UNIVERSITY OF VAASA, FINLAND

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Long Zhou

THE INTERACTION BETWEEN MONETARY POLICY AND STOCK MARKET: AN EMPIRICAL INVESTIGATION ON CHINA

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UNIVERSITY OF VAASA	
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Author:	Long Zhou
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Name of the Supervisor:	Professor Timo Rothovius
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ABSTRACT

The thesis aims to study the interaction between the monetary policy and stock market in China. The research problem includes two aspects that on one side, we study the influence of stock market development on monetary policy via exploring whether the Chinese stock market is qualified to be considered as a new monetary policy transmission channel to make monetary policy regulation more effective on macro economy. On the other side, we examine the impact of monetary policy intermediate targets, i.e. interest rate and money supply, on stock market respectively.

According to the set of study purpose, the empirical analysis is mainly divided into three parts corresponding to each research hypothesis, and a series of modern econometric techniques are employed such as Vector Autoregression, Cointegration modeling and Error Correction Model, Granger-causality test, Impulse Response function and Variance Decomposition, etc.

The empirical results suggest that the stock market's effect on economy is extremely limited and even negatively in the long-run, so the Chinese stock market can hardly impact the monetary policy formulation that it is not qualified to be a new monetary policy transmission channel or intermediate target. Thus the central bank only need to concern the stock market but do not have to peg. Meanwhile, for the impact of monetary policy on the stock market, the interest rate has negative effect on stock price. And money supply, regarded as currency demand, is observed to be positively affected by stock price, not vice versa as presumed.

KEYWORDS: interaction, monetary policy, Chinese stock market, transmission channel, intermediate target

1. Introduction

For the past decades, along with the world's economic development and the speeding up of financial deepening process, a conspicuous trend of worldwide financial structure evolution is that the financial market, especially the stock market, has an extraordinarily rapid development that in the financial system, the stock market's status and role has been rising and strengthening day by day. Traditionally, we regard the function of the stock market as by direct financial means efficiently allocating fund resources, improving finance efficiency, accurately revealing price information and reflecting the macroeconomic situation, etc. That is why we regard it as a macroeconomic weatherglass. But in quite a long time the impact of stock market on the real economy was quite limited that in most countries the commercial banks dominate the financial system, and the credit costs and acquirability of commercial banks form the dominant mechanism which the central bank's monetary policy is based on. As a consequence the central bank did not fully consider the stock market's impact on the real economy and monetary policy transmission mechanism.

From the 1990s, however, the situation had changed, that the correlation enhanced between monetary policy and stock market whose scale kept increasing. The deepening stock market's ‘wealth effect’ and ‘balance sheet effect’ had become to important monetary policy transmission mechanisms, and had begun to have a profound effect on monetary policy objectives, such as economic growth. This also had a certain impact on the formulating of monetary policy. Therefore in developed countries with high degree of financial market’s liberalization, like in Europe and America nowadays, the stock market has been concerned by monetary policy makers as an effective channel of the policy transmission. On August 27th 1999’s monetary policy conference, Alan Greenspan, the US Federal Reserve Chairman at that time, stressed that as U.S. residents put substantial income into the stock market, monetary policy makers should give more concerns to the factors from stock market. Since then, that whether stock price should be accounted into general price level and added into monetary policy regulation targets has become the focus of the argument between economists and central bankers.

In China, different views of scholars in the theoretical circle are broadly divided into three schools. The first school is researchers of stock funds, whose basic views are that they require the central bank to concern and affect financial asset prices, and demand the central bank increase the intensity of intervention when the stock market fluctuates overly. The second school is scholars from academic research institutions.

They stress the stock market's own function in the allocation of resources, and insist the stock market has its own law of development. The central bank, as an administrative department of the government, should not excessively intervene in the market. In operation, because there are high speculative opportunities in Chinese stock market and stock prices often tend to depart from the economy, Chinese monetary policy should not follow the asset prices. Xie Ping (2000) believes that if monetary policy excessively takes the stock market into account, it will not only lose independence but also negatively affect the establishment of normal market discipline. The stock price index must not be made a reference target for the decision-making of the central bank. The role of the monetary policy to the stock market should be neutral. If the monetary policy is intended to stimulate the stock market, it would create the moral risk and harm both monetary policy and the stock market. The third school is researchers of government departments. Their basic views are that the central bank should 'concern' the price fluctuations of financial assets, but not 'peg on'. The stock price should be brought into the monetary policy as subsidiary monitoring indicator and contribute to establish the relevant indicator system. According to the market trends and changes of the price, we should make appropriate judgments and take necessary actions to control (Sun Huayu, Ma Yue, 2003). Monetary policies not only have a direct impact on the currency market and financial agents, but also influence the investment of enterprises and residents, as well as consumer behaviors through changing the participants' expectation of financial market. Since this interaction and influence is reversible, financial asset price is an important macroeconomic indicator. Thus we need to pay attention to the changes of the financial asset prices when we make monetary policy decisions (Qian Xiaoan, 2001). Through several years' theoretical and practical exploration, the third school's theoretical viewpoint is widely applied by the central monetary administration.

For the worldwide background a large number of scholars have conducted exploratory research covering various aspects. Firstly, the stock price's function of providing information in monetary policy-making is investigated as an information variable. People study about the information content that stock price reflects and especially about the role of stock price on forecasting output and inflation (Peter Christoffersen, Torsten Slok, 2000; James H. Stock, Mark W. Watson, 2000). Secondly, people do a lot of research about the role of stock price as intermediary in the monetary policy transmission process, which is researched as the adjustment variable in the monetary policy transmission mechanism (Charles Goodhart & Boris Hofmann, 2001). Thirdly, people inspected the central bank's actual response and effect to the stock price volatility when monetary policies are formulated and operated (Christopher Kent &

Philip Lowe, 1997; Stephen G. Cecchetti, 2000; Roberto Rigobon & Brian Sack, 2001). In addition, according to the general principles of monetary policy, from the economic stability's angle, they have studied the relationship between the stock price and financial instability, particularly the bank instability, and the corresponding monetary policy response principles (Jan Toporowski, 1999).

Compared with developed countries, China has a unique economy situation. The stock market in China is an emerging market with short developing time but high developing speed. By the end of 2007, the total number of listed companies has reached 1550, the total market value of Shanghai and Shenzhen stock market over 32.71 trillion Yuan, the secondary market value in circulation over 9.31 trillion Yuan, A-share individual investor accounts 109 million, and funds holders 25.9495 million which is seven times of that in last year. However, this market is far from mature in the real sense that abnormal and irregular fluctuations are frequently observed, while its volatility and risk is much higher than mature markets worldwide. In such case, complicated interaction between monetary policy and stock market provides both difficulties and importance for the study.

1.1. Purpose of the study

So far, domestic researches are basically built on logical deduction and normative analysis, and the depth and breadth of the discussion and the modern econometrical technical adoption are to be strengthened.

This paper aims to make theoretical analysis and deep empirical study on the interaction effect and correlation between monetary policy and stock market in China, in order to provide reference for the monetary policy formulation and implementation of central currency administration. The research includes two aspects that on one side, we study the influence of stock market development on monetary policy via exploring whether the Chinese stock market is qualified to be considered as a new monetary policy transmission channel to make monetary policy regulation more effective on macro economy. On the other side, we examine the impact of monetary policy on stock market, incorporating the effect and forecasting capability of monetary policy intermediate target, such as interest rate and money supply, on Chinese stock market.

1.2. Research hypothesis

Since this paper study on the interaction between the monetary policy and stock market, such relationship is respected as from two sides. As introduced above on the research problem, firstly we would like to discuss the impact of stock market on the monetary policy. In particular, it is equally as the impact of stock market development on the monetary policy formulation, that if the stock market presents significant effect on the economic growth, then the monetary policy formulation is said to be affected and has to consider the situation and gives chance to let it be a new transmission channel or intermediate target. So in the first research hypothesis we assume the situation exists referring to the fact that developed countries' mature markets already have such significant effect.

H1: Chinese stock market development has positive and significant effect on the economic growth.

Meanwhile, we also study on the impact of monetary policy on the stock market, which is divided by two parts since the monetary policy usually affect stock market by two policy tools, the interest rate and money supply. We observe their impacts on the stock price respectively. Based on the theoretical analysis and practical experience, we set the following two research hypothesis as below.

H2: The interest rate negatively impacts the stock price.

H3: The money supply positively drives the stock price rising.

1.3. Literature review

1.3.1. Review of international researches

Fama (1990) investigates many factors which affect the payoff from the American stock market during 1953 to 1987. He discovers that the growth rate of industrial production (as the dependent variable) can be interpreted by the past actual stock return (as the independent variable) in the regression.

With the American data from 1947 to 1992, Domian and Lonton (1997) test the forecasting power of stock return towards the growth rate of industrial production. They build dummy variables and asymmetric models to discuss whether the impact of stock return on the growth of industrial production has asymmetry. The results indicate that when the stock return is negative, the growth rate of industrial production diminishes significantly; when the stock return is positive, the growth rate of industrial production only increases slightly. It can be generated from these results that stock return moves is able to predict the economy fluctuation, and it predicts more efficiently when it falls.

Rigobom and Sack (2003) point out that the fluctuation of stock market play an enormous role in the American economy. For instance, for the level of stock possession by American household sector in 2000, when the S&P 500 Index rises by 5%, resident wealth will increase 578 billion dollars. Assuming that the marginal propensity of consume of stock wealth is 4%, under this situation the total consumption will increase 23 billion dollars and the GDP will subsequently grows by 0.23 percentage. Therefore they insist that it is necessary for the Federal Reserve Board to react to the stock price fluctuation.

On the other hand, some economists get different conclusions. Their practical researches show that there is only weakly positive correlation between stock parameters and economic growth (Harrison, 1997). Moreover, stated by Harrison, in the developed countries the indexes in the stock market do help understanding the growth of real GDP per capita, while even if the correlation does exist in the undeveloped countries, it would be very weak. B. Friedman (2000) applies empirical analysis on how the American stock price affects inflation and output in a long period. The conclusion is that the effect is not significant enough to attract attentions from the policy makers as one information variable.

Base on the previous researches on the correlation between monetary policy and stock returns, it is discovered that monetary policy could forecast the future stock price movements to a certain extent. According to the conclusions of Hardouvelis (1987), information which related to the monetary policy has more significant influences on the movement of stock prices than the others have.

With the methods of Long-Horizon regressions and Short-Horizon VARs, Paetlis (1997) investigates the role played by monetary policy in the American stock market and the forecast ability it has, and shows strong evidence of that loose monetary policy is usually followed by increasing stock price. It is also suggested that the relationship between monetary policy and stock price exists in every phase of an economic period.

Huang. R.D. and W.A. Kracaw (1994) apply news model to their research and find that there exists a positive correlation between stock price and money supply and a negative correlation between stock price and interest rate. Similar results come from Dayananda.D. and Wen-Yao Ko (1996)'s research on Taiwan sample. They report that stock return rate is also positively correlated with money supply with a weak statistical significance and negatively correlated with interest rate.

In fact economists have started researches on the relationship between money supply and stock price early from the 1960s, and mainly focused on the existence and direction of causality. The majority believe that money supply indirectly influences the stock market, and usually this influence works through the interest rate of long-term bonds and expected profit of companies. However, from the figure of stock price and currency increasing rate, Sprinkel (1964) finds that stock price is direct function of historical money supply. By constructing the regression equation for money supply and stock price, Homa and Jaffee (1971) also prove that stock price is directly influenced by money supply to a significant extent. Further than that, Hamburger and Kochin (1972) reveal that money supply has important short-term direct impacts on stock price, which act independently from the interest rate and expected profit of companies.

Following the definition of Granger-causality and the test method used by Hisao (1981), Ho, Y. K. (1983) conducts a bivariate autoregression model to discuss the correlation between money supply and stock price in six countries and areas, i.e. Australia, Hongkong, Japan, Singapore, Philippines and Thailand. The results suggest that the movement of security market is predictable.

The American data shows that money supply well explains stock price fluctuations (Friedman, M., 1988), which is enhanced by Dhakal, Kandil and Sharma (1993)'s analyses on American sample under the assumption of currency market equilibrium. They also state that through asset substitution effect increased money supply will change the amount of money at equilibrium and increase the money balance. Hence the demand for financial asset will grow and lead to its price rising. On the other hand, increased money supply will bring inflation expectation thereby negatively affect the asset price. Both positive and negative correlations between M1 and stock price are found in the long-run from data sample of Europe, Japan, Southeast Asia and South Korea (Chung S.Kwon, 1999; Alireza Nassel et al., 2000; Ralf Ostermarka, 2001; Praphan Wongbangpo et al., 2002;).

Studying with the quarterly data of stock price of America during 1961-1986, M. Friedman (1988) reaches to some findings in his empirical research on the money demand effect of stock price. First, there is no significant portfolio effect when stock price is rising. Second, transaction effect has insignificant influence on M2 but has significant influence on M1 and M0. Third, the increasing of stock price causes larger wealth effect than substitution effect for M2. However, the 1886-1985 data supports an opposite statement to the third finding, which represents that the increase of stock price would reduce currency demand. As a result the third finding is considered as an exception.

In the paper of Fieldman (1984), the variable of trading volume is introduced to the currency demand function. The data analysis shows that from 1919 to 1929 the volume expanded sharply, which resulted in the increase of transaction demand for money. This research indicates that without the rapid volume growth after 1925, the demand for M1 would be 17% lower than it actually was. Claimed by Palley (1995), trade volume and currency demand have significantly positive correlation, which is generated from the data of American stock market in 1976-1991. He also finds that it would strengthen the capability of prediction of money demand function if stock market variable is introduced.

Mooker.r. and Qiao Yu (1999)'s analyses to Singaporean stock market give evidence on the existence of a stable equilibrium between stock price and money supply. They also find that the later one moves after the former one.

After that, S.B. Carpenter and J. Lange (2002) apply the Cointegration and Error Correction Model to their research of American money demand function using quarterly data from 1995 to 2002. They find that the higher volatility of stock market tends to increase the M2 balance, and the short-term dynamic model demonstrates that the growth of expected returns would decrease the growth rate of M2.

1.3.2. Review of Chinese researches

It should be pointed out that the background of most of the above researches is developed financial market, which differs from the Chinese case and has restrictions as the references. In terms of the domestic study, Tan Ruyong (2000) tests relations between the development of Chinese stock market and economic growth using quarterly data. Its results show that the development of Chinese stock market affects the economic growth but its influence is extremely limited. Not only that, but also he find out the coefficients of stock market factors are significantly negative, which shows that Chinese stock market did not adapt to the mainstream economics point of view that the stock market promotes economic growth, but has negative effect to some extent.

