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The Differentiated Research of China's Monetary Policy's Effect on Stock Price under the SVAR Model----Empirical Analysis Based on Different Economic Backgrounds

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Authors' contributions

This work was carried out in collaboration between all authors. Author JL designed the study, performed the statistical analysis and wrote the protocol. Author PT wrote the first draft of the manuscript and managed the analyses of the study. All authors read and approved the final manuscript.

Research Article

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ABSTRACT

This paper empirically analyzes the impact of China's monetary policy on stock price in different economic backgrounds by constructing the SVAR (Structural Vector Auto Regression) based on the standard VAR (Vector Auto Regression). The results show that: (i) In different economic backgrounds, the direction and size of China's monetary policy's impact on stock price are not same; (ii) There exist different impacts on stock price from monetary policy in short run, but in long-term the impacts do not exist in two economic backgrounds.

Keywords: Monetary policy; stock price; SVAR model; differentiated research.

1. INTRODUCTION

Over the years, the focus of the financial and economics scholars have centered on the impact of monetary policy on stock price. Another subject associated with this is what the impact will be under different economic backgrounds. In order to facilitate the study, we

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devide economic backgrounds into financial crisis background and non-financial crisis backgrounds. Especially after the global financial turmoil triggered by the subprime mortgage crisis, various countries' central banks extremely loosed monetary policy to inject liquidity into the global economy at the same time. After that, most countries' stock index experienced a process of rising. As for China, the monetary policy was not loosed until September 2008 when Lehman Brothers declared broken. It was criticized that China's monetary is always belated. So in financial crisis, will monetary policy have different impact on stock price? Wu (2009) believes that the objectives of monetary policy and the way to achieve them should be re-examined to adapt to the changing international economic and financial market conditions. [1] Monetary policy should be more actively respond to asset price volatility and focus on "symmetrical" reverse cycle operation. Liu (2009) points out that on the basis of conventional monetary policy, the FED（Federal Reserve System） had also adopted a series of monetary policy tools of innovation to inject liquidity into the financial markets in the subprime mortgage crisis. [2] Innovation and application of these monetary policy tools had played an important role in stabilizing market confidence, improving the function of financial markets and also providing a reference to other nations' central banks. Although our scholars and the monetary authorities have paid close attention to the interaction of monetary policy and the stock market, there are few studies about monetary policy's impact on stock price in different economic context at the present stage. Considering that China has suffered the impact of Southeast Asian financial crisis and the U.S. subprime mortgage crisis in recent years, to study the differences in impact of the economic context of monetary policy on the stock market has important theoretical significance and application value.

This paper selects two periods (May, 2002 to Dec, 2009 and Jan, 2001 to Aug, 2008), respectively on behalf of the financial crisis and non-financial crisis period. The reason so selected is that since the U.S. subprime mortgage crisis happened in 2007, The People's Bank of China reduced the bank deposit reserve ratio in August 2008, which indicated the end of the tight monetary policy and the beginning of moderately loose monetary policy. In Dec, 2009, this loose monetary policy ended. Therefore, we choose the above two periods respectively including and excluding the financial crisis, and by building the SVAR model, we empirically analyze the impact of China's monetary policy on stock price in different economic backgrounds.

2. LITERATURE REVIEW AND THEORETICAL BASIS

2.1 Literature Review

Some foreign scholars have empirically studied whether the difference in the impact of monetary policy on stock price exists in different economic backgrounds. Miron、Romer、Weil（1994）and Driscoll（2004）believe that there is no enough evidence to show that the effect of monetary policy exert through the channel of bank credit, so that the impact of monetary policy on stock prices in different economic backgrounds is no difference.[3] However, Kashyap、Stein、Wilcox（1993）and Stein（2000）confirm that the evidence is there[4,5]. McQueen and Roley（1993）use the Federal Reserve discount rate and stock index to examine the dependence of the stock market to monetary policy response to economic conditions. It shows that in the period of economic rise, the stock market shows significant reaction to macroeconomic news. [6] Boyd、Hu、Jagannathan（2005）find that the reaction of stock market to unemployment rate depends on the state of the economy.[7] By testing the response of different departments to credit, Peersman and Smets（2005）prove that the monetary policy will produce different effects in different economic

backgrounds through the bank credit channel.[8] Andersen、Bollerslev、Diebold、Vega（2007）find that there is a positive reaction to the “bad news” in economic expansion period, but negative reaction during the recession [9].

