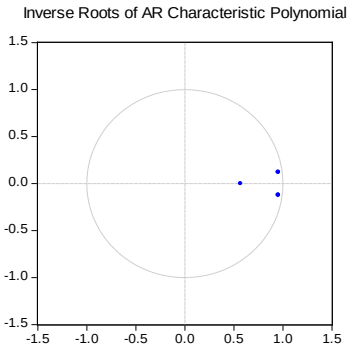


Figure 3. Stationarity Test Graph of VAR (1) Containing R, CPI and SZ

The points in the graph are the inverse roots of the VAR model. It can be seen in the graph all the points are in the circle, which means the VAR (1) containing R, CPI and SZ is stationary. Now we can use the lag order 1 to finish the Granger causality test. Results of the test are as below.

Table 4. Granger Causality Test Results of R, CPI and SZ

Null Hypothesis:	Obs	F-Statistic	Prob.
LNR does not Granger Cause LNCPI	64	0.32458	0.5710
LNCPI does not Granger Cause LNR		7.21581	0.0093
LNSZ does not Granger Cause LNCPI	64	23.1225	1.E-05
LNCPI does not Granger Cause LNSZ		6.62155	0.0125
LNSZ does not Granger Cause LNR	64	2.25580	0.1383
LNR does not Granger Cause LNSZ		5.13030	0.0271

The Granger cause can be got from the table. CPI is the Granger cause of R at 1% significant level, but R is not the Granger cause of CPI. SZ and CPI are the Granger cause to each other at 1% and 5% significant level respectively. SZ is not the Granger cause of R, but R is the Granger cause of SZ at 5% significant level.

4.2.1 Granger causality test of M1, M2, CPI and SZ.

Use the same method above. Determine the optimal lag order among M1, M2, CPI and SZ. The parameters given by different criterions at different lag orders are as below.

Table 5. Parameters of M1, M2, CPI and SZ at Different Lag Orders.

Lag	LogL	LR	FPE	AIC	SC	HQ
0	250.8537	NA	2.03e-09	-8.661533	-8.518161	-8.605813
1	663.0911	752.1525	1.87e-15	-22.56460	-21.84774*	-22.28600
2	687.2145	40.62890	1.42e-15*	-22.84963*	-21.55928	-22.34816*
3	699.8023	19.43384	1.63e-15	-22.72991	-20.86607	-22.00556
4	709.9124	14.18961	2.09e-15	-22.52324	-20.08592	-21.57602
5	731.2401	26.94019*	1.86e-15	-22.71018	-19.69937	-21.54007
6	744.2830	14.64468	2.31e-15	-22.60642	-19.02212	-21.21344
7	757.3094	12.79785	3.01e-15	-22.50208	-18.34430	-20.88623
8	773.5647	13.68868	3.79e-15	-22.51104	-17.77977	-20.67231

* indicates lag order selected by the criterion

From parameters in the table, it can be seen that FPE, AIC, HQ criterions choose the lag order 2 as optimal. However, LR criterion chooses lag order 5 and SC criterion chooses order 2. Considering all the choices made by the criterions, take the choice of the majority lag order 2 as optimal. The AR roots graph of VAR (2) including M1, M2, CPI and SZ is as below.

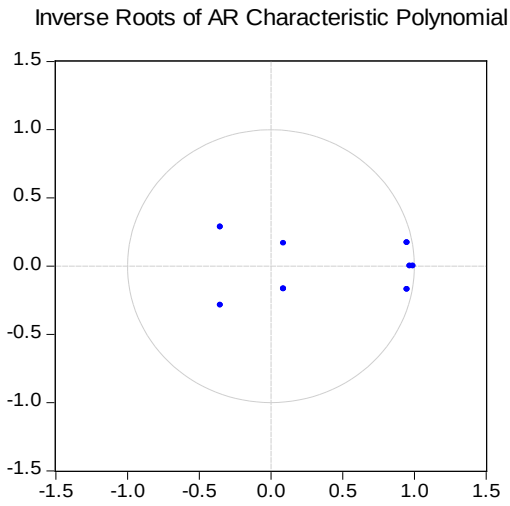


Figure 4. Stationarity Test of VAR (2) Containing M1, M2, CPI and SZ

All the inverse roots are in the circle, which means the VAR (2) model containing M1, M2, CPI and SZ is stationary.

Examine the Granger cause among M1, M2, CPI and SZ with lag order 2.