Zheng Jianghuai, Yuan Kuangliang and Hu Zhiqian (2000) adopt quantitative analysis and get that household savings and the total market value of the stock market have significant positive relationship, which means the stock market’s development has a major impact on the residents savings behavior, as revealed that the mechanism of economic growth which affected by Chinese current stock market is already obvious. However, the same results also showed that even the mechanism is existed, but in fact from the statistical results the contribution to economic growth is not significant.

Zhao Zhijun (2000) reveals a strong negative correlation between the ratio of the Chinese stock market value to GNP and the growth rate of GNP. A positive correlation between stock market value and GNP is found by Shi Jianmin (2001), although the coefficient is very small. In the study of Xie Ping and Jiao Jinpu (2002) the correlation coefficient between total retail sales and Shanghai & Shenzhen stock composite Index is found negative and that between industrial value added and the index is pretty low.

Qian Xiaoan (1998) has studied the impact of asset price changes to monetary policy and pointed out that asset price changes could put a great impact on the stability of currency demand and the performance of monetary policy. Some corresponding adjustments should be made in determining monetary policy goals and implementing monetary policy.

Yi Gang et al (2002) found that the relationship between currency amount and inflation not only depends on the general price of commodity and service but also to some extent depends on the stock market. When stock prices deviate far from equilibrium, the economy operation would be unsafe. Therefore, the price of the stock market and that of commodity and service should be both taken into consideration by the central bank when the currency policy is set down. However, the fundamental policy goal is still to maintain the currency value stability.

The authoritative report published by Project Group of Research Department, People's Bank of China (2002) argued in theory that with the development of capital market and the financial innovation, the boundary that distinguishes monetary from other financial assets grows blurred. The stable association between money supply and actual economic variables is losing. Currency amount is no longer simply proportional with general price and income, but has an important correlation with all the transactions that need currency as media, including financial market transaction. The conclusion is that the stock market cannot be one of the decisive factors of monetary policy, that is, we should concern the stock market volatility but not peg.

From the theoretical analysis, Zhao Huaiyong (2001) points out that asset prices, especially the stock prices, weaken the relativity and controllability of money supply, that is, the stable relationship between money supply and general price, the stable relationship between money and outputs, the controllability of money supply. Song Huaqing and Yu Sha (2002) point out that the changes of stock price affect the money multiplier and the money base to impact the money supply eventually. Liu Jian and Xie Chaohua (2003) theoretically analyzed that the changes in money supply affect the stock price through asset restructuring channel, the wealth adjusting channel, the liquidity effect channel, the balance sheet channel and the stock market channel. Yu Yuanquan (2004) believes that the fluctuations of stock price affect the measurability and controllability of money supply, and the relativity between economic growth and money supply. Zhou Xingjian (2004) theoretically analyzed the changes in stock prices have influence on the money supply structure and quantity, which makes the effectiveness of money supply, as an intermediate target, weakened.

On the empirical analyses, Xie Fuchun and Dai Chunping (2000) use 1994 - 1999 years' quarterly data on currency demand function estimation finding that there is a significant positive correlation between M1, M2 and nominal balance of expected currency. DuanYu and Wang Zhiqiang (2000) show that there is a stable positive correlation between stock price index and the narrow sense of money demand.

Li Hongyan and Jiang Tao (2000) studied the relationship between the money supply and stock prices from January 1993 to August 1999. The results show that in the 1990s, there is a long-term equilibrium cointegration between the Chinese stock price and money supply, and the stock price is the cause, the money supply is the effect. The stock price's impact on the different levels of money supply is diverse. It has greater impact on non-cash level than the cash level.

Employing quarterly data of 1993-2002 Shi Jianmin (2001) obtained the result that the growth rate of stock market trading turnover is positively correlated with the growth rate of balance of M1 and M2.

Zhou Yingzhang and Sun Qiqu (2002) studied the sample in January 1993 to April 2001 and presented the relation between different levels of money supply M0, Ml, M2 and the fluctuations of Shanghai Stock Exchange A-share stock price index. The results show that in the long run, statistically speaking, stock price and money supply closely related to each other. Between them, stock price is dominant. It affects money supply significantly, while the money supply has little impact on promoting stock price which affects the money supply at different levels diversely, greatest impact on Ml, followed by M0, the least is on M2.

Li Wenjun (2002) studied the relations between the monetary policy and stock market from the second quarter in 1995 to the first quarter in 2002. Through Granger test, he found that Chinese money supply affects the fluctuations of the stock prices to a certain extent, and vice versa.

Jiang Boke and Chen Hua (2003) used the stock rate of return and its variance to estimate the impact of stock market on currency demand, and the results show that there is a significant positive correlation between the expectation and variance of real stock rate of return and the real balance of currency demand.

Chen Xiaoli (2003) set the monthly data of January 1997 to April 2002 as the samples, studied the relationship between Chinese stock prices and monetary policy. The results showed that in the short term, stock prices and money supply are Granger-caused by each other.

Liu Hunsong (2004) set January 1995 to August 2003 as the sample interval, researched on the money supply and stock market fluctuations. The results showed that different levels of money supply do have impacts on the stock price. The changes of stock price will lead to changes of M0.

Xu Haiyan and Song Guanghui (2004) set the annual data from 1990-2001 as the sample to study the relationship between stock market and the money supply. The results showed that the stock price and the money supply have interaction between them. The volatility of stock price will influence the structure of money supply and its quantity, while money supply also influence the stock price.

Jin Dehuan and Li Shengli (2004) set January 1997 to July 2003 as the sample interval and get the results showing that among stock price and M0, M2, there exists a long-run cointegration steady state, and M0, M2 could be used to explain the stock market price, while price changes are not the cause of changes in the money supply.

Duan Jin, Zeng Linghua and Zhu Jingping (2006) did similar study as above, and the results present that the stock market is affected by M2 statistically on borderline, but not affected by M1. They also found it is the structure of M2 that affected by stock market, but not the quantity of M2.

Zhang Xiaobing (2007) shows different results according to different time intervals that in the long-run, the currency demand positively correlates with stock price while in the short-run, stock price has negative impact, implying there exists significant substitution effect for currency demand.

1.4. Structure of the thesis

The thesis is constructed with six chapters. In the first chapter, the purpose of the study and corresponding research hypothesis are introduced, as well as the research background and review on both international and Chinese literatures. The following two chapters deal with the theoretical support that chapter two gives the brief introduction of the monetary policy and stock market, and chapter three focuses on the theory concerning the correlation mechanism between them. In the rest three chapters, empirical analysis is provided. Chapter four lists the data description, sample period, and methodology that would be employed in chapter five, where the empirical tests and results are summarized. At last, interpretations and conclusions on the study are to be presented in chapter six.

2. MONETARY POLICY AND STOCK MARKET

2.1. Monetary policy

Monetary policy is an important instrument for the currency administration to stimulate or depress economy. The central bank could apply a series policy tools to achieve the goal of regulating economy or security market. Whereas a relative long course will be required with respect to the formulation, implementation and achievement of monetary policy, various external error shocks could affect the policy's expected effect. Thus to be in control of the policy transmission effect, the monetary policy's intermediate targets are preferred to be in virtue of, which are also the important reference for investors' judgment on stock price fluctuations.

2.1.1. Monetary policy targets

Monetary policy targets are divided into ultimate targets and intermediate targets. Ultimate targets, which include price stabilization, full employment, economic growth and balance of payments, are the final objectives of the monetary policy in the long-run, and are closely related to the economic issues in the society.

Intermediate targets are required to be measurable, practicable and correlative. They are the variables conducted by the policy makers in order to achieve the ultimate targets. Arguments go with the selection of intermediate targets, but usually the interest rate and monetary supply are chosen by most governments in practice.

2.1.2. Monetary policy tools

Monetary policy tools are instruments and techniques for the currency administration to achieve the ultimate targets through intermediate targets. Monetary policy tools have two kinds, general tools and specified tools. The former affects the credit and currency situation of the entire economy through influencing the asset and debt operating activities of the whole commercial bank system, while the later specifically act on some particular operating activities or specific banks.

Open market operations, required reserve ratio and discount rate are widely used as general tools. Through buying or selling the securities on the open market, almost any intermediate targets set by the monetary authorities can be achieved. Therefore it is recommended by many economists. Required reserve ratio directly affects the available amount of loans granted by commercial banks, which is powerful but lacking of flexibility thus rarely applied. Discount rate is a passive reaction with uncontrollable advertising effects, which creates disturbance for the monetary policy targets realized.

Specified tools contain moral suasion, required margin ratio, consumption credit restriction, real estate credit restriction, interest rate cap and so on. Most are disused gradually because their impacts are not only weak but also involve unavoidable disadvantages.

2.1.3. Monetary policy transmission mechanism

The mechanism serves the monetary policy effect course on how to achieve expected policy targets. Keynes school and Currency school are the two main streams contributing to the theory of transmission mechanism of monetary policy. Keynes school states that from the partial equilibrium angle, monetary policy first acts on the reserves of commercial banks, which leads to the change of money supply. Consequently, the interest rate is resettled and the investment changes accordingly. Through multiplier effect the national income and expenditure would be influenced.

Currency school describes the transmission mechanism as follows: The central bank applies certain policy tools to increase the reserve of commercial banks, which expands the loanable funds and lower the interest rate. On one hand, both investment and loan are boosted; on the other hand, the price of financial assets rises, while that of durable material assets, like estates, decreases. As a result the demand for these durable material assets grows and drives prices up. Along with this effect spreading to other material assets, additional currency demand is created and nominal income is increased.

2.2. Chinese Stock market

2.2.1. Stock price measurement

The Chinese stock market consists of two parts, Shanghai Stock Exchange and Shenzhen Stock Exchange, in which the Shanghai stock market value covers over 80% of the whole Chinese stock market value and usually represents the whole Chinese market.

The Shanghai Stock Exchange Comprehensive Price Index, which is the generally adopted statistic index reflecting the macro trend of Shanghai stock market, is published on July 15th, 1991 by Shanghai Stock Exchange. Along with the rapid development of Shanghai stock market, it published the new A-share price index and B-share price index on Feb 21st, 1992, to reflect the different type of shares' fluctuation.

The A-shares are issued by domestic companies, purchased and exchanged with RMB (Chinese Yuan) by domestic institutes, organizations or individuals. In comparison B-shares are issued domestically and marked with RMB, but can only be transacted with foreign currency, which are aim at foreign investors and that from Hongkong, Macao, or Taiwan district. Nowadays the B-share market is also opened to domestic investors owning dollar account. Nevertheless, the B-shares can hardly reflect the whole market since its market value and share number are much smaller than that of A-shares.

2.2.2. Function of stock market

As the market mechanism for resource allocation, property right trade-off, risk dispersing and corporation management, the stock market's functions are generally as follows: financing for enterprises to accelerate their development, encouraging their technological innovation and marketization in order to improve the national economy restructuring, benefiting the optimal allocation of social resources, deepening financial reform and improving macro-economic regulation.

3. THEORY OF THE CORRELATION MECHANISM BETWEEN MONETARY POLICY AND STOCK MARKET

3.1. The stock market as monetary policy transmission channel

3.1.1. Investment channel

According to Tobin's q theory (1969), q is defined to be the market value divided by its reset cost. When the central bank carries out loose monetary policy, stock price would be promoted by the interest rate fall. Therefore q being larger than one represents that the market value is higher than the reset cost. Under this circumstance the company is capable of issuing less stock with higher price and getting more assets. As a result the company investment rises and causes gross demand and output to grow.

3.1.2. Wealth channel

Modigliani (1971) considers that wealth effect is mainly responsible for the correlation between monetary policy and assets price. According to life circle rule, when stock price rises, the consumers' nominal wealth increases. Then their present and future consumption both grow and gross demand as well as output increase.

3.1.3. Balance sheet channel

The supporters of this theory believe that information asymmetry exists on the credit market. Asymmetry provides chances for the monetary policy to spread to the real economy activities through stock market channel, which is the impact of stock price on the company's balance sheet. When stock price is stimulated by loose monetary policy, company's wealth would appreciate and present net value raise, which means the financing ability of the company, is strengthened for collateralization. As a result, bank loans expand and pull up investment, gross demand and gross output.

3.1.4. Liquidity channel

Investment combinations differ among investors. Durable products and real estates have low liquidity while stock, fund, security and other financial assets are easy to be cashed in. Loose monetary policy stimulates stock price and makes financial assets prices appreciate, which is a sign for an optimistic expectation that the probability of financial difficulties would drop in the future. Therefore the expenditure for durable assets grows and gross demand expands as well as the gross output.

3.2. Effect of monetary policy on stock market

3.2.1. Effect of interest rate on stock market

Stock market is sensitive to the interest rate that both adjusting from central bank and change of investors' expectation, even rumors for interest rate are likely to cause a stock price fluctuation. There are ways for interest rate to influence stock price. First, comparative price and profit structure of different investment objectives will change following interest rate change. Lower interest rate represents that bond holders would receive relatively less returns than stock holders. As a result bond holders incline to exchange their possession for stock, which drives up stock price and brings enterprises better financial condition. Under this situation company investment is likely to increase, and social investment, consumption and income would grow accordingly. Second, interest rate influences company's profit. High interest rate forms higher loan cost and lower profit, which is against the operation of a company and pulls down its stock price. Third, from the investors' point of view, higher interest rate would create more risk and cost for the short-run leveraged stock exchange, then reducing demand and price. Last but not least, based on present value theory, security price is mainly determined by expected return and the interest rate (discount rate) of the time, and is positively correlated to the former while negatively related to the later.

3.2.2. Effect of money supply on stock market

Monetary policy has effect on stock market through three channels. (1) Expectation effect. The intention of monetary policy expansion would change expectation on the currency market. Consequently, money supply, price and scale in the stock market will be affected. (2) Asset substitution effect. Under loose policy, the public possess more money with decreased marginal utility (investment payoff). With all other conditions standing still, the currency they hold will exceed the necessary amount of daily use. As a result a part of it tends to step into the stock market, which could drive stock price up. (3) Intrinsic value effect. When monetary supply increases, investment would expand while interest rate declines, and then stock return rises through multiplier effect. Therefore stock price increases. Generally speaking, the above three effects are positive. In other words, increased money supply is followed by increased stock price.