Domestic scholars mainly focus on the effectiveness of the operation of monetary policy tools on the stock market. Qian(1998) uses the static regression method to study the correlation between money supply and stock prices, the result shows that the change of the stock index is in the same direction with M0, nothing to do with M1, and in the opposite direction with M2. So he believes that the expected factor in the stock price formation is more important, and monetary policy has little effect on stock prices. [10] Yi and Wang(2002), by establishing the stock market of the monetary policy transmission mechanism theoretical model, derive that monetary policy has impact on stock price, the relationship between the quantity of money and inflation depends not only on the price of goods and services but also the stock market. [11] Sun and Ma (2003) use dynamic rolling vector regression and Granger causality test to study the relationship between monetary policy and stock price, and find that money supply M0, M1and M2 have no impact on stock market but the central bank's interest rate variable has a significant impact on stock price [12].

2.2 Theoretical Basis

There are two channels through which stock prices respond to monetary news. The first and more traditional channel is the interest rate channel that relates to economic activity primarily through consumption and investment. This channel of monetary transmission relies on the effect of interest rate changes on loan demand. A cut in the interest rates reduces the cost of borrowing for investment and leads to an increase in economic activity. Furthermore, reduced cost of borrowing translates into lower cost of capital for firms, increasing the present value of future cash flows and thereby directly affecting the stock prices. A drop in the interest rates also promotes current over future consumption. Alternatively, an increase in the cost of borrowing increases the cost of capital for firms and reduces consumer demand. Hypothetically, the interest rate channel may lead to time variation in the response of stock re-turns if the elasticity of investment borrowing varies over time or if the intertemporal elasticity of substitution of consumption is cyclical.

The second channel of monetary policy transmission, the credit channel, can be subdivided into two mechanisms: the bank loan channel and the balance sheet channel. The bank loan channel stresses cyclicality in the availability of loans. A reduction in the supply of bank credit affects the economic activity of bank-dependent borrowers. The balance sheet channel focuses on changes in creditworthiness of firms due to procyclical fluctuations in the quality of their balance sheets. Both mechanisms of the credit channel stress the supply of funds to the firms. When credit markets are tight, a surprise monetary easing reduces the quantity restrictions on the availability of credit, resulting in a larger effect on the level of economic activity. Theories of the credit channel predict that worsening credit market conditions give rise to the ‘‘financial accelerator” effects by amplifying the effect of real or monetary shocks on the economy. Borrowers have better information about their creditworthiness than the lenders do. Such informational frictions lead to an “external finance premium” between the cost of internally generated funds and funds raised from financial markets. Bernanke and Gertler (1989) argue that these frictions are largest in recessions, when weak balance sheets lead to higher costs of external finance, resulting in lower investment demand and reduced economic activity. Furthermore, banks and other financial intermediaries may tighten credit standards ahead of a period of weak economy, reducing

the supply of credit to weaker borrowers. These riskier borrowers have limited access to alternative sources of credit. As a result, they are more affected by macroeconomic shocks in adverse credit market conditions.

3. VARIABLE SELECTION AND MODEL SPECIFICATION

The vector auto regression model (VAR) is a convenient and effective tool to study the correlation between stock market and monetary policy, this model so far has been widely applied to the related research. However, since the VAR model is based solely on the characteristics of data-driven, it may produce the following two questions in the process of applying: first, there is no basis of economic theory, it is difficult to distinguish between endogenous and exogenous variables; second, as the impact of current period between variables can not be considered, the VAR model can not be recognized. To solve the problems, Bernanke (1986) put forward Structural Vector AutoRegression model(SVAR), which is set according to economic theory constraints, and relaxes the assumption that variable current impact is zero.[13] By taking full account of its own lagged variables and other variables' influence on the main object of study in current and lag periods, the SVAR model can be well identified, and to some extent makes up for the VAR model. Therefore, this paper uses SVAR (based on VAR) to study the impact of China's monetary policy on stock price under different economic backgrounds.