Table 6 Granger causality test results of M1, M2, CPI and SZ

Null Hypothesis:	Obs	F-Statistic	Prob.
LNM2 does not Granger Cause LNM1	63	1.12818	0.3306
LNM1 does not Granger Cause LNM2		3.50978	0.0364
LNCPI does not Granger Cause LNM1	63	8.30551	0.0007
LNM1 does not Granger Cause LNCPI		4.64449	0.0135
LNSZ does not Granger Cause LNM1	63	6.90424	0.0020
LNM1 does not Granger Cause LNSZ		1.22770	0.3005
LNCPI does not Granger Cause LNM2	63	7.05914	0.0018
LNM2 does not Granger Cause LNCPI		1.83023	0.1695
LNSZ does not Granger Cause LNM2	63	8.99081	0.0004
LNM2 does not Granger Cause LNSZ		0.73436	0.4842
LNSZ does not Granger Cause LNCPI	63	9.57270	0.0003
LNCPI does not Granger Cause LNSZ		2.99543	0.0578

According to the results, we can get the conclusion. M2 is not the Granger cause to M2 but M1 is the Granger cause to M2 at 5% significant level, which is consistent with the theory. CPI and M1 are the Granger cause to each other at 5% significant level. SZ is the Granger cause to M1 at 5% significant level and M1 is not the Granger cause to SZ. CPI is the Granger cause to M2 at 1% significant level and M2 is not the Granger cause to CPI. The same as M1, SZ is the Granger cause to M2 at 1% significant level and M2 is not the Granger cause to SZ.

4.3 Cointegration test

Johansen cointegration test is one test based on VAR model, which use the maximum likelihood estimate method to test the cointegrate vector of the model. Johansen cointegration test has been chosen to analyze in this article.

4.3.1 Johansen cointegration test of R, CPI and SZ

Based on the analysis above choose the lag order 1and the model with intercept to test. Results of Johansen cointegration test are as below.

Table 7. Johansen cointegration test results of R, CPI and SZ

Unrestricted Cointegration Rank Test (Trace)

Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	0.05 Critical Value	Prob.**
None *	0.319555	42.25809	35.19275	0.0074
At most 1	0.149993	18.00261	20.26184	0.0994
At most 2	0.115953	7.764410	9.164546	0.0915

Trace test indicates 1 cointegrating eqn(s) at the 0.05 level

Unrestricted Cointegration Rank Test (Maximum Eigenvalue)

Hypothesized No. of CE(s)	Eigenvalue	Max-Eigen Statistic	0.05 Critical Value	Prob.**
None *	0.319555	24.25548	22.29962	0.0263
At most 1	0.149993	10.23820	15.89210	0.3131
At most 2	0.115953	7.764410	9.164546	0.0915

Max-eigenvalue test indicates 1 cointegrating eqn(s) at the 0.05 level

No matter the trace or maximum eigencalue method, both come to the same conclusion that the hypothesis can be rejected, indicating 1 cointegrating equation at 5% significant level. So there is 1 cointegrating equation among R, CPI and SZ.

4.3.2 Johansen cointegration test of M1, M2, CPI and SZ

Based on the analysis above choose the lag order 2 and the model with intercept and trend to test. Results of Johansen cointegration test are as below.

Table 8. Johansen cointegration test results of M1, M2, CPI and SZ

Unrestricted Cointegration Rank Test (Trace)

Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	0.05 Critical Value	Prob.**
None *	0.409584	62.67380	47.85613	0.0011
At most 1 *	0.327193	30.00429	29.79707	0.0473
At most 2	0.050822	5.433931	15.49471	0.7611
At most 3	0.034863	2.200070	3.841466	0.1380

Trace test indicates 2 cointegrating eqn(s) at the 0.05 level

Unrestricted Cointegration Rank Test (Maximum Eigenvalue)

Hypothesized No. of CE(s)	Eigenvalue	Max-Eigen Statistic	0.05 Critical Value	Prob.**
None*	0.409584	32.66951	27.58434	0.0101
At most 1*	0.327193	24.57036	21.13162	0.0157
At most 2	0.050822	3.233861	14.26460	0.9299
At most 3	0.034863	2.200070	3.841466	0.1380

Max-eigenvalue test indicates 2 cointegrating eqn(s) at the 0.05 level

No matter the trace or maximum eigencalue method, both come to the same conclusion that the hypothesis containing at most 1 cointegrating equation can be rejected, indicating 2 cointegrating equation at 5% significant level. So there is 2 cointegrating equation among M1, M2, CPI and SZ.

4.4 Impulse response

4.4.1 Impulse response of SZ to R and CPI

Give an impulse of R and CPI to SZ respectively. The graphs reflecting the response of SZ are as below.