Meanwhile, stock price could also have feedback on money supply. The fluctuation in the stock market could break the balance of money demand, and then result in the change on the money supply's accumulation and structure. This impact approach is summarized by M. Friedman (1988) into four aspects. (1) Wealth effect. The increase of stock price creates more nominal wealth; Incremental wealth produces larger demand for money. (2) Portfolio effect. Rising stock price could be considered as a higher expected return of risky assets compared to the risk-free assets. Assume that the degree of risk aversion of the public remains the same. People have to reconstruct the proportion of each type of asset in order to rebuild the risk balance. For example, they might increase the share of short-term bond and cash as offset, which would lead to an extra currency demand. (3) Trading effect. The increase of stock price always goes with the expansion of trading volume. Accordingly, more money is required to support the trades. (4) Substitution effect. Higher price plus higher volume usually make a stock more attractive and more popular. To a certain extent, the money supply, for example the savings deposit, becomes substitutable by stock. Therefore the demand for currency declines. In sum, currency demand will be boosted by wealth effect, portfolio effect and trading effect, while it will be decreased by substitution effect.

3.3. Theory of regarding stock price as monetary policy regulating target

3.3.1. Theory of regarding stock price as monetary policy intermediate target

Tobin is one of the representative characters of Yale school who claim that stock price should be selected as an intermediate target of monetary policy. Because the central bank could not directly affect the supply and demand of material assets, it has to utilize interest rate structure to communicate monetary policy with real economy activities. Stock is the financial claim for material assets, so that its price reflects the supply and demand for material assets. Meanwhile, stock price is the bridge of connecting monetary policy and social economic activities. Stock price grows when the demand for material capital increases. It represents that production is more active and monetary policy is expanding, vice versa. For these reasons, stock price is good radar, which sensitively captures the intention of monetary policy and gives rapid and precise feedback.

Tobin believes that central bank is capable of effectively controlling stock price. From his point of view, along with the incremental issuance of Treasury bond and the increasing proportion it accounts for gross social debt, government has more and more power to manipulate the economy, which could be seen from the development and improvement of Treasury bond management policy. Thus the central bank is capable of adjusting the scale, structure and rate of return of social capitals as well as interest rate and money supply. Moreover, the central bank can conduct social demand towards financial assets by influencing the public expectations and their risk attitude through certain monetary policy.

Based on the above discussions, Tobin suggests that stock price well reflects attitudes of the capital market and the intention of monetary policy, and it is also completely controllable by central bank, thus it is eligible to be an intermediate target. Although his theory is logically reasonable, it has met many criticisms for being not practical. Criticisms focus on three aspects. First is against the controllability. Among all factors that have impacts on stock price, some are not well controlled by central bank, such as assessment on risk, choices between income and convenience and so on. Therefore stock price is not fully manipulable. Second, the volatilities of security market are frequent and unpredictable. Stock price not always precisely represents policy intention. Third, it is difficult to choose an ideal stock price to truly reflect the supply and demand in the capital market. All types of stock prices would be affected by many factors, monetary policy, industry policy, social preference, district diversity and company operation for instance. However, their reactions towards these impacts vary in both extent and direction. So that it is not easy to describe the capital market with a proper stock price, especially in the economic depression or overheating.

3.3.2. Theory of regarding stock price as monetary policy ultimate target

For long, most countries including China have considered stable price level as the significant ultimate target of the monetary policy. Actually along with the development of security market, some economists suggest adding stock price to the ultimate policy targets basing on the following arguments. First, the fluctuation of stock price is caused not only by the change of the economy fundamental. It is unnecessarily for the central bank to react to the stock market fluctuation if the stock market is rational and the price only reflects the fundamental. In reality, other issues such as irrational behavior of the investors and inefficient supervision system could also affect the security price. Second, the creation and breaking of stock price bubbles both have great influences on the real economy. For instance, stock price bubbles can self-strengthen the influences through financial institutions, and because of their inevitability of collapse, which behaves usually in the form of a stock market disaster in a short time, the stock price bubbles are considered to be a huge threat to the stabilization of the financial system as well as the development of the national economy. Therefore stock price control is a necessary way to accomplish monetary policy.

However, disagreements are always around. Ben Bernanke and Mark Gertler (1999) have proved that the policy pegging stock price would probably intensify the fluctuation of price and output. And as introduced above, Friedman (2000)'s research on the impact of American stock price on the long-run inflation and output comes up with the conclusion that there exists no significant influence. Hence the stock price can hardly be concerned as an information variable during the decision making of monetary policy makers. Xie Ping (2000) believes over-concerning the stock market is not only weakening the policy independency but also negatively affects the establishment of normal market discipline.

4. DATA AND METHODOLOGY

4.1. Data

4.1.1. Data descriptions

In this thesis we employ monthly data to make empirical analysis, and they all well represent the research objects that the study focuses on. All data are collected from online authoritative information source: the website of The People's Bank of China (http://www.pbc.gov.cn), the web site of China Securities Regulatory Commission (http://www.csrc.gov.cn), the website of National Bureau of Statistics of China (http://www.stats.gov.cn) and the financial database of China Macroeconomic Information Network (http://www.macrochina.com.cn). Logarithm transformation is preferred to be applied on the data which are all input into the econometric analysis software, Eviews 5.0, for empirical study.

As followed we introduce the data we adopt which is denoted by code name with always a character "L" ahead as logarithmically transformed.

LIVA represents the industrial value added. It measures the new increased industrial ultimate production value created by Chinese industrial enterprises within a specified time span. In the empirical part of the thesis we are supposed to use GDP value as object data to measure the economic growth status of China, but it is unavailable for monthly GDP data which is only accessible on yearly or seasonal value, also considering China is experiencing a high speed of industrialization with a predominant output proportion of the whole economic production, so we select the industrial value added as substitute.

LLOAN denotes total loans granted by financial institutions to each economy sector including short-term loans, medium & long-term loans and trust loans, etc. It measures the scale of credit funds in China.

LTM is short for total market value of Chinese stock market which is constructed by two parts, Shanghai Stock Exchange and Shenzhen Stock Exchange. They mainly have national large-sized enterprises listed and private small & medium-sized enterprises listed respectively. So the total market value sums up all the stock exchange listed enterprises' market value and it is the most important indicator of the magnitude and advanced degree of a country's stock market as a reference to measure the effect on Chinese economy.

LIBR represents China Interbank Offered Rate, a benchmark interest rate based on several specified large banks' everyday quote on each fund of maturity. As the leading interest rate that guides other interest rates in money market, it reflects the real price of capitals and affects the saving & loan interest rate provided by financial institutes. The rate consists of varieties of maturities, usually from overnight to 12 months, and we hereby adopt the weighted average rate which is calculated by trading volume as weight for each variety of maturity.

LM0 denotes the circulating cash asset in China, measuring the highest liquidity of money supply outside financial institutes and the debts of central bank.

LM1 weighs the money supply including M1 and current deposits of every economy sector. Because the current deposit allows withdraw or transfer at any moment without notifying the bank in advance at any moment, the M1 scale of money supply is also with high liquidity.

LM2 measures M1 plus all time deposits including savings deposit, fixed deposit, foreign currency deposit, trust deposit and margin for clients of securities companies. Compared to M0 and M1 it has the lowest liquidity to be convertible to cash.

LSSEA represents Shanghai Stock Exchange A-share Price Index. The index covers all the A-share stocks listed in Shanghai Stock Exchange and is calculated by weighted sample market value. It can fully represent the stock price of all shares exchanged with RMB in Shanghai stock market and is proved to be the leading price indicator for the whole China stock market. The index was initiated on Feb 21^{st}, 1992 and its base time point is Dec 19^{th}, 1990, base value 100.

LSSEQ denotes the trading turnover of all listed A-share stocks in Shanghai Stock Exchange in a given period. It is calculated by Chinese Yuan, RMB.

4.1.2. The data sample period

In order to analyze the research topic detailedly we have the empirical part of this paper divided into three sub-parts, and each of them has a specified sample period. Because the data we collected are not necessarily covering the same time period, we have to cut the extra longer time period of the series in order to level with others within different empirical sub-parts. So the three sample periods is defined as follows.

For the empirical analysis of LIVA, LLOAN, LTM and LM2, the sample period is from December 1999 to December 2007.

For the empirical analysis of LIBR, LSSEA and LSSEQ, the sample period is from January 1999 to April 2008.

For the empirical analysis of LSSEA, LM0, LM1 and LM2, the sample period is from February 1999 to April 2008.

4.2. Methodology

4.2.1. VAR

VAR, short for Vector Autoregression, is a modeling approach for multiple time series analysis. The model initiated by Christopher Sims (1980) could be applied to study whether there are significant effects of variables' lag terms on the other level variables within the model implying that all the variables depend not only on their own history values but also on others'.

The VAR regression model is represented as below:

(1) $Y_t = \mu + \Phi_1 Y_{t-1} + \cdot\cdot\cdot + \Phi_p Y_{t-p} + \varepsilon_t$

In the equation Y_t represents an m×1 vector composed with m time series y_{it}, i = 1, . . . , m, and t = 1, . . . , T. Correspondingly μ is m×1 constant vector, Φ_p is m×m coefficient matrix and ε_t is m×1 error vector.

Additionally a VAR model is assumed to have the same lag order, so how to select the lag order is also needed paying attention to. There are several criterions as tools to help determine the lags, for example, Akaike's criterion function (AIC), Schwarz's criterion function (BIC) and the likelihood ratio (LR) test. For AIC and BIC, the calculation result minimizing the criterion function is corresponded to the selected lag length.

AIC is defined as

(2) AIC = −2 logL+2s

where L and s represent the Likelihood function and the number of estimated parameters. Below is BIC defined as, with parameters the same meanings to AIC.

(3) BIC = −2 logL+s log T

The likelihood ratio test is defined as follows when VAR(k) is the true one.

(4) $LR = T(\log L_k - \log L_p) \sim \chi^2_{df}$

(5) $LR = (T - mp)(\log L_k - \log L_p) \sim \chi^2_{df}$

where L_k stands for the maximum likelihood estimate of the residual covariance matrix of VAR(k) and analogical for L_p (p>k). And df is short for degree of freedom, equaling the difference of number of estimated variables between the two VAR models. The second LR test is the modified version for the original applied to short sample period condition.

4.2.2. Impulse response function

In a VAR model a variable is affected by others combined, while if you want to explore the variable response to other ones' shock separately, we should pick up the shock from every other single variable's innovations and observe how the effects work on the current and future values of the variable.

Still consider the VAR equation (1), we can transform it to moving average form so that every variable in the VAR can be presented as the random error shocks from the current and history terms of all the other variables:

(6) $Y_t = \Phi^{-1}(L)(\mu + \varepsilon_t) = \eta + \sum_{i=0}^{\infty} \Psi_i \, \varepsilon_{t-i}$

where $\eta = \mu \cdot \Phi^{-1}(L)$, and $\Phi^{-1}(L) = (I - \Phi_1 L - \ldots - \Phi_p L^p)^{-1} = I + \Psi_1 L + \ldots + \Psi_p L^p$ is the matrix lag polynomial.

Since the error terms ε_t represent shocks in the VAR system, every single variable has chance to be a function of pure error shocks. So we can plug our target variable into the function and study the variables interaction with observing the impulse response. When there arises a standard error shock to one variable, we can obtain all the variables' dynamic response process in current and future terms via studying the parameters change in impulse response function. From that we can figure out the effect is persistent or volatile; positive or negative; strong or weak and long or short. For instance, it is such that the effect of a shock in y_j on y_i is given the process

(7) $\psi_{ij,1}, \psi_{ij,2}, \psi_{ij,3}, \cdots$

where $\psi_{ij,k}$ is the ijth element of the Ψ_k matrix (i, j = 1, …, m) which defined as the effect in Y from a shock in ε_t, k periods ahead:

(8) $$\frac{\partial Y_{t+k}}{\partial \varepsilon_t} = \Psi_k$$

Ψ_k is so called dynamic multipliers representing the system's response to a shock in all the variables at time point t.

4.2.3. Variance decomposition

Variance decomposition, also called innovation accounting, is a technique to analyze how much the error variance of the s step-ahead forecast of a variable is accounted for by innovations to every other variable. However, the variance decomposition is based on the contemporaneous uncorrelatedness of error terms. To remove the potential autocorrelations over time and single out the individual effect the residuals and impulse response coefficients must be orthogonalized first, which could be accomplished by Choleski decomposition choosing S to be a lower triangular matrix such that

(9) $$SS' = \Sigma_\varepsilon = E(\varepsilon_t \varepsilon_t')$$

Then we put it into equation (6), we get

$$Y_t = \eta + \sum_{i=0}^{\infty} \Psi_i \, \varepsilon_{t-i}$$

$$(10) \qquad = \eta + \sum_{i=0}^{\infty} \Psi_i S S^{-1} \varepsilon_{t-i}$$

$$= \eta + \sum_{i=0}^{\infty} \Psi_i^* \nu_{t-i}$$

where $\Psi_i^* = \Psi_i S$ and $\nu_t = S^{-1}\varepsilon_t$. Then $Cov(\nu_t) = E(\nu_t \nu_t') = S^{-1}\Sigma_\varepsilon S'^{-1} = I$.

As a consequence now we get the uncorrelated residuals over time, which have already been uncorrelated between equations. And besides, we also have the new impulse response function of y_i to a unit shock in y_j

$$(11) \quad \psi_{ij,0}^*, \psi_{ij,1}^*, \psi_{ij,2}^*, \ldots$$

After the orthogonalizing we can get the components of the error variance of the s step-ahead forecast of y_i accounted for by shock to y_j

$$(12) \quad \sum_{k=0}^{s} \psi_{ij,k}^{*\,2}$$

4.2.4. Cointegration test, unit root test and VECM

Granger (1986) points out that when time series is non-stationary, it will eliminate the implied long-run information with only short-run reserved if we difference the series to make it stationary. Fortunately the cointegration test provides another technique to explore whether there is long-run equilibrium relationship between series.

There are general case and special case of cointegration definition and as follows we introduce the special one first.

If x_t and y_t are both integrated of order one i.e. being I(1), then they are cointegrated if there exists $a \neq 0$ such that the linear combination of y_t and ax_t is stationary. We denote that $(x_t, y_t)' \sim CI(1,1)$.

Then we generalize the case with making x_t and y_t both be elements of vector $Y_t = (y_{1t}, \ldots, y_{mt})'$ with $y_{it} \sim I(d)$. If there exists a cointegrating vector $A=(a_1,\ldots,a_m)'$

that $A'Y_t \sim I(d-b)$, y_{it} are cointegrated of order b, where b>0 and it is denoted as $Y_t \sim CI(d,b)$. Notice that the general case above is just when d=b=1.

Generally the two-step analysis technique initiated by Engel and Granger is applied to test cointegration relationship, which includes the unit root test for the series and Johansen's test.