This article selects four variables in the SVAR model: output, money supply, stock price index and inflation rate. Output and inflation rate are macroeconomic variables, reflecting the trend of macroeconomic development; the money supply is monetary policy variable, reflecting the trend of monetary policy; stock price index reflects price movements of stock markets in general. Specifically, output is represented by GDP in general research, but considering that China's GDP is measured quarterly, we replace GDP with the industrial added value (i_t) .The broad money supply (m_2) represents the monetary policy, The Shanghai Composite Index (s_t) represents the stock price, and consumer price index (π_t) on behalf of the inflation rate.

The basic idea of constructing the VAR model is as follows: According to the mainstream practice in studying the relationship between monetary policy and macroeconomic variables, this article assumes that recursive structure exists between the money stock, stock prices and output, inflation rate. It means output and inflation rate can have an immediate effect on monetary policy, but the impact of monetary policy on output and inflation rate has to lag one period. Since the problem of identifying the model exists, the usual approach is to assume that stock prices will affect macroeconomic variables and the variables of monetary policy tools while these variables will not affect the stock price changes simultaneously. The reasonableness of the assumptions will be greatly challenged because of the rapidly changing stock market, stock price index is very sensitive to changes in monetary policy, and any change in monetary policy will be quickly digested and reflected in the stock index. Therefore, we assume that immediate effect exists between monetary policy and stock price. Setting the model in this way, of course, is more in line with economic realities, but the SVAR model will be insufficiently identified. To solve this problem, the article assumes that there is no long-term effect of monetary policy on stock price. Combined with existing short-term constraints, SVAR model can exactly be identified by adding a long-term constraint. So the specific VAR model is as follows:

$$X_t = B_1 X_{t-1} + B_2 X_{t-2} + \cdots B_p X_{t-p} + \varepsilon_\varepsilon \quad (1)$$

$X_t = (i_t, \eta_t, s_t, m_t)'$, B_p is a 4*p-order coefficient matrix. P is the lag phases of each variable. ε_ε is residual term, and subject to independent and identically distributed, $\varepsilon_\varepsilon \sim i.i.d(0, \Omega)$.

Generally, standard VAR model can be written as a vector moving average form, s follows:

$$X_t = B(L)\varepsilon_\varepsilon \quad (2)$$

$B(L)$ is 4*4-order matrix, and $B(L) = \sum_{j=0}^{\infty} D_j L^j$ .L is the lag operator.

Now assume the following linear relationship between the structural perturbation of e_t and residuals of ε_ε:

$$\varepsilon_\varepsilon = \Gamma e_t \quad (3)$$

In which Γ is a 4*4-order constant coefficient matrix.

Put equation (3) into equation (2), we can get a new equation as follows :

$$X_t = B(L)\Gamma e_t$$

Let $C(L) = B(L)\Gamma$, therefore,

$$X_t = C(L)e_t \quad (4)$$

In order to effectively identify the model, you must first identify the matrix Γ. So we make the following assumptions, i) e_t is subject to the standard normal distribution; ii) variables in e_t are Orthogonal to each other; iii) Money neutrality.

Learning from Bjornland and Leitemo (2009)'s [14] method of studying the relationship among monetary policy, macroeconomic variables and stock price, we impose five short-term constraints in SVAR model: (1) we suppose the recursive structure exists between macroeconomic variables and monetary policy instrument variables, which means that the shock of macroeconomic variables will impact on monetary policy immediately and that the impact of monetary policy on macroeconomic variables lags one period. So we have $\Gamma_{14} = \Gamma_{24} = 0$. (2) The recursive structure exists between macroeconomic variables and stock price. So $\Gamma_{13} = \Gamma_{23} = 0$. (3) The shock of output will have immediate impact on inflation rate, while the impact of monetary policy on macroeconomic variables lags one period. So $\Gamma_{12} = 0$. Therefore, The matrix form of the SVAR model can be written as:

$$\begin{bmatrix} i_t \\ \pi_t \\ s_t \\ m_t \end{bmatrix} = B(L) \begin{bmatrix} \Gamma_{11} & 0 & 0 & 0 \\ \Gamma_{21} & \Gamma_{22} & 0 & 0 \\ \Gamma_{31} & \Gamma_{32} & \Gamma_{33} & \Gamma_{34} \\ \Gamma_{41} & \Gamma_{42} & \Gamma_{43} & \Gamma_{44} \end{bmatrix} \begin{bmatrix} e_t^1 \\ e_t^\pi \\ e_t^s \\ e_t^m \end{bmatrix} \quad (5)$$