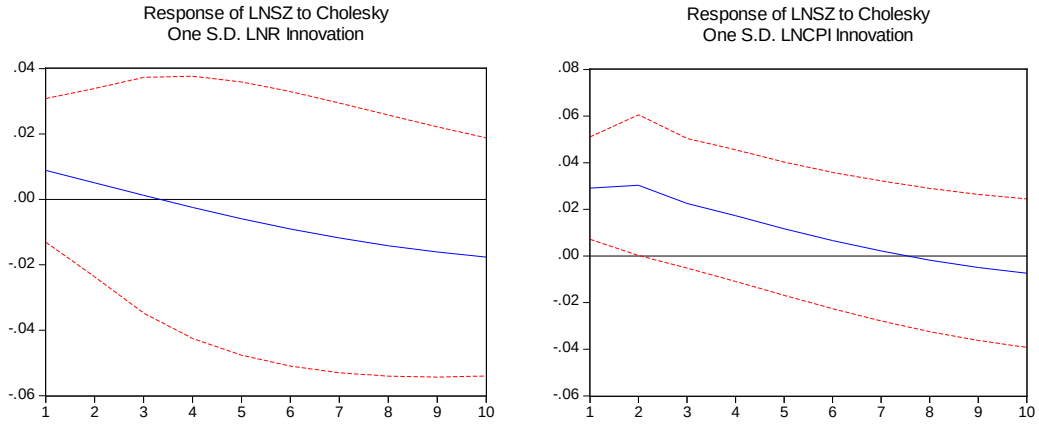


Figure 5. Response of SZ to R and CPI

From the graphs above, it can be seen that SZ basically has little response to R's impulse. The influence of R on SZ is not very significant. The second graph shows the response of SZ to CPI. When there is a positive impulse of CPI, SZ will increase in the previous 2 stage and get the peak value at the second stage. Then the value of SZ begins to fall down. CPI can influence the SZ temporarily not permanent.

4.4.2 Impulse response of SZ to M1and M2

Give an impulse of M1 and M2 respectively to SZ. The response of SZ to M1 and M2 is as below.

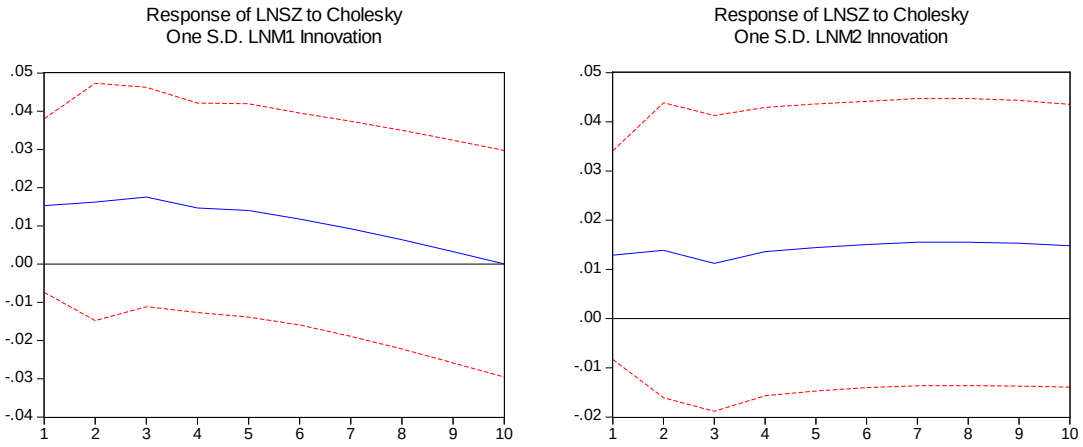


Figure 6. Response of SZ t o M1and M2

The two graphs show the response of SZ to money supply M1 and M2. The SZ rises slowly after getting the impulse of M1 in previous 3 stages and gets the peak value at the third stage. Then SZ begins to fall down from the third stage. The second graph shows the response of SZ to M2. The SZ rises slightly after the impact of M2 impulse in previous 2 stages. Then the SZ has a steady but slow-growing performance from the third stage to eighth stage, getting the peak value at the eighth stage. The 2 graphs reflect money supply can bring the Equidirectional impact to Shanghai stock index, but M2 has longer and more stable influence on SZ than M1.

5. Conclusions

In this article, the VAR model is built under the financial crisis environment. The influence of money supply and seven days interbank lending rate on Shanghai stock index has been researched. The following conclusion has been obtained.

A. Money supply M1 and M2 are not the Granger cause to Shanghai stock index, but Shanghai stock index is the Granger cause to money supply. On the other hand, seven days interbank lending rate is the Grange cause to Shanghai stock index and Shanghai stock index is not the Grange cause to seven days interbank lending rate.

B. There are cointegrating equations between money supply, seven days interbank lending rate and Shanghai stock index.

C. The impulse response of Shanghai stock index to seven days interbank lending rate is not significant and the money supply has an enhancement effect on Shanghai

stock index. The effect of M2 is longer than M1, which is consistent with the theory that M1 has a strong liquidity than M2 and M2 with stable velocity of circulation reflects the trend in long term better.

This article is based on the financial crisis environment. The whole environment has been affected by the negative influence seriously. The investment prospects inside and outside of China is not very good. Although Chinese government has implemented a series of loose monetary policy but the effect on the real economy is not very obvious. The obscure economic makes most of the companies cut their investments even the cost of fund raising has decreased at a large extent. These aspects make the promotion of money policy deplete. Though there is a big fall on the promotion of money policy, it can be denied still has some positive effect on real economy. So in order to cope with the financial crisis, only implementing the loose monetary policy is not enough. The government should make some policies from the point of view to increase the domestic demand. Only the domestic demand increased then the real economy can really be promoted.

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Vitae

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