The first step is to test the stationarity of time series. It is assumed that all the concerning time series are stationary for the empirical research based on time series data, otherwise spurious regression would appear and make results and forecasts invalid. That a time series is stationary means the mean value and variance of this stochastic process are both constants and the covariance of any two time points depends only on the lag between them but not time points themselves.

The traditional way of testing the time series stationarity is DF (Dickey-Fuller) unit root (1979), later Engle and Yoo (1987) developed ADF (Augmented Dickey-Fuller) test to solve the autocorrelation problem existed in DF test, which is added into drift term and trend term made more scientific and appropriate.

Unlike conventional empirical regression, cointegration allows the non-stationarity existence which has been proved to be a typical attribute of most economic time series. Such non-stationary series will be gradually biased to its mean value as an accumulated effect to external impact, while stationary series only have temporary response for that.

In this study, firstly we mainly use ADF test as unit root test to check the stationarity of the relative series and if not, find out its order of integration. The ADF regression model is as

$$(13)\quad \Delta y_t = \theta y_{t-1} + \alpha + \beta t + \sum_{i=1}^{m} \phi_i \Delta y_{t-i} + \varepsilon_t, \quad H_0: \theta = 0 \text{ vs } H_1: \theta < 0$$

where Δy_t is the first difference to the series, t is trend as time variable, and Δy_{t-i} term is added to DF test to remove the effect of higher-order autocorrelation that most financial time series have. If the test result shows θ is not statistically significant different from 0, then it suggests a unit root existed and needs testing its differenced series to ensure its integration order. Otherwise the series is I(0) i.e. stationary.

The second step is Johansen's test for cointegration. The test presumes there are r cointegrating relations as null hypothesis and examine it with maximum likelihood ratio testing. Before the test procedure is introduced, we need realize the VECM (Vector Error Correction Model) as background of r.

Still consider equation (1), and rewrite it as a first difference form

$$
\begin{aligned}
\Delta Y_t &= \Gamma_1 \Delta Y_{t-1} + \Gamma_2 \Delta Y_{t-2} + \ldots + \Gamma_{p-1} \Delta Y_{t-p+1} + \Pi Y_{t-p} + \mu + \varepsilon_t \\
&= \sum_{i=1}^{p-1} \Gamma_i \Delta Y_{t-i} + \Pi Y_{t-p} + \mu + \varepsilon_t \\
& t = 1, 2, \ldots, p. \\
& \Gamma_i = -I + \Phi_1 + \Phi_2 + \ldots + \Phi_i, i = 1, 2, \ldots, p-1 \\
& \Pi = -I + \Phi_1 + \Phi_2 + \ldots + \Phi_p.
\end{aligned}
\quad , \qquad (14)
$$

The most important coefficient matrix in this VECM is Π, which is so called Long-term impact matrix, embodying all long-term information in $Y_{t.}$ It can be decomposed as $\Pi = \alpha\beta'$, where α and β are $m \times r$ matrices, and they represent adjustment coefficient matrix and cointegration vector matrix individually. So VECM offers chance to reflect long run equilibrium states between series and also short run adjustment towards the long run cointegration, which is a highly stable and reliable model combining different time span conditions.

Now the r appears as the rank of Π matrix and it determines the number of cointegration vectors. There are three cases for the rank r that when r = m, Π is of full rank indicating Y_t is stationary; when r = 0, variables in Y_t are not cointegrated; and when r < m, which is the most common case, there are r cointegrating vectors inside Y_t. Now we can move forwards to the core content of the Johansen's test to find out the cointegration order, r.

Two statistics are tested in Johansen's test, the trace statistics and the maximum eigenvalue statistic.

The trace test has hypotheses

H_0 : there are at most r cointegrating relations

H_1 : there are at most m cointegrating relations

The maximum eigenvalue test has hypotheses

H_0 : rank (Π) = r, there are r cointegrating relations

H_1 : rank (Π) = r + 1, there are r + 1 cointegrating relations

4.2.5. Granger-causality test

Granger-causality test is used to explore whether the history of a variable could help to predict the future value of the other variable. It adopts linear forecasting and judges the predicting ability between variables through so called MSE, Mean Square Error, while time point that information occurs on is also brought into consideration. We have Granger-causality defined into four catalogs.

The first one is causality. If we have such mean square error that $\sigma^2(y_t \mid y_{t-1}, y_{t-2}, \ldots, x_{t-1}, x_{t-2}, \ldots) < \sigma^2(y_t \mid y_{t-1}, y_{t-2}, \ldots)$, we say x Granger-cause y, indicating a lower mean square error makes the prediction for y superior based on not only history value of y itself but also of x.

The second one is named as instantaneous causality. We have instantaneous causality from x to y if $\sigma^2(y_t \mid y_{t-1}, y_{t-2}, \ldots, x_t, x_{t-1}, x_{t-2}, \ldots) < \sigma^2(y_t \mid y_{t-1}, y_{t-2}, \ldots)$. Such relationship adds the effect of current value of x to the causality making prediction better.

The third relationship within Granger-causality is so called feedback causality, such that we say there is feedback causality between x and y, if there is $\sigma^2(y_t \mid y_{t-1}, y_{t-2}, \ldots, x_{t-1}, x_{t-2}, \ldots) < \sigma^2(y_t \mid y_{t-1}, y_{t-2}, \ldots)$ on the one hand, and on the other hand there is also $\sigma^2(x_t \mid y_{t-1}, y_{t-2}, \ldots, x_{t-1}, x_{t-2}, \ldots) < \sigma^2(x_t \mid x_{t-1}, x_{t-2}, \ldots)$. It implies a bilateral causality between x and y.

The last one is independence, which indicates there is no causality between x and y if

$$\sigma^2(y_t \mid y_{t-1}, y_{t-2}, \ldots, x_t, x_{t-1}, x_{t-2}, \ldots) = \sigma^2(y_t \mid y_{t-1}, y_{t-2}, \ldots, x_{t-1}, x_{t-2}, \ldots) = \sigma^2(y_t \mid y_{t-1}, y_{t-2}, \ldots)$$

$$\sigma^2(x_t \mid y_t, y_{t-1}, y_{t-2}, \ldots, x_{t-1}, x_{t-2}, \ldots) = \sigma^2(x_t \mid y_{t-1}, y_{t-2}, \ldots, x_{t-1}, x_{t-2}, \ldots) = \sigma^2(x_t \mid x_{t-1}, x_{t-2}, \ldots)$$

. Under the circumstance the prediction of y is not enhanced by also considering x besides y given the past.

Usually if there is cointegration relationship between two variables then there is at least causality in one direction. Grange-causality test assumes the forecasting information of relative variables is involved in their series and it requires the following equations regressed:

$$(15)\quad \begin{aligned} y_t &= \mu_1 + \sum_{i=1}^{p} \alpha_i y_{t-i} + \sum_{j=1}^{p} \beta_j x_{t-j} + \varepsilon_1 \\ x_t &= \mu_2 + \sum_{i=1}^{p} \lambda_i x_{t-i} + \sum_{j=1}^{p} \delta_j y_{t-j} + \varepsilon_2 \end{aligned}$$

where x and y represent different variable individually and they all assume that each variable's future value is predicted by both two's history. If estimation result for the first equation shows the sum of coefficient matrices of x is statistically different from 0, it is said x Granger-cause y. And correspondingly we say y Granger-cause x if the sum of coefficient matrices of y is statistically different from 0 either. Contemporaneously that both are statistically significant different from 0 suggests a bilateral Granger-causality.

5. EMPIRICAL RESEARCH AND RESULTS

5.1. Unit root test for the sample data

For the following empirical tests, it is required to confirm the integrated order of each series in advance, because according to the conditions of the cointegration test and relative modeling, only the data those have the same order are eligible to be estimated. The corresponding test instrument is unit root test, by which we will find out whether the series is stationary, and if it is not, the integrated order is to be ascertained.

The test results are presented in the appendix 1, which shows that all the logarithm time series are integrated of order 1. So the cointegration test can be applied in each empirical part. Besides, the cointegration equation series generated from each part are also tested for stationarity, and the results are also attached in the table, which implies all the cointegration series are stationary for us to rely on the discovered cointegration relations.

5.2. The impact of stock market on monetary policy transmission mechanism

We found in western developed countries most theoretical and empirical researches already indicate that stock market's developing has affected monetary policy transmission mechanism, and could positively further explain economic growth. So in that case the monetary authority should reflect stock market when framing the policy. Then we hereby analyze how the case is in China with setting LIVA as economic growth, LLOAN as the credit channel of China monetary policy transmission, LM2 as currency channel and LTM as the stock market channel. Because the interrelations between the variables are complicated we adopt VAR based modeling to realize each channel's effect step by step.

In the beginning when introducing unrestricted VAR to model the variables we should select appropriate lag length first for the system. Here VAR Lag Order Selection Criteria of EViews is adopted to determine which the most proper one is. The testing result is shown below in table 1.

Table 1. VAR Lag Order Selection Criteria.

Lag	LogL	LR	FPE	AIC	SC	HQ
0	219.9754	NA	9.17e-08	-4.853380	-4.741531	-4.808297
1	837.5132	1165.689	1.24e-13	-18.37108	-17.81184*	-18.14567
2	865.4075	50.14695	9.48e-14	-18.63837	-17.63173	-18.23262
3	891.5644	44.67251*	7.59e-14*	-18.86662*	-17.41258	-18.28054*
4	905.5516	22.63102	8.02e-14	-18.82138	-16.91995	-18.05497
5	918.3875	19.61443	8.76e-14	-18.75028	-16.40146	-17.80354
6	929.1009	15.40791	1.01e-13	-18.63148	-15.83526	-17.50440
7	946.1845	23.03412	1.03e-13	-18.65583	-15.41222	-17.34842
8	965.5069	24.31581	1.00e-13	-18.73049	-15.03948	-17.24275

* indicates lag order selected by the criterion
LR: sequential modified LR test statistic (each test at 5% level)
FPE: Final prediction error
AIC: Akaike information criterion
SC: Schwarz information criterion
HQ: Hannan-Quinn information criterion

Practically Eviews gives various answers for the lag length selection because there are different test criterions and they do not necessarily lead to the unique result. So finally it is important to decide the appropriate lag length manually. Whether the lag order is suitable to the model we will later see how it performs in the residual test, which means if there is not much statistically significant correlations left in residuals and the residual test is passed, it is safe to rely on the choice for the lag order.

As we can see Eviews supplies five criterions and four of them give the same answer as the lag order being 3, while only Schwarz information criterion points to lag 1. Empirically it is rare to find a multi-variable time series modeling with only 1 lag, more important it is far from enough to eliminate autocorrelations and heteroscedasticity in the residuals. In that case, the unrestricted VAR modeling, the following cointegration and other relative modeling will make no sense at all. So lag 3, the result most criterions offer, is applied for the analysis in this section.

Table 2. Vector Autoregression Estimates.

	LIVA	LLOAN	LTM	LM2
LIVA(-1)	0.379288*** (0.09926) [3.82111]	-0.020106* (0.01118) [-1.79765]	0.128429 (0.10294) [1.24761]	0.007373 (0.01381) [0.53378]
LIVA(-2)	-0.109938 (0.10443) [-1.05275]	-0.015360 (0.01177) [-1.30534]	-0.100574 (0.10830) [-0.92865]	-0.003472 (0.01453) [-0.23892]
LIVA(-3)	0.152479* (0.09073) [1.68061]	0.018557* (0.01022) [1.81522]	0.066432 (0.09409) [0.70603]	0.038186*** (0.01263) [3.02430]
LLOAN(-1)	-0.725053 (1.21011) [-0.59916]	1.097818*** (0.13635) [8.05144]	-0.482249 (1.25496) [-0.38427]	0.196134 (0.16841) [1.16466]
LLOAN(-2)	2.009693 (1.72053) [1.16807]	0.077820 (0.19386) [0.40142]	-0.744076 (1.78431) [-0.41701]	0.180870 (0.23944) [0.75539]
LLOAN(-3)	-0.971646 (1.16098) [-0.83692]	-0.259726** (0.13082) [-1.98544]	0.830772 (1.20401) [0.69000]	-0.404218** (0.16157) [-2.50184]
LTM(-1)	0.050656 (0.10568) [0.47933]	0.013274 (0.01191) [1.11477]	1.182828*** (0.10960) [10.7925]	0.004236 (0.01471) [0.28801]
LTM(-2)	-0.014149 (0.16553) [-0.08547]	-0.009481 (0.01865) [-0.50834]	-0.038954 (0.17167) [-0.22691]	-0.018415 (0.02304) [-0.79942]
LTM(-3)	-0.063774 (0.10915) [-0.58427]	-0.006527 (0.01230) [-0.53072]	-0.117021 (0.11320) [-1.03377]	0.014542 (0.01519) [0.95731]
LM2(-1)	-4.075862*** (0.91050) [-4.47650]	-0.016111 (0.10259) [-0.15704]	-0.674470 (0.94425) [-0.71429]	0.555720*** (0.12671) [4.38574]
LM2(-2)	0.902919 (1.12207) [0.80469]	-0.059133 (0.12643) [-0.46771]	2.203731* (1.16366) [1.89379]	-0.030630 (0.15615) [-0.19615]
LM2(-3)	3.731879*** (0.96215) [3.87869]	0.174782 (0.10841) [1.61221]	-1.271127 (0.99781) [-1.27391]	0.440145*** (0.13390) [3.28716]
C	-5.402123*** (1.24237) [-4.34825]	-0.040410 (0.13999) [-0.28867]	0.502784 (1.28842) [0.39023]	0.418246** (0.17289) [2.41908]

Standard errors in ( ), T-statistics in [ ]
*** denotes significance at 1% level
** denotes significance at 5% level
* denotes significance at 10% level

We learn from the table above that when LIVA is dependent variable, the estimated coefficients of LIVA(-1), LIVA(-3), LM2(-1) and LM2(-3) are statistically significant, which means the industrial value added is affected by its historical value of 1 and 3 months ago, and by general money supply 1 month ago negatively, 3 month ago positively. We also notice that the power of the explaining ability of M2 is strong as the coefficients are as large as 4 at both 1% significant level.

When LLOAN is dependent variable, the statistically significant estimated coefficients are of LIVA(-1), LIVA(-3), LLOAN(-1) and LLOAN(-3). That implies the balance of domestic financial institutes loan is influenced by its own and slightly by industrial value added of 1 and 3 months ago individually.

As the dependent variable LTM is only statistically significantly interpreted by LTM(-1) strongly, and weakly by LM2(-2). Additionally the coefficients are both positive. So the total stock market value is positively affected by M2 of 2 months ago and itself of last month.