The SVAR model contains four endogenous variables, to identify the model, we need 4*(4-1)/2=6 constraints. Five short-term constraints can be obtained by the recursive structure, however, there is still a constraint needed. We have assumed that two-way immediate effect exist between monetary policy and stock price, and also recognized the long-term currency neutral, Thus we can get the following long-term constraints:

$$\sum_{i=0}^{\infty} C_{34,i} = 0 \tag{6}$$

Where $C(L) = B(L)\Gamma$, let $C(l) = \sum_{i=0}^{\infty} C_i$, long-term constraints can also be written as $C_{34}(l) = 0$, namely

$$B_{31}(l)\Gamma_{14} + B_{32}(l)\Gamma_{24} + B_{33}(l)\Gamma_{34} + B_{34}(l)\Gamma_{44} = 0 \tag{7}$$

Through vector autoregression in standard VAR model (equation 1), we can calculate the value of all elements of the matrix $B(L)$.

Since we know the short-term constraint is $\Gamma_{14} = \Gamma_{24} = 0$, the sixth constraint can be written as:

$$B_{33}(l)\Gamma_{34} + B_{34}(l)\Gamma_{44} = 0 \tag{8}$$

Therefore, there are a total of six constraints, the first five short-term constraints adding the long-term constraint (8), which is enough to identify the model.

4. DATA SELECTION AND PROCESSING

Based on the research needs, we select a monthly time series data from January 2001 to December 2009 and divide it into two groups, the first set of data from January 2001 to August 2008, and the second set of data from 2002May to December 2009. The monthly growth rate of the Industrial added value represents output, and the chain growth rate of CPI, which chooses 2000 as the base year, represents price index. The level of stock price is represented by the Shanghai Composite index which is the most representative of China's stock market. According to domestic mainstream method of studying monetary policy, we use the broad money growth rate to represent monetary policy. All of the above data come from the China National Bureau of Statistics website and the wind financial database.

Data in addition to the monthly growth rate of industrial added value and broad money is logarithmic, and all the data is seasonally adjusted by CensusX12. Due to the absence of the industrial added value data in January, 2007-2008, we use interpolation to derive the missing data.

5. EMPIRICAL TEST

5.1 Determining the Lag Order and Testing the Stability of the Model

The lag order of SVAR model is determined by lag order of the corresponding VAR model.

Considering the AIC criterion and the SC guidelines in standard VAR model, we select 2 as the optimal lag order.

The stability of the model can be used to test whether theory and the lag order choice are reasonable, and the impulse response analysis cannot be done before the stability test. The test results of the stability of the two sets of sample are as follows:

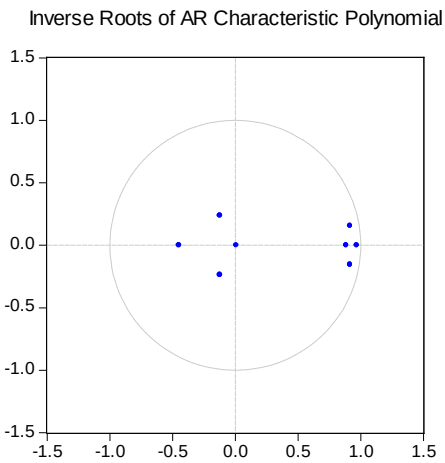

Fig. 1. AR Roots in financial crisis period

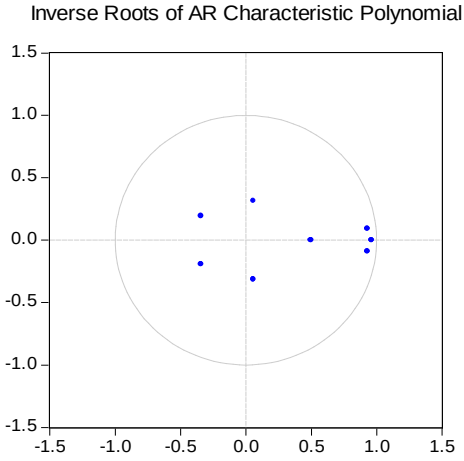

Fig. 2. AR Roots in non-financial crisis period

AS Fig. 1 and Fig. 2 show, all the AR roots' mode is in the unit circle, which means the VAR model is stable in this article. Therefore, the economic system we have established and the choice of lag order are reasonable to ensure further research effectively.

5.2 Impulse Response Analysis

Impulse response function can reflect the impact of the one-time impact of a variable on other variables; this section will accordingly focus on the analysis of the impact of the different periods of China's monetary policy on the stock market, taking the impact of price and output on the stock market into account as a reference. In previous literature, in order to identify the SVAR model, it is assumed that no real-time interaction effect exists between monetary policy and stock prices, and usually Cholesky decomposition is used to analyze the mutual effect between variables. Obviously this assumption does not match the real economic situation, so the conclusion is also doubtful. This article assumes that mutual immediate effect exists between monetary policy and stock price, so the SVAR model can be identified by establishing long-term constraint in this model. So we use structural decomposition to do Impulse response analysis instead of Cholesky decomposition.

5.2.1 Impulse response analysis of the period which contains the financial crisis

(i) The impact of monetary policy shocks on stock price

Fig. 3 shows the response curve of stock price to monetary policy impact. In the Figure, the solid line represents the impulse response curve, the dotted lines represent plus or minus

twice the standard deviation of the deviation from the band. Unexpected money growth represents expansionary monetary policy shocks.

As Fig. 3 shows, when a positive monetary policy shock occurs, stock price will rise immediately, and reach its highest point in two months, then gradually return to normal level. Such an impact will be in the opposite direction seven months later. This result shows that in the case of financial crisis, China's expansionary monetary policy will have a positive impact on stock price in short term, with the passage of time, this positive impact will be transformed into a negative impact, but in long term this effect will disappear.

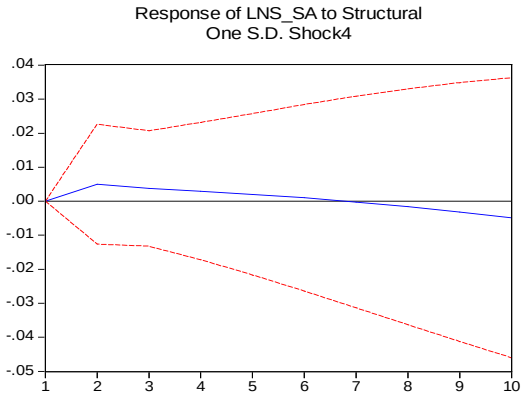

Fig. 3. Response Curve of monetary policy shocks on stock price

(ii) The impact of output and price index shocks on stock price

As Fig. 4 shows, when a positive output shock occurs, the price of the stock market will rise and reach its highest point in two months, and then decrease gradually. After five months it will produce a negative effect on stock price. The impulse response curve in Fig. 5 indicates that a positive output shock will have a positive impact on stock price immediately, and the impact will become stronger in two months and be negative four months later.