Compared to the other three variables, it seems that LM2 could be explained more widely that except LTM, coefficients of LIVA(-3), LLOAN(-3), LM2(-1) and LM2(-3) are all highly statistically significant. And among them all are positive except that of LLOAN(-3). That shows the general money supply is positively affected by itself and industrial value added 3 months ago, negatively by total domestic loan.

Besides, if we point to the explaining ability of every single variable, we could figure out some interesting stuff that LIVA and LM2 have widest effects as both of their past values could help predict the other two variables' present values besides their own. Meanwhile, historical general money supply could not be a member to interpret the loan balance, nor for industrial value added to the market value, whose present value could only be predicted by itself and past value unable to explain any other variables in the model. So far it may be widely accepted that LTM is qualified as a "lonely" variable for its poor society.

After fitting the unrestricted VAR model to the variables system we move on to cointegration test. Unlike VAR model providing a method to see how a variable could be explained and predicted not only by its own past values but also others' within the series pool, cointegration test could reveal the long-run relationship of them if, however, there is any. Such long-run relationship promises them being not apart far away from each other for too long time and definitely a long-run equilibrium relationship. For testing whether there exists any such cointegration relationship between them we apply two cointegration rank tests, Trace test and Maximum Eigenvalue test. Test results are presented individually as follows:

Table 3. Unrestricted Cointegration Rank Test (Trace).

Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	0.05 Critical Value	Prob.**
None *	0.310647	52.74386	47.85613	0.0162
At most 1	0.103531	17.77572	29.79707	0.5827
At most 2	0.071243	7.502292	15.49471	0.5200
At most 3	0.005886	0.554954	3.841466	0.4563

Trace test indicates 1 cointegrating eqn(s) at the 0.05 level
* denotes rejection of the hypothesis at the 0.05 level
**MacKinnon-Haug-Michelis (1999) p-values

Table 4. Unrestricted Cointegration Rank Test (Maximum Eigenvalue).

Hypothesized No. of CE(s)	Eigenvalue	Max-Eigen Statistic	0.05 Critical Value	Prob.**
None *	0.310647	34.96814	27.58434	0.0047
At most 1	0.103531	10.27342	21.13162	0.7186
At most 2	0.071243	6.947338	14.26460	0.4954
At most 3	0.005886	0.554954	3.841466	0.4563

Max-eigenvalue test indicates 1 cointegrating eqn(s) at the 0.05 level
* denotes rejection of the hypothesis at the 0.05 level
**MacKinnon-Haug-Michelis (1999) p-values

Now from the tests results we find there is only one significant cointegration equation between the series LIVA, LLOAN, LTM and LM2 at the 0.05 level. And next we will find out how the relationship shows. The cointegration equation is worked out automatically by EViews based on the VAR, and it is presented below:

Table 5. Cointegrating Equation for LIVA, LLOAN, LTM and LM2.

Cointegrating Eq:	CointEq1
LIVA(-1)	1.000000
LLOAN(-1)	0.200078
	(0.45531)
	[0.43943]
LTM(-1)	0.055882
	(0.02334)
	[2.39386]
LM2(-1)	-1.608333
	(0.40316)
	[-3.98931]
C	8.499681

Standard errors in ( )
T-statistics in [ ]

In the table 5 there list the coefficient of each variable and constant with their standard errors and t-statistics at underside. However, we may notice that the t-statistic value of coefficient of LLOAN(-1) is too small to be statistically significant, so considering this situation we could try to kick it out of the equation, which EViews qualifies, and see whether the hypothesis could pass. We could do so with setting b(1,2)=0 as a coefficient restriction formula imposed to the cointegration, since the coefficient of LLOAN is corresponded to the element at first row and second column of β' matrix.

Table 6. VEC Coefficient Restrictions.

Cointegration Restrictions:	
B(1,2)=0	
Convergence achieved after 4 iterations.	
Not all cointegrating vectors are identified	
LR test for binding restrictions (rank = 1):	
Chi-square(1)	0.162500
Probability	0.686865

Hence the restriction test supports the hypothesis that variable LLOAN is not needed in the cointegration equation which is shown below as a new version:

(16) 18.48514737*LIVA(-1) = -1.029734636*LTM(-1) + 26.44305811*LM2(-1) - 160.9093669

From this equation we find that coefficient of LTM(-1) is negative, while LM2(-1) has a positive coefficient as the dependent variable LIVA(-1) does. So in the long run, the model suggests a weakly negative relationship between the total market value and economic growth, compared to which the money supply is positively related to economic growth. The most surprising result is that domestic loan is not needed in the stationary long-run relation and money supply becomes the leading role that promises the economic increasing. However, it is definitely not surprised, particularly in China, that the total stock market value has a negative impact and the reason why we will refer to explain in conclusion part. After investigating the long-term equilibrium we look into the short-term relations which VECM supplies. The VECM gives the estimates of α matrix representing the speed of adjustment towards the long-run relationship as below:

Table 7. Vector Error Correction Estimates.

Error Correction:	D(LIVA)	D(LLOAN)	D(LTM)	D(LM2)
CointEq1	-0.556121***	-0.020793	0.156404	0.038919**
	(0.12301)	(0.01413)	(0.13274)	(0.01706)
	[-4.52076]	[-1.47199]	[1.17831]	[2.28168]
D(LIVA(-1))	-0.044415	-0.002558	0.003969	-0.033563**
	(0.10892)	(0.01251)	(0.11752)	(0.01510)
	[-0.40778]	[-0.20451]	[0.03377]	[-2.22240]
D(LIVA(-2))	-0.152197*	-0.018576*	-0.091884	-0.037664***
	(0.08943)	(0.01027)	(0.09650)	(0.01240)
	[-1.70180]	[-1.80881]	[-0.95216]	[-3.03724]
D(LLOAN(-1))	-0.884070	0.155632	-0.063028	0.210473
	(1.16552)	(0.13384)	(1.25762)	(0.16161)
	[-0.75852]	[1.16286]	[-0.05012]	[1.30236]
D(LLOAN(-2))	1.283224	0.209826	-0.344404	0.373461**
	(1.11424)	(0.12795)	(1.20229)	(0.15450)
	[1.15166]	[1.63995]	[-0.28646]	[2.41724]
D(LTM(-1))	0.087786	0.015375	0.273169**	0.002042
	(0.10017)	(0.01150)	(0.10809)	(0.01389)
	[0.87637]	[1.33670]	[2.52732]	[0.14699]
D(LTM(-2))	0.080890	0.003222	0.194679*	-0.017949
	(0.10164)	(0.01167)	(0.10968)	(0.01409)
	[0.79581]	[0.27603]	[1.77502]	[-1.27351]
D(LM2(-1))	-4.896088***	-0.060915	-0.551703	-0.383480***
	(0.86023)	(0.09878)	(0.92821)	(0.11928)
	[-5.69160]	[-0.61668]	[-0.59437]	[-3.21500]
D(LM2(-2))	-3.914117***	-0.134141	1.553786	-0.419266***
	(0.94032)	(0.10798)	(1.01462)	(0.13038)
	[-4.16255]	[-1.24233]	[1.53139]	[-3.21565]
C	0.125605***	0.009230***	0.005725	0.018182***
	(0.01839)	(0.00211)	(0.01984)	(0.00255)
	[6.83142]	[4.37197]	[0.28855]	[7.13161]

Standard errors in ( )
T-statistics in [ ]
*** denotes significance at 1% level
** denotes significance at 5% level
* denotes significance at 10% level

The derived VECM above presents the data that only coefficients of D(LIVA(-2)), D(LM2(-1)), D(LM2(-2)) and cointegration equation have statistically significant explaining power to D(LIVA), in which D(LIVA(-2))'s coefficient is even significant on borderline. Although the first difference of LTM lag 1 and 2 both have positive effect on the latest short-term change of economic growth, which is the result we prefer obtaining, they are however not statistically significant. The coefficients of cointegration equation are just elements of α matrix, and two of them are not statistically different from 0 indicating the cointegration vector does not qualify the equation determining D(LLOAN) and D(LTM). So they are both weakly exogenous to the system and considering LLOAN does not belong to the long-run cointegration relation, we can get rid of the effect of domestic loan balance either from long-run or short-run. Without being related to the cointegration relation, D(LTM) has no significant relation with other variables either, except its own lag terms. The big value of t-statistics shows a negative relationship between the short term change of money supply and industrial value added which is consisted with the case when D(LIVA) being dependent variable. We also get positive relation between D(LM2), cointegration equation and D(LLOAN(-2)), in which the estimated coefficient of the equation is more important since it represents the α matrix that in this case a 1 percent disequilibrium causes on average a 0.038919 percent adjustment in next month's general money supply. And the number is -0.556121 for industrial value added which is a negative and high adjusting speed compared to that of money supply.

So far we observed the interrelation between the economic growth, domestic loan balance, total stock market value and general money supply as a whole within the multivariable regression system, and we could accept the estimated data result for the modeling performs well in residual test that it is such that:

Table 8. VEC Residual Portmanteau Tests for Autocorrelations.
H0: no residual autocorrelations up to lag h

Lags	Q-Stat	Prob.	Adj Q-Stat	Prob.	df
1	2.771939	NA*	2.801745	NA*	NA*
2	10.15557	NA*	10.34589	NA*	NA*
3	17.80281	0.3356	18.24524	0.3097	16
4	35.56435	0.3041	36.79617	0.2564	32
5	57.32231	0.1678	59.77649	0.1185	48
6	66.12148	0.4035	69.17561	0.3070	64
7	85.93485	0.3049	90.58316	0.1964	80
8	109.1169	0.1700	115.9217	0.0813	96
9	117.8169	0.3349	125.5429	0.1801	112
10	128.4152	0.4731	137.4028	0.2692	128
11	154.3895	0.2620	166.8195	0.0937	144

*The test is valid only for lags larger than the VAR lag order.
df is degrees of freedom for (approximate) chi-square distribution

The Q-test suggests that there is definitely no autocorrelation left in residuals. After confirming the validity of the analysis above we would like to see if there is any causality existed between the series since we have found a cointegration relationship and there is always causality relationship in at least one direction in cointegrated series. Next we move to Granger-causality test to investigate such relationship pairwise.

Table 9. Pairwise Granger-causality Test.

Lags: 2

Null Hypothesis:	F-Statistic	Probability
LLOAN does not Granger Cause LIVA	26.1299	1.1E-09***
LIVA does not Granger Cause LLOAN	3.08903	0.05041*
LM2 does not Granger Cause LIVA	38.2975	9.2E-13***
LIVA does not Granger Cause LM2	0.63229	0.53372
LTM does not Granger Cause LIVA	0.31673	0.72933
LIVA does not Granger Cause LTM	1.56060	0.21564
LM2 does not Granger Cause LLOAN	3.73078	0.02776**
LLOAN does not Granger Cause LM2	0.16275	0.85006
LTM does not Granger Cause LLOAN	1.21947	0.30022
LLOAN does not Granger Cause LTM	1.87524	0.15926
LTM does not Granger Cause LM2	0.15857	0.85360
LM2 does not Granger Cause LTM	2.28193	0.10796

*** denotes significance at 1% level
** denotes significance at 5% level
* denotes significance at 10% level

Table 9 shows the Granger-causality pairwise under the assumption of 2 lags. Judging with the probability value we figure out that LLIVA and LLOAN Granger cause each other, while the causality from LIVA to LLOAN is significant on borderline. The null hypothesis “LM2 does not Granger cause LIVA” is highly rejected indicating the similar fact with above that the general money supply could help predict the economic growth. And LM2 is also found to Granger cause LLOAN implying a common phenomenon regarding traditional commercial bank operating that loans issuing is based on the savings. The total market value does not Granger cause economic growth, so although they are cointegrated but there is no causality in both directions. Interestingly and reversely the domestic loan is not cointegrated with industrial value added but Granger causes it.

Finally we proceed to study the dynamic process of response of industrial value added to other variables shock individually. Appling impulse response function we will trace how the industrial value added reacts serially.

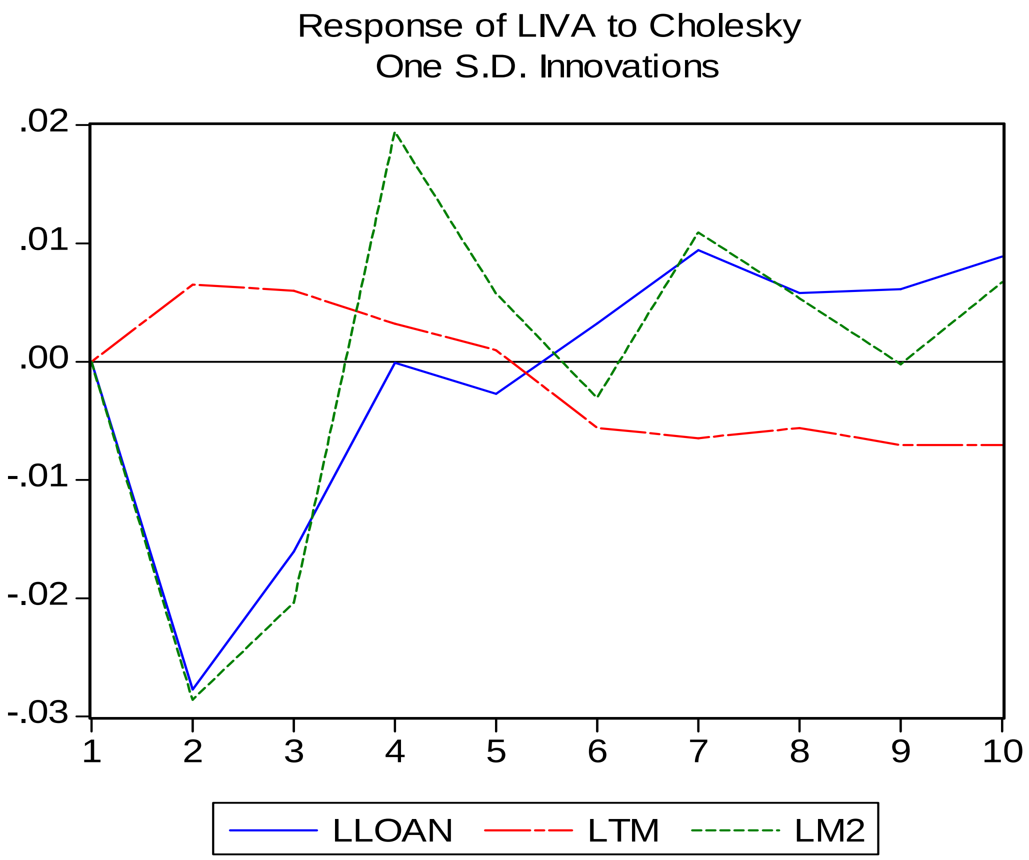

Figure 1. Impulse Response process of LIVA.

According to the figure 1, basically the responses of LIVA to shocks from innovations of LLOAN and LM2 both present a concussively climbing up pattern movement that they sharply descend to the bottom at second month and then go up rapidly with gradually narrow swing. For the response to LLOAN, it is negative in the first half year and turns out to be positive in the periods later, while for the LM2 it is a little faster to be positive that it is already up zero in the fourth month and presents a stronger swing compared to that of LLOAN. Compared to their significant swing the response to LTM goes more stably: first five months positive, negative later and finally be leveled on approximate -0.7%. That means the industrial value added will decrease 0.7% once the total stock market value generates one standard error shock, which indicates a long-run negative relationship between the two variables.

Now we obtain the effect process of each variable's error shock on LIVA, furthermore, what about the proportion they account for the error variance of LIVA's steps-ahead forecast? To discuss the question we still need an analyzing technique, variance decomposition. We will work out a table through EVIEWS to show the error variance of the industrial value added 10 step-ahead forecast decomposed into parts each variable's innovation contributes to.

Table 10. Variance Decomposition of LIVA.

Period	S.E.	LIVA	LLOAN	LTM	LM2
1	0.064131	100.0000	0.000000	0.000000	0.000000
2	0.081257	75.35408	11.63308	0.638155	12.37468
3	0.085706	68.18824	13.96577	1.058748	16.78724
4	0.088252	65.01848	13.17184	1.128614	20.68106
5	0.088499	64.68020	13.19363	1.133955	20.99221
6	0.088836	64.29741	13.22639	1.524821	20.95138
7	0.090255	62.34216	13.90368	1.993323	21.76084
8	0.090791	61.65143	14.14756	2.352430	21.84858
9	0.091277	61.01104	14.44571	2.926205	21.61705
10	0.092225	59.76528	15.07558	3.454107	21.70504

The table above shows clearly that from the periods ahead 1 to 10, the proportion of the forecast variance explained by LIVA itself decreases from 100% to less than 60% and by LLOAN increases from 0% to more than 15%, while the most contribution to the variance outside of LIVA comes from innovations of LM2, from 0% to about 21.71%, and the least, not surprisingly so far, comes from LTM, also from 0% but to only 3.45%.

Summing up the results from this part's empirical study we can figure out several tested facts about the relationship between these variables. Firstly, LLOAN does not belong to the cointegration equilibrium in the long-run, and it has also no impact on LIVA in the short-run. Although it Granger-cause LIVA, we can not promise that it would not deviate from the steady state with LIVA in a long time interval. Secondly, LM2 has long-run strong positive effect on LIVA and proved to be its cause, while the effect is not well stable that even in the short-run it has temporary negative influence. Thirdly, LTM presents a weak and negative effect on LIVA, and it is an effect for a long-run period because they are cointegrated. But there is no causality between them although cointegrated, and short-run impact is also not found. So we can definitely reject the research hypothesis above that Chinese stock market development has positive and significant effect on the economic growth.

5.3. The impact of interest rate on stock price

At present the interbank financing is the primary short-term fund financing way in China, so in order to explore the relationship between stock price and interest rate which the short-term fund cost achieves popularity to represent, we select China interbank offered rate, Shanghai Stock Exchange A-share price index and the corresponding transaction turnover as estimated variables.

Then we begin to model the variables and it is necessary to obtain the lag length firstly which all series equally have. Here we apply criterion functions provided by EViews again as before, and result is presented in the table below.

Table 11. VAR Lag Order Selection Criteria.

Lag	LogL	LR	FPE	AIC	SC	HQ
0	-70.19925	NA	0.000868	1.463985	1.542140	1.495616
1	154.8995	432.1896	1.15e-05	-2.857990	-2.545370*	-2.731467*
2	168.0116	24.38842	1.06e-05	-2.940231	-2.393146	-2.718816
3	176.5685	15.40250	1.07e-05	-2.931370	-2.149819	-2.615063
4	181.2317	8.114021	1.17e-05	-2.844635	-1.828619	-2.433435
5	189.1365	13.28003	1.20e-05	-2.822731	-1.572249	-2.316638
6	194.7949	9.166519	1.29e-05	-2.755897	-1.270950	-2.154913
7	210.7067	24.82251	1.14e-05	-2.894135	-1.174722	-2.198258
8	223.1736	18.70025	1.07e-05	-2.963471	-1.009594	-2.172702
9	232.9119	14.02317	1.07e-05	-2.978238	-0.789895	-2.092576
10	248.4334	21.41975	9.55e-06*	-3.108669*	-0.685861	-2.128115
11	251.1142	3.538578	1.11e-05	-2.982284	-0.325010	-1.906837
12	264.8425	17.29773*	1.03e-05	-3.076851	-0.185112	-1.906512

* indicates lag order selected by the criterion
LR: sequential modified LR test statistic (each test at 5% level)
FPE: Final prediction error
AIC: Akaike information criterion
SC: Schwarz information criterion
HQ: Hannan-Quinn information criterion

We have here up to 12 lags as options given by the criterions. Schwarz information criterion and Hannan-Quinn information criterion both give 1 as lag length, while FPE and Akaike information criterion agree on 10, and LR test even suggests 12 as the answer. Practically it will bring in too many parameters to estimate and lead to weakening the power of modeling if we adopt whatever 10 or 12 as number of lags.

So 1 lag is temporarily accepted and we still have to see whether it is enough to assure there is no autocorrelation left in residuals.

After fitting in the lag order of 1 we get the VAR model for the series and find out it is obviously not enough because it does not pass the residual test at all. The null hypothesis “no residual autocorrelations up to lag h” is highly significantly rejected as below.

Table 12. VAR Residual Portmanteau Tests for Autocorrelations.
H0: no residual autocorrelations up to lag h

Lags	Q-Stat	Prob.	Adj Q-Stat	Prob.	df
1	19.56272	NA*	19.74056	NA*	NA*
2	36.21197	0.0000	36.69531	0.0000	9
3	47.42585	0.0002	48.22068	0.0001	18
4	57.32617	0.0006	58.49111	0.0004	27
5	73.52056	0.0002	75.44938	0.0001	36
6	87.34116	0.0002	90.05974	0.0001	45
7	103.9124	0.0001	107.7463	0.0000	54
8	115.4874	0.0001	120.2204	0.0000	63

*The test is valid only for lags larger than the VAR lag order.
df is degrees of freedom for (approximate) chi-square distribution

Considering this situation we orderly take 2 as lag length and it turns out to be enough to eliminate residual autocorrelations. So following the unrestricted VAR model is presented with 2 lags included.

Table 13. Vector Autoregression Estimates.

	LSSEA	LSSEQ	LIBR
LSSEA(-1)	0.867311***	2.088708***	-0.149350
	(0.11920)	(0.70002)	(0.17699)
	[7.27597]	[2.98379]	[-0.84385]
LSSEA(-2)	-0.008474	-1.811653***	0.236930
	(0.10528)	(0.61824)	(0.15631)
	[-0.08049]	[-2.93033]	[1.51576]
LSSEQ(-1)	0.048685**	0.538221***	0.011554
	(0.01866)	(0.10956)	(0.02770)
	[2.60960]	[4.91264]	[0.41713]
LSSEQ(-2)	0.003976	0.239395**	-0.031990
	(0.01833)	(0.10763)	(0.02721)
	[0.21691]	[2.22415]	[-1.17552]
LIBR(-1)	0.146503**	0.210272	0.486448***
	(0.06293)	(0.36957)	(0.09344)
	[2.32797]	[0.56897]	[5.20608]
LIBR(-2)	-0.046009	-0.001738	0.304759***
	(0.05993)	(0.35194)	(0.08898)
	[-0.76771]	[-0.00494]	[3.42500]
C	0.576414***	-0.475827	-0.330943
	(0.20835)	(1.22354)	(0.30935)
	[2.76656]	[-0.38889]	[-1.06980]

Standard errors in ( )
T-statistics in [ ]
*** denotes significance at 1% level
** denotes significance at 5% level
* denotes significance at 10% level

Through observing the result we could clearly find out different patterns of the ways that dependent variables related to independent variables. For example, as dependent variable LSSEA is only significantly correlated to other variables' history value of one month ago besides itself's. And LSSEQ is modeled to be related with all the variables except LIBR's history values, while LIBR only has its own history as independent variables, which is a common consequence since China interbank offered rate is weakly exogenous to the stock market system, and it is further affirmed by the VECM later.

What should be paid more attention in this table is that the interest rate of lag 1 and 2 can not join to enhance the regression power of stock trading turnover, and also the result that one month lag's interest rate is positively related to stock price. It is not accorded with what financial theory and practice are supposed to be, so a probable and reasonable explanation is attributed to the existence of lag effect. The negative impact of interest rate on stock price may have such deep and long time delay more than one month. In fact we observed the negative coefficient of LIBR(-2) for LSSEA, however, it is obviously not statistically significant enough.

In such case we need to move forward to cointegration test to explore whether there is indeed such a negative long-run relation. Firstly cointegration rank test is employed to ensure the cointegration existence.

Table 14. Unrestricted Cointegration Rank Test (Trace).

Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	0.05 Critical Value	Prob.**
None *	0.437045	86.46630	42.91525	0.0000
At most 1	0.174857	23.26518	25.87211	0.1020
At most 2	0.019118	2.123321	12.51798	0.9606

Trace test indicates 1 cointegrating eqn(s) at the 0.05 level
* denotes rejection of the hypothesis at the 0.05 level
**MacKinnon-Haug-Michelis (1999) p-values

Table 15. Unrestricted Cointegration Rank Test (Maximum Eigenvalue).

Hypothesized No. of CE(s)	Eigenvalue	Max-Eigen Statistic	0.05 Critical Value	Prob.**
None *	0.437045	63.20112	25.82321	0.0000
At most 1 *	0.174857	21.14186	19.38704	0.0276
At most 2	0.019118	2.123321	12.51798	0.9606

Max-eigenvalue test indicates 2 cointegrating eqn(s) at the 0.05 level
* denotes rejection of the hypothesis at the 0.05 level
**MacKinnon-Haug-Michelis (1999) p-values

The two tables offer different results that Trace test indicates there is only one significant cointegration equation at 5% level while Maximum Eigenvalue test suggests there are 2 of them, but they both point to one situation that the series will not depart from each other eternally. So we work out the cointegration and vector error correction model to see how the long-run relation and short-run adjustment exhibit.

(17) LSSEA(-1) = 0.6360659355*LSSEQ(-1) - 0.2653489557*LIBR(-1) - 0.008525761882*TREND + 3.226248621

We notice that there is trend term included in the cointegration equation, indicating a trend stationary series proved by unit root test. So the three variables constitute a long-run equilibrium in which LSSEQ has positive cointegration coefficient and LIBR has negative one. In the former analysis above we have got the result that the interest rate of one month ago could join to advance regression of stock price's current value, and it is positive for the effect. Now via the cointegration we obtain the result that the interest rate is negatively related to stock price in the long-run, normally more than one month.

Table 16. Vector Error Correction Estimates.

Error Correction:	D(LSSEA)	D(LSSEQ)	D(LIBR)
CointEq1	-0.050672	0.969750***	-0.042905
	(0.03236)	(0.16961)	(0.04897)
	[-1.56581]	[5.71742]	[-0.87610]
D(LSSEA(-1))	0.025768	2.186577***	-0.303812
	(0.10762)	(0.56404)	(0.16286)
	[0.23945]	[3.87666]	[-1.86552]
D(LSSEQ(-1))	0.008929	-0.069255	0.007487
	(0.01886)	(0.09886)	(0.02855)
	[0.47335]	[-0.70051]	[0.26230]
D(LIBR(-1))	0.098519	-0.161599	-0.374954***
	(0.05987)	(0.31379)	(0.09060)
	[1.64555]	[-0.51499]	[-4.13850]
C	0.011019	0.023127	-0.004383
	(0.00761)	(0.03988)	(0.01152)
	[1.44808]	[0.57985]	[-0.38062]

Standard errors in ( )
T-statistics in [ ]
*** denotes significance at 1% level
** denotes significance at 5% level
* denotes significance at 10% level

Few estimated coefficients in the result table are statistically significant, for the first difference of LSSEA there is even none. So in the short-term it is not affected by any variables at least in this system, neither by cointegration relationship, which implies itself a weakly exogenous variable. And the situation is also applied on D(LIBR) responding the presumption above in VAR analysis since the α coefficient is not statistically significant. Compared to that the equilibrium relation can not determine the short-term change of their value, D(LSSEQ) has the adjusting parameter highly significant and is also positively related to D(LSSEA(-1)). The cointegration modeling is also passes the residual test that for lags larger than 1, null hypothesis of no residual autocorrelations is accepted, which is listed below.

Table 17. VEC Residual Portmanteau Tests for Autocorrelations.
H0: no residual autocorrelations up to lag h

Lags	Q-Stat	Prob.	Adj Q-Stat	Prob.	df
1	0.817040	NA*	0.824536	NA*	NA*
2	5.663004	0.7731	5.760240	0.7637	9
3	17.51936	0.4877	17.94902	0.4590	18
4	24.71403	0.5905	25.41518	0.5512	27
5	39.74111	0.3070	41.15784	0.2550	36
6	58.20667	0.0895	60.68872	0.0592	45
7	65.31997	0.1391	68.28545	0.0914	54
8	74.96657	0.1437	78.68864	0.0878	63
9	81.57419	0.2061	85.88506	0.1261	72

*The test is valid only for lags larger than the VAR lag order.
df is degrees of freedom for (approximate) chi-square distribution

As we already found that the interbank offered rate has a negative impact on stock price in the long-run, we would like to see whether there is Granger-causality in such time interval since there has been cointegration relationship between them.

Table 18. Pairwise Granger-causality Test.
Lags: 8

Null Hypothesis:	F-Statistic	Probability
LSSEQ does not Granger Cause LSSEA	1.46485	0.18183
LSSEA does not Granger Cause LSSEQ	3.02459	0.00480***
LIBR does not Granger Cause LSSEA	2.64810	0.01198**
LSSEA does not Granger Cause LIBR	2.38527	0.02252**
LIBR does not Granger Cause LSSEQ	0.76023	0.63845
LSSEQ does not Granger Cause LIBR	1.59143	0.13901

*** denotes significance at 1% level
** denotes significance at 5% level
* denotes significance at 10% level

In the table 18 there are three null hypothesis rejected statistically then as expected we finally get 8 lags with which LSSEA Granger cause LSSEQ and LIBR, and also the most important, LIBR Granger cause LSSEA. In such case we get to know not only the long-run negative relation and also that for 8 months interval the interest rate has Granger-causality on stock price.