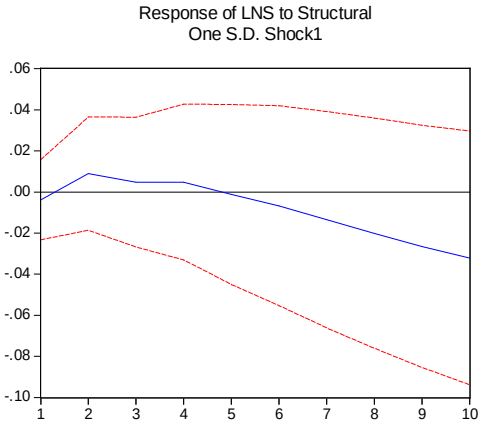

Fig. 4. Response Curve of output shocks on stock price

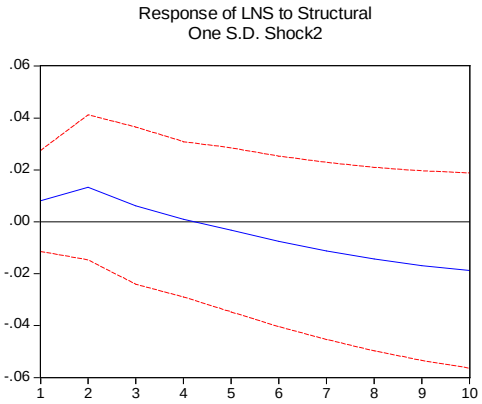

Fig. 5. Response Curve of price index shocks on stock price

5.2.2 Impulse response analysis of the period which dose not contain the financial crisis

(i) The impact of monetary policy shocks on stock price

As Fig. 6 shows, when a positive monetary policy shock occurs, stock price will decrease immediately, and reach its lowest point in two months, then gradually return to normal level, such an impact will be in the opposite direction three months later. This effect of monetary policy shock will reach a peak in eighth month and gradually decline to zero after that. This result shows that in the case of none-financial crisis, China's expansionary monetary policy will have a positive impact on stock price in short term, but in the long term this effect does not exist.

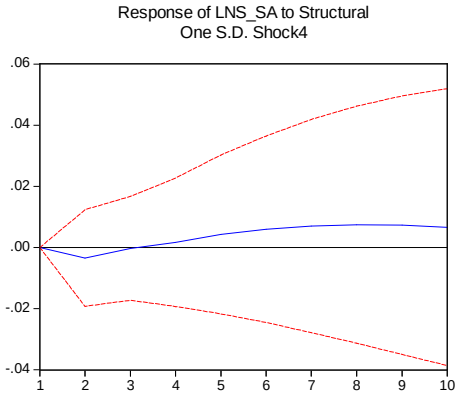

Fig. 6. Response Curve of monetary policy shocks on stock price

(ii) The impact of output and price index shocks on stock price

As Fig. 7 shows, when a positive output shock occurs, the price of the stock market will rise and reach its highest point in two months, and then decrease gradually. After five months it will produce a negative effect on stock price. The impulse response curve in Fig. 8 indicates

that a positive output shock will have a positive impact on stock price immediately, and the impact will become strongest in two months and be negative four months later.

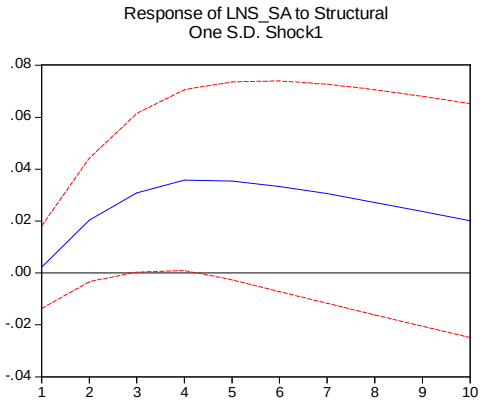

Fig. 7. Response Curve of output shocks on stock price

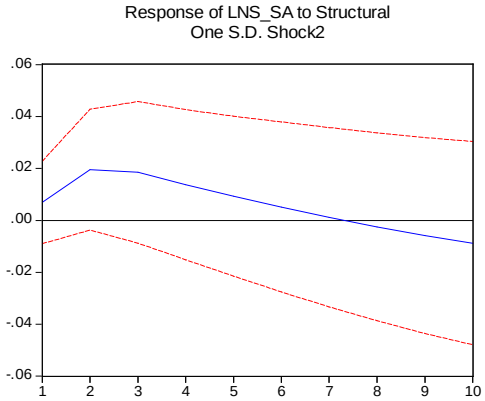

Fig. 8. Response Curve of price index shocks on stock price

Based on the above analysis, in the period containing financial crisis, expansionary monetary policy has a positive impact on stock price in short term. This effect will gradually decrease and turn negative over time, and in the long run monetary policy dose not have an impact on stock price. However, in the period without financial crisis, expansionary monetary policy has a negative impact on stock price in short term. This effect will turn positive over time, in the long run it does not exist.