Summing up the empirical results for this part we can observe that the interest rate negatively impact share price and Granger-causes the price significantly, both serving the fact that when the interest rate rises, the share price falls; the rate descends, the price moves up, and with the time interval extending the impact will remarkably strengthen. So in such case the second research hypothesis is accepted that the interest rate negatively impacts the stock price.

5.4. The impact of money supply on stock price

To analyze the relationship between money supply and stock market price completely and detailedly we employ the three scales of money supply individually to make pairwise tests instead of doing so by modeling them in a comprehensive system. So we directly look into their cointegration test and VECM first without constructing a whole VAR model. Although VAR is not preferred here we still work out the appropriate lag length to be used which is 3 and the result tables are listed in the appendix 2. So as following we will adopt 2 as numbers of lag since VECM applies the lag length that is 1 less than that of an unrestricted VAR.

Through Trace test and Maximum Eigenvalue test we get a common result that there is one significant cointegration relationship between stock price and the three scales of money supply respectively. The cointegration rank test result tables and lag length selection result tables are not listed here for the purpose of conciseness since there are too many of them for three test groups and we just move on directly to main parts below. The three cointegration equations are presented individually that:

(18) LSSEA(-1) = 18.28045345*LM0(-1) - 0.1573551982*TREND - 163.369522

(19) LSSEA(-1) = 36.03990676*LM1(-1) - 0.4439409139*TREND - 372.9603161

(20) LSSEA(-1) = 854.3293873*LM2(-1) - 11.22473112*TREND - 9830.378617

All cointegration equations are proved to be stationary, which indicates the stock price is indeed cointegrated with all scales of money supply and the outcome is reliable. They appear analogous pattern that correspondingly all the coefficients have same signs across the equations, and LM0, LM1, LM2 are all positively related to LSSEA. The coefficient of LM0 is 18.28, compared to which it is almost doubled as 36.04 for LM1, and for LM2 it is as big as 854.33. That implies if M0 changes for one unit, then stock price would change 18.28 units in the long-run, and it is the same situation for M1 and M2, which is consisted with relative theoretical analysis.

Next we report the VECM for the three pair series to see how they are related in the short-run.

Table 19. Vector Error Correction Estimates for LM0 and LSSEA.

Error Correction:	D(LSSEA)	D(LM0)
CointEq1	-0.013598	0.032966***
	(0.00883)	(0.00630)
	[-1.53926]	[5.23637]
D(LSSEA(-1))	0.106760	-0.026662
	(0.09638)	(0.06868)
	[1.10775]	[-0.38820]
D(LSSEA(-2))	0.192784*	-0.084930
	(0.10057)	(0.07167)
	[1.91683]	[-1.18497]
D(LM0(-1))	-0.086415	0.154820
	(0.14974)	(0.10671)
	[-0.57709]	[1.45083]
D(LM0(-2))	-0.183823	0.011614
	(0.13662)	(0.09736)
	[-1.34552]	[0.11929]
C	0.009772	0.009172
	(0.00807)	(0.00575)
	[1.21021]	[1.59393]

Standard errors in ( )
T-statistics in [ ]
*** denotes significance at 1% level
** denotes significance at 5% level
* denotes significance at 10% level

Table 20. Vector Error Correction Estimates for LM1 and LSSEA.

Error Correction:	D(LSSEA)	D(LM1)
CointEq1	0.008128	0.008079***
	(0.00973)	(0.00227)
	[0.83574]	[3.56172]
D(LSSEA(-1))	0.084146	-0.007788
	(0.09963)	(0.02324)
	[0.84456]	[-0.33514]
D(LSSEA(-2))	0.176683*	-0.023306
	(0.10471)	(0.02442)
	[1.68741]	[-0.95431]
D(LM1(-1))	-0.031614	-0.062920
	(0.42734)	(0.09967)
	[-0.07398]	[-0.63126]
D(LM1(-2))	0.280930	-0.164582*
	(0.40230)	(0.09383)
	[0.69830]	[-1.75397]
C	0.004707	0.016045***
	(0.01135)	(0.00265)
	[0.41476]	[6.06219]

Standard errors in ( )
T-statistics in [ ]
*** denotes significance at 1% level
** denotes significance at 5% level
* denotes significance at 10% level

Table 21. Vector Error Correction Estimates for LM2 and LSSEA.

Error Correction:	D(LSSEA)	D(LM2)
CointEq1	-0.000565	0.000218***
	(0.00059)	(6.5E-05)
	[-0.95420]	[3.35527]
D(LSSEA(-1))	0.093002	0.006133
	(0.09712)	(0.01068)
	[0.95756]	[0.57423]
D(LSSEA(-2))	0.187808*	-0.006082
	(0.10127)	(0.01114)
	[1.85460]	[-0.54613]
D(LM2(-1))	-0.862740	-0.261396***
	(0.83402)	(0.09172)
	[-1.03444]	[-2.85002]
D(LM2(-2))	-0.592495	-0.278085***
	(0.81421)	(0.08954)
	[-0.72770]	[-3.10577]
C	0.025948	0.019493***
	(0.01843)	(0.00203)
	[1.40815]	[9.61978]

Standard errors in ( )
T-statistics in [ ]
*** denotes significance at 1% level
** denotes significance at 5% level
* denotes significance at 10% level

Interestingly we could also observe similar pattern that each pair series shows in the short term coefficients estimation. For example, all scales of money supply have highly significant and positive adjusting coefficient, and along with the money supply statistical scale expanded from M0 to M2, the speed of adjustment to disequilibrium tends to grow slower, that is, from 0.03, then 0.008, to finally 0.0002. Meanwhile, short term change of LSSEA is however not statistically related to cointegration as comparison, and only affected by its own short term change of history value of lag 2 with almost the same coefficient magnitude, around 0.18. Besides that the change of money supply is always statistically affected by change of its history to some extent, the results also suggest that in the short-run, basically the change of money supply of all scales and stock price are negatively related, although the corresponding significance is not statistically enough.

So far we have analyzed the long-run and short-run relationship between stock price and money supply which is divided into three scales, and the results tell positive and negative relatedness respectively. Nevertheless, it can not make clear that which side occupies the position of cause and which side is as the effect. So it is important to confirm the direction of Granger-causality between them. Applying Granger-causality test we get the result in the table that

Table 22. Pairwise Granger-causality Test

Lags: 12

Null Hypothesis:	F-Statistic	Probability
LM1 does not Granger Cause LM0	4.34061	3.4E-05***
LM0 does not Granger Cause LM1	11.4135	1.5E-12***
LM2 does not Granger Cause LM0	1.02558	0.43510
LM0 does not Granger Cause LM2	4.32892	3.5E-05***
LSSEA does not Granger Cause LM0	2.30558	0.01469**
LM0 does not Granger Cause LSSEA	0.90892	0.54235
LM2 does not Granger Cause LM1	3.24348	0.00087***
LM1 does not Granger Cause LM2	2.71537	0.00430***
LSSEA does not Granger Cause LM1	1.51314	0.13869
LM1 does not Granger Cause LSSEA	0.33329	0.98051
LSSEA does not Granger Cause LM2	0.77774	0.67115
LM2 does not Granger Cause LSSEA	0.44699	0.93828

*** denotes significance at 1% level
** denotes significance at 5% level
* denotes significance at 10% level

It is shown explicitly that there are statistically significant causalities between LM0, LM1, and LM2 each other, and the situation is totally common in practice since they are just different scales of money supply and are diverse only because of statistical caliber difference but not separate and independent variables. Other than the causalities inside money supply, Granger-causality of it and stock price is significantly discovered that the null hypothesis of “LSSEA does not Granger cause LM0” is highly rejected. And this is the only causality statistically appeared between money supply and stock price, besides there is no causality existed between LSSEA and M1 or M2, although it is a little less enough than borderline of 1% significance to reject the null hypothesis of “LSSEA does not Granger cause LM1”.

So the outcome confirms that it is stock price that Granger causes money supply, at least strongly causes M0 and weakly M1, but definitely not vice versa. Since we have achieved the direction of causality, it is rather significant to study the how the cause-effect progresses. As followed we will trace how the money supply responses dynamically to shock effects from stock price. Impulse Response function of M0, M1 and M2 are listed below orderly.

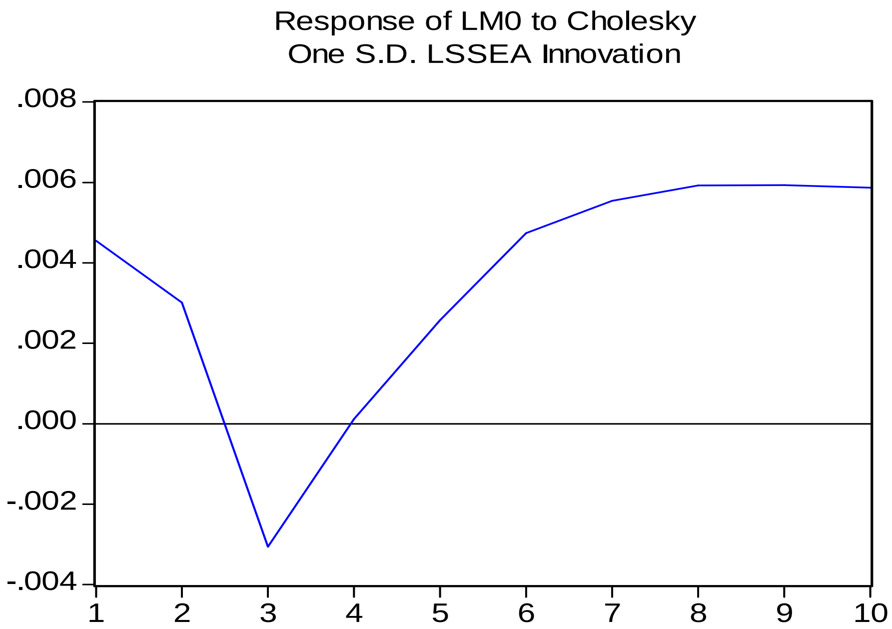

Figure 2. Impulse Response process of LM0.

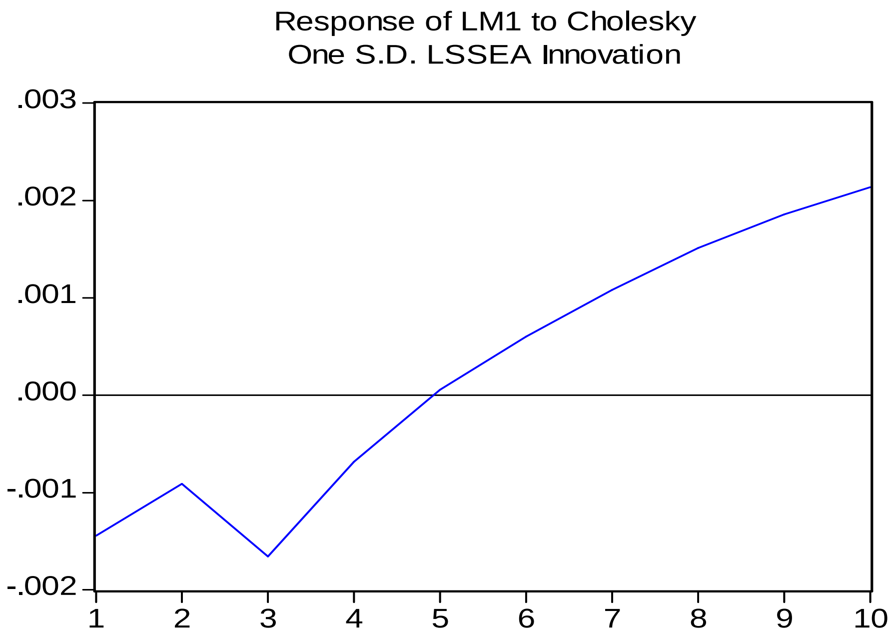

Figure 3. Impulse Response process of LM1.

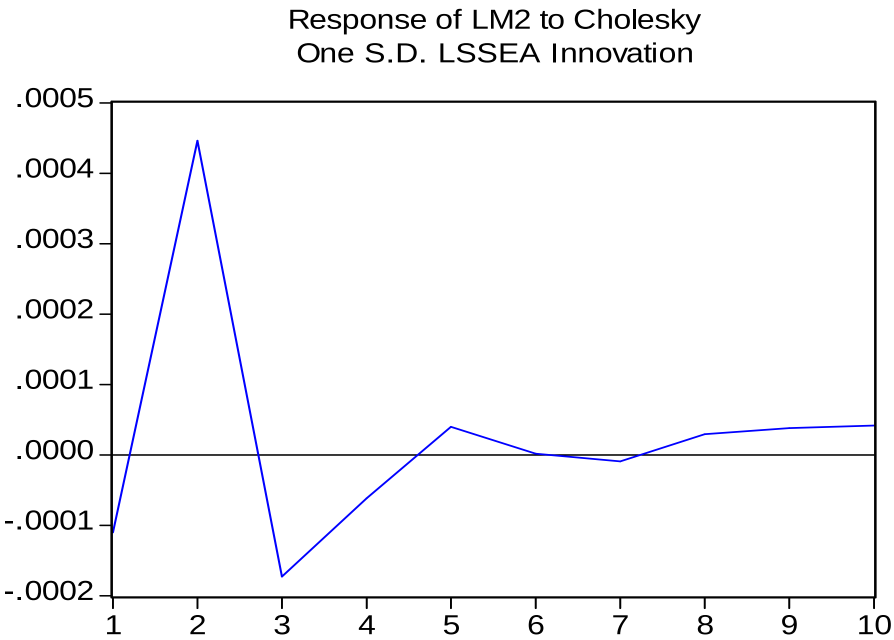

Figure 4. Impulse Response process of LM2.

The response of M0 to shock from stock price turns out to be a "V" pattern that at third month it descends to the bottom of -0.003 and in other time it remains positive with final leveling on 0.006. The process indicates that half year later one unit shock from stock price will keep M0 increased by 0.6%.

Generally it presents a graduate growth pattern for the response process of M1 and the turning point is the fifth month passing over which it turns to positive from negative. The track is still up going until the tenth month with no sign to be stable.

For the dynamic process of M2 it tracks as swing type around zero. In the first half year it concusses strongly, compared to which it turns to stabilize and finally settles down on about 0.004%, small but positive.

Summing up this part's results, we can see that the stock price is cointegrated with all the scales of money supply respectively, and what is the most important is that it is the stock price that impacts money supply, not vice versa. The impacts are all significantly positive in the long-run and unstable in the short-run. So according to this we reject the third research hypothesis that we could have accepted otherwise if it were stated vice versa.

6. CONCLUSIONS

Until now we have finished the theoretical and empirical analysis for the interaction between the monetary policy and stock market in China and obtained some empirical results that make us agree or reject the advanced hypothesis. According to the outcomes we do observe significant relationships and they present variedly, providing us important implications.

In the first empirical part testing each monetary policy transmission channel's effect on the economy, we find out that basically LLOAN almost has no significant influence on the economic growth. Because whenever in the long-run or short-run, there is no distinct evidence for it to be in the equilibrium state or impose effect temporarily. Such result in fact coincides with the process of market economy reform starting from 1990s. In the period of planned economy system for decades, China applied credit scale control as technique to directly allocate the limited credit resources, however, such technique has actually been proved of low efficiency especially for the late larger and larger economy scale growth. Nowadays with the economy role turning around and development of financial innovations, Chinese enterprises have more options to raise funds. Various indirect macro control facilities have been gradually adopted by currency administration, and the old mechanism dominating the bank loan quantity to influence the economic activities has been weakened and gradually disappeared.

As a consequence, the currency channel is left for the central bank to impose on the real economy since traditionally both currency channel and credit channel are considered to be instruments for the central bank in China. That is why in the modeling LM2 performs strong effect on the economic growth. Although the currency channel course is not well stable, we still have the stock market that is supposed to be a new channel, nevertheless, we can not count on the total market that based on the empirical result it makes no cause to the economic growth and even negative impact deeply in the long-run. That implies the stock market has extremely limited function on promoting the economic development, and further of course can not escape from the conclusion that the effect of developing countries' capital markets is weak and inefficient on the economic growth.

The reason why the stock market development is still not qualified to facilitate the macro economy may due to several phenomena probably uniquely existed in China. Until the end of 2007 of all the stock exchange listed enterprises the majority are state-owned, covering more than 80% of the whole market value, while the private enterprises are comparative minority but generating almost 70% of Chinese GDP. Many companies with great contribution to the economy are unable to get listed but those making less contribution or even nothing occupy the seats and aim at collecting capital to escape from the lurch without supervising the use of financed money. The longer they are listed, the lower for their efficiency and their share prices can not reflect the real operating achievement. So there is no doubt the market value is negatively correlated with national economic trend.

Besides, the majority state-owned shares and corporation shares are restricted circulating shares and are insignificantly or negatively related with company operating achievements, such improper equity causing them operate not completely by market criterion thereby depress the profiting capacity. In the bubble period, financial resources' racing in the market also disturbs the real economy. So summarizing the reasons we can evidently conclude that the Chinese equity market is of government dominating type that it does not exist with economic growth as support.

Absent for the promotion function to the economy, the stock market can be regulated by the interest rate. Consisting with the traditional theory and practical experience, the monetary policy intermediate target significantly affects the stock price according to the empirical test. In the long-run, the stock price index is negatively affected, and deeply along with time moving forward. The circumstance may be attributed to the comparatively low sensitiveness of the stock market, which state-owned companies cover the majority, to the monetary policy. As a consequence the currency administration has to implement regulation continuously when needed. Based on these we can conclude the interest rate as the monetary policy intermediate target is effective on the stock market.

For the relationship between money supply and stock market we find out that it is not performed as presumed. In the research hypothesis part we assume that money supply has positive effect on the stock price, however, it is reverse situation for the assumption that money supply actually occupies the position of effect in the form of currency demand. In detail, the effect of stock market to M0 is the most significant, and the causality from stock market to M1 is a little bit weak to be statistically significant in comparison. Referring to the general money supply M2, we did not observe any important relative Granger-causality except with its subclass, M1.

In the long-run all the scales of money supply are cointegrated with the stock price constructing a positive equilibrium, implying the stock market has regurgitation effect that when the stock price moves up, with using the financed fund the efficient companies invest the planned project, gain the investment return and therefore increase the total national income making each scales of money supply expanded in the long time interval. When we look into the effect on each scale, they are different from each other that it is the biggest for M0, then M1, and smallest for M2 meaning the more liquid for the money supply, the bigger effect it receives. As analyzed in China the stock market is not mature enough since various institution investors dominate the market to some extent, and manipulating activities are intense especially when the market price ascends. As a result millions of personal investors follow the trend and make 'herd effect' realized. That is why the liquid scales of money supply are impacted most.

At the same time, the rural residents which account over 60% of the whole popularity basically have no minds or techniques to invest stocks, and their assets are hold mainly in the form of savings deposit that is measured within M2. So the changes of M2 are relatively weakly interpreted by stock price. Speaking synthetically, although the money supply is predominated by the central bank, the money supply's increase just reflects the monetary policy conforms to the need of economy growth and stock market development.

The stock market's impact on currency demand is described in classical theory to apply four effects, in which three are positive effects and one is negative. We have observed the three effects dominating the relationship in the long-run, and we also discovered the negative effect in the short-run, which is the substitution effect. That means the stock price rising and trading volume expanding usually enhance the attraction of stocks and therefore substitute the currency to some extent and reduce the currency demand. So in the short time the substitution effect would cover the effect of other three temporarily, while in the long-run, the wealth effect, portfolio effect and trading effect will come into impact.

At last, we try to summarize the interaction between monetary policy and stock market. We realize that the stock market's effect on economy is extremely limited and even negatively in the long-run, so the Chinese stock market can hardly impact the monetary policy formulation that it is not qualified to be a new monetary policy transmission channel or intermediate target. Thus the central bank only need to concern the stock market but do not have to peg. However, if the central bank only intends to affect the stock market, it is available but only the interest rate is competent to be the policy tool since it is the stock price that affects money supply, not vice versa, according to the actuality of China.

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APPENDICES

Appendix 1. Unit root test results for the whole empirical part.

H0: the series has a unit root

Series	t-Statistic	Test critical values			Test result
		1% level	5% level	10% level	
LIVA	-2.106596	-4.06963	-3.46355	-3.158207	Unit root
DLIVA	-3.88765829	-3.51026	-2.89635	-2.585396	Stationary
LLOAN	-2.258234	-4.05646	-3.4573	-3.154562	Unit root
DLLOAN	-7.584435	-3.50067	-2.8922	-2.583192	Stationary
LTM	3.642355	-3.49991	-2.89187	-2.583017	Unit root
DLTM	-7.457559	-4.05753	-3.45781	-3.154859	Stationary
LSSEA	1.353737	-2.58596	-1.94374	-1.614818	Unit root
DLSSEA	-5.43923	-2.58635	-1.9438	-1.614784	Stationary
LSSEQ	-3.178944	-4.04282	-3.45081	-3.150766	Unit root
DLSSEQ	-14.78947	-2.58615	-1.94377	-1.614801	Stationary
LIBR	-1.644171	-3.568	-3.02	-2.73	Unit root
DLIBR	-15.67507	-2.58615	-1.94377	-1.614801	Stationary
LM0	11.07324	-2.58853	-1.94411	-1.614596	Unit root
DLM0	-13.35342	-3.49773	-2.89093	-2.582514	Stationary
LM1	-3.285846	-4.05439	-3.45632	-3.153989	Unit root
DLM1	-14.64892	-3.49135	-2.88816	-2.581041	Stationary
LM2	10.38392	-2.58655	-1.94382	-1.614767	Unit root
DLM2	-11.30542	-3.49193	-2.88841	-2.581176	Stationary
CE16*	-6.269862	-2.58953	-1.94425	-1.61451	Stationary
CE17*	-6.340362	-2.58615	-1.94377	-1.614801	Stationary
CE18*	-6.501106	-2.58635	-1.9438	-1.614784	Stationary
CE19*	-2.425116	-2.58902	-1.94418	-1.614554	Stationary
CE20*	-4.215071	-2.58635	-1.9438	-1.614784	Stationary

*CE16 denotes the cointegration equation 16 in the empirical part 5.2.

CE17 denotes the cointegration equation 17 in the empirical part 5.3.

CE18, 19 and 20 denotes the cointegration equation 18, 19 and 20 respectively in the empirical part 5.4.

Appendix 2. The VAR Lag Order Selection Criteria in empirical part 5.4.

VAR Lag Order Selection Criteria for LM0 and LSSEA

Lag	LogL	LR	FPE	AIC	SC	HQ
0	-53.19608	NA	0.010012	1.071769	1.122928	1.092490
1	254.6997	597.8558	2.74e-05	-4.829120	-4.675640*	-4.766955*
2	256.8414	4.075510	2.84e-05	-4.793037	-4.537238	-4.689429
3	264.1917	13.70151	2.66e-05*	-4.858091*	-4.499972	-4.713041
4	265.2028	1.845525	2.82e-05	-4.800054	-4.339616	-4.613561
5	268.0117	5.017926	2.89e-05	-4.776927	-4.214169	-4.548991
6	270.2001	3.824353	3.00e-05	-4.741750	-4.076673	-4.472371
7	272.0086	3.090153	3.13e-05	-4.699195	-3.931798	-4.388373
8	278.0199	10.03835*	3.02e-05	-4.738250	-3.868534	-4.385985

* indicates lag order selected by the criterion
LR: sequential modified LR test statistic (each test at 5% level)
FPE: Final prediction error
AIC: Akaike information criterion
SC: Schwarz information criterion
HQ: Hannan-Quinn information criterion

VAR Lag Order Selection Criteria for LM1 and LSSEA

Lag	LogL	LR	FPE	AIC	SC	HQ
0	-87.33048	NA	0.019425	1.734573	1.785732	1.755294
1	374.0694	895.9220	2.70e-06	-7.146978	-6.993499*	-7.084814*
2	377.1133	5.792329	2.75e-06	-7.128413	-6.872614	-7.024806
3	385.6853	15.97893*	2.52e-06*	-7.217191*	-6.859072	-7.072140
4	387.1279	2.633098	2.65e-06	-7.167533	-6.707094	-6.981039
5	392.1257	8.927988	2.60e-06	-7.186906	-6.624148	-6.958970
6	393.1727	1.829711	2.75e-06	-7.129566	-6.464489	-6.860187
7	395.6147	4.172881	2.84e-06	-7.099315	-6.331919	-6.788493
8	399.7928	6.976929	2.84e-06	-7.102773	-6.233056	-6.750508

* indicates lag order selected by the criterion
LR: sequential modified LR test statistic (each test at 5% level)
FPE: Final prediction error
AIC: Akaike information criterion
SC: Schwarz information criterion
HQ: Hannan-Quinn information criterion

VAR Lag Order Selection Criteria for LM2 and LSSEA

Lag	LogL	LR	FPE	AIC	SC	HQ
0	-94.08939	NA	0.022150	1.865813	1.916973	1.886535
1	448.1525	1052.897	6.40e-07	-8.585486	-8.432007*	-8.523322
2	453.5582	10.28655	6.23e-07	-8.612781	-8.356982	-8.509174
3	463.2355	18.03923	5.58e-07*	-8.723020*	-8.364901	-8.577970*
4	464.4285	2.177479	5.90e-07	-8.668515	-8.208077	-8.482021
5	470.3599	10.59586*	5.69e-07	-8.706017	-8.143259	-8.478081
6	472.6084	3.929441	5.89e-07	-8.672008	-8.006930	-8.402629
7	474.9436	3.990230	6.09e-07	-8.639681	-7.872284	-8.328859
8	479.3551	7.366828	6.05e-07	-8.647672	-7.777956	-8.295407

* indicates lag order selected by the criterion

LR: sequential modified LR test statistic (each test at 5% level)

FPE: Final prediction error

AIC: Akaike information criterion

SC: Schwarz information criterion

HQ: Hannan-Quinn information criterion

Appendix 3. VEC Residual Portmanteau Tests for Autocorrelations in empirical part 5.4.

VEC Residual Portmanteau Tests for LM0 and LSSEA
H0: no residual autocorrelations up to lag h

Lags	Q-Stat	Prob.	Adj Q-Stat	Prob.	df
1	0.101862	NA*	0.102814	NA*	NA*
2	0.907551	NA*	0.923705	NA*	NA*
3	1.821898	0.7685	1.864176	0.7607	4
4	4.971495	0.7606	5.134912	0.7431	8
5	8.137449	0.7743	8.454552	0.7487	12
6	14.56377	0.5568	15.25890	0.5058	16
7	18.83356	0.5327	19.82460	0.4689	20
8	21.22928	0.6252	22.41199	0.5547	24
9	24.95235	0.6304	26.47351	0.5470	28
10	29.10110	0.6140	31.04561	0.5147	32
11	32.59292	0.6314	34.93341	0.5192	36

*The test is valid only for lags larger than the VAR lag order.
df is degrees of freedom for (approximate) chi-square distribution

VEC Residual Portmanteau Tests for LM1 and LSSEA
H0: no residual autocorrelations up to lag h

Lags	Q-Stat	Prob.	Adj Q-Stat	Prob.	df
1	0.268934	NA*	0.271447	NA*	NA*
2	1.039171	NA*	1.056217	NA*	NA*
3	4.464459	0.3468	4.579371	0.3332	4
4	8.893917	0.3513	9.179192	0.3274	8
5	9.046978	0.6989	9.339683	0.6737	12
6	12.06977	0.7392	12.54029	0.7060	16
7	14.04310	0.8283	14.65039	0.7961	20
8	16.51206	0.8687	17.31686	0.8348	24
9	22.75903	0.7450	24.13173	0.6746	28
10	27.85381	0.6766	29.74639	0.5811	32
11	28.30780	0.8161	30.25186	0.7381	36

*The test is valid only for lags larger than the VAR lag order.
df is degrees of freedom for (approximate) chi-square distribution

VEC Residual Portmanteau Tests for LM2 and LSSEA

H0: no residual autocorrelations up to lag h

Lags	Q-Stat	Prob.	Adj Q-Stat	Prob.	df
1	0.364414	NA*	0.367820	NA*	NA*
2	0.518430	NA*	0.524741	NA*	NA*
3	2.154521	0.7074	2.207579	0.6976	4
4	9.685669	0.2878	10.02839	0.2630	8
5	11.25664	0.5071	11.67562	0.4721	12
6	18.38818	0.3017	19.22665	0.2571	16
7	19.91443	0.4633	20.85869	0.4055	20
8	26.96292	0.3062	28.47106	0.2407	24
9	29.16420	0.4042	30.87245	0.3228	28
10	34.72655	0.3393	37.00239	0.2489	32
11	36.15116	0.4616	38.58855	0.3534	36

*The test is valid only for lags larger than the VAR lag order.

df is degrees of freedom for (approximate) chi-square distribution