5.3 Variance Decomposition

In order to compare the impact of monetary policy on stock price in different economic backgrounds more clearly, we have calculated the degree of interpretation of the various shocks on stock price according to the results of the impulse response analysis. Compare Tables 1 and 2, we can find that in short term although the impact of monetary policy on stock price in two periods is less than 1%, the impact in financial crisis shocks larger than that in non-financial crisis. In the second month, 0.15% of price change can be explained by

the shock of monetary policy in the case of the financial crisis, while only 0.09% in non-financial crisis case. With the increase of the lag phases, in the context of the financial crisis, 1.24% of stock price changes can be explained by the impact of monetary policy in twentieth month, but in the context of non-financial crisis, only 0.47% can be explained.

Table 1. Variance decomposition in financial crisis period

Period	S.E.	Shock1	Shock2	Shock3	Shock4
1	2.62	0.03	0.67	99.30	0.00
2	2.84	0.74	1.14	97.97	0.15
4	3.30	0.72	0.69	98.45	0.14
8	3.52	0.78	0.76	98.38	0.08
12	3.56	4.32	1.72	93.78	0.18
16	3.64	9.50	2.39	87.52	0.58
20	3.72	12.98	2.56	83.23	1.24
Factorization: Structural					

Table 2. Variance decomposition in non-financial crisis period

Period	S.E.	Shock1	Shock2	Shock3	Shock4
1	2.70	0.08	0.84	99.08	0.00
2	2.93	3.19	3.25	93.47	0.09
4	3.11	8.65	3.12	88.18	0.05
8	3.30	9.67	1.56	88.52	0.25
12	3.40	7.88	1.46	90.35	0.31
16	3.44	6.42	2.10	91.21	0.26
20	3.46	5.67	2.88	90.99	0.47
Factorization: Structural					

6. SUMMARY AND CONCLUSION

Based on the standard VAR model, this paper uses the SVAR model to analyze the effects of China's monetary policy on the stock market in different economic backgrounds. By impulse response function and variance decomposition analysis, we can get the following conclusions:

In different economic backgrounds, the direction and size of monetary policy's impact on stock market are not the same. The impulse response analysis reflecting the direction of impact in two backgrounds is different in short run, but this impact does not exist in the long run. Variance decomposition confirms the different size of impact, in most periods, monetary policy in financial crisis period can explain the change of stock price much more than in non-financial period. This indicates that China's stock market seems to be capital-driven in the context of the financial crisis, and it will be more effective for central bank to influence the stock market by regulating the money supply. However, in the period of sustained economic expansion, capital may not be the decisive factor to affect stock price.

This paper argues that effect of monetary policy on the stock market seems to be weaker in non-financial crisis period. In the stage that stock index is rising and capital bubble is accumulating, it is questionable for central bank to tighten liquidity frequently in order to inhibit the rapid rise of capital market. In addition to increasing the short-term volatility of capital markets, frequently using monetary policy of tightening liquidity has no obvious long-term effect. Of course, due to the cumulative effects of the policy gradually precipitating, the

overheated capital market will eventually respond to the monetary policy, but often overcorrected then. Performance against overheating of the economy such as high real estate prices before the outbreak of the U.S. subprime mortgage crisis, the Federal Reserve rise interest rate 17 times, making the benchmark interest rate upwards from 1% to 5.25%. But once the crisis broke out, the market also began to move toward the other extreme, and plenty of money seemed to disappear overnight, the Fed had to take a lot of money funds into the market to avoid a recession, but injecting a large amount of monetary funds planted a huge risk for future inflation even the next crisis.

The conclusions reached in this article are consistent with economic theory to a certain extent. Since China's stock market experienced a split share structure reform during the time scope of this analysis, it is necessary to select the cartridge time point to make a more detailed analysis of the relationship between stock market and macroeconomic and monetary policy in future research. In addition, one feature of China's monetary policy is the management and control of the amount of credit, therefore, it is also to be considered whether the important variable in this monetary policy has effect on stock price in future research.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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