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The Impact of China's Monetary Policy Shocks on Stock Prices

중국 통화정책 충격이 주식 가격에 미치는 영향

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Abstract

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This study investigates the effect of China's monetary contractionary policy shocks to the domestic stock price using structural VAR models for the periods after adoption of managed float exchange rate regime in China (July 21, 2005). The repo rate is chosen as the policy instruments of China's monetary policy, Shanghai composite index and 10 SSE sector indices are selected to reflect the stock prices of the overall and different sectoral stock markets. The main empirical results are as follows. Firstly, the positive repo rate shocks have a statistically significant negative influence on both aggregate and most of the sectoral stock prices except industrial sector although the effect is modest. In addition, the impact of repo rate shocks on different industries is asymmetric and the reason can be attributed to the degree of the monopoly and sensitivity to the change of interest rate. For example, the information technology sector responses more actively to the contractionary monetary shock than utilities sector.

Keywords : Stock prices, Monetary policy shocks, SVAR, China

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1. Introduction

In recent years, more and more research has provided evidence for the relationship between monetary policy and the stock market. Most studies focus on the real impact of monetary policy on the stock market of the US, the EU, Canada or other developed countries, but the impact of the China's policy on stock markets are insufficiently studied. Despite its establishment in the early 1990s, the Chinese stock market has become one of the most influential stock markets in the world now. As of April 2018, the Shanghai Stock Exchange has become the world's fourth largest stock market with a market capitalization of $5.5 trillion. However, in consideration of the specific political and economic environment of China, its stock market has not fully matured yet compared to developed countries such as the USA and the UK which means the mechanisms and theories of monetary policy transmission that appropriate for those developed countries cannot be directly used in the Chinese stock markets. Thus conducting a research concerning the impact of monetary policy shocks on Chinese stock markets not only enriches former research on developed countries but also provides a reference for related study on developing countries.

1.1 Chinese Monetary Policies

China’s monetary policy consist of two types of monetary policy instruments: the instruments of the People’s Bank of China (PBoC) which is the central bank of

China, as well as the non-monetary policy instruments. Moreover, the PBoC's monetary instruments include quantity-based direct and price-based indirect tools (Geiger,2006). Quantity-based instruments comprise required reserve ratios (RRR), central bank bills and repurchase or reverse repurchase amounts. Price-based policy instruments contain benchmark lending and deposit rates, the issuance rate of central bank bills, repurchase or reverse repurchase rates. After October 2015, the PBoC cancelled the interest rate control on retail deposits and loans, even though it continues to announce benchmark deposit and lending rates. Since then, the PBoC has been trying to establish an interest rate corridor system similar to the European Central Bank, with the central bank's excess reserve rate as the bottom line and the standing loan instrument (SLF)[1] service rate as the upper limit for short-term interest rates. Through the adjustment of short-term interest rates, the PBoC aims to influence long-term interest rates, consequently affecting inflation and real economic activity. (Chen, 2017).

Because of China's special interest rate system, most of the previous studies paid more attention on money supply and reserve requirement ratio as the research object to investigate the impact of the quantity-based instruments of monetary policy and ignored the studies of interest rates. While in this paper, I use the repo rate as a monetary policy instrument to analyze the influence of monetary policy on Chinese stock market according to the conclusion by Cho(2018) that the repo rate

[1] Standing lending facility (SLF) is a liquidity adjustment tool created by the PBoC in 2013 to meet large liquidity requirements of financial institutions with a long term.

shows more significant results and is likely to be more effective in explaining the transmission channels of China's monetary policy than the reserve requirement ratio.

1.2 Chinese Stock Markets

The Chinese stock market is supervised by PBoC's Securities Regulation Committee, with the original goal of assisting state-owned companies in raising capital and further reforming the economy. Following the success in the first phase of economic reform (from planned economy to free market economy) in rural areas as a political test, the Chinese stock market helped state owned companies diversify their shareholders by selling the company shares to private investors. Therefore, in the 1980s, the government started giving some companies the opportunity to publish equity to raise capital. The issuance of shares increased the demand for the exchange of shares. OTC trading[2] was very prevalent in some cities in 1989. In this context, the Shanghai Stock Exchange(SSE) was established on November 26, 1990 and the Shenzhen Stock Exchange(SZSE) was founded on April 11, 1991. There are two categories of shares traded on the Chinese Stock Exchange, the A shares and the B shares. A-share and the B-share divided the markets. A shares are available only to domestic citizens and institutions while B shares are intended for foreign investors before the market was opened to domestic

[2] Over-The-Counter trading, securities transactions conducted outside the stock exchange.

investors.

At present, the two most influential stock indexes in China are Shanghai composite index and Shenzhen component index, which respectively reflect the overall picture of the stock market of Shanghai stock exchange and Shenzhen stock exchange. The correlation coefficient between the two is very high. Taking into account some representative factors such as market size, liquidity and trading volume, this paper selects the Shanghai Composite Index as a proxy variable to represent Chinese stock market aggregate price. The Shanghai Composite (SCI) Index includes all listed stocks of A-shares and B-shares in the Shanghai Stock Exchange. The base day of SCI index is December 19, 1990 issued by SSE, with the base value of 100.

Compared to previous studies, this paper assesses the impact of monetary policy of the People's Bank of China on the stock prices from not only the national market dimension but also industrial market dimension. I collected the data of top 100 stocks of A shares based on total market cap from Shanghai stock exchange and sorted these stocks into 10 sectors of which classification standard is issued by China Security Index Co., LTD. These sectoral indices are SSE Energy Sector Index (SEI), SSE Materials Sector Index (SMI), SSE Industrial Sector Index (SII), SSE Consumer Discretionary Sector Index (SCDI), SSE Consumer Staples Sector Index (SCSI), SSE Health Care Sector Index (SHCI), SSE Financial Sector Index (SFI), SSE Information Technology Sector Index (SITI), SSE Telecommunication

Services Sector Index (STSI), SSE Utilities Sector Index (SUI)[3].

The pie chart shows that financial stocks accounted for more than 1/3 of the market share of Shanghai stock market, and together with industrial stocks took up over half of the market share. Therefore, it is necessary to study how these two sectoral stock prices changed when facing the monetary policy shock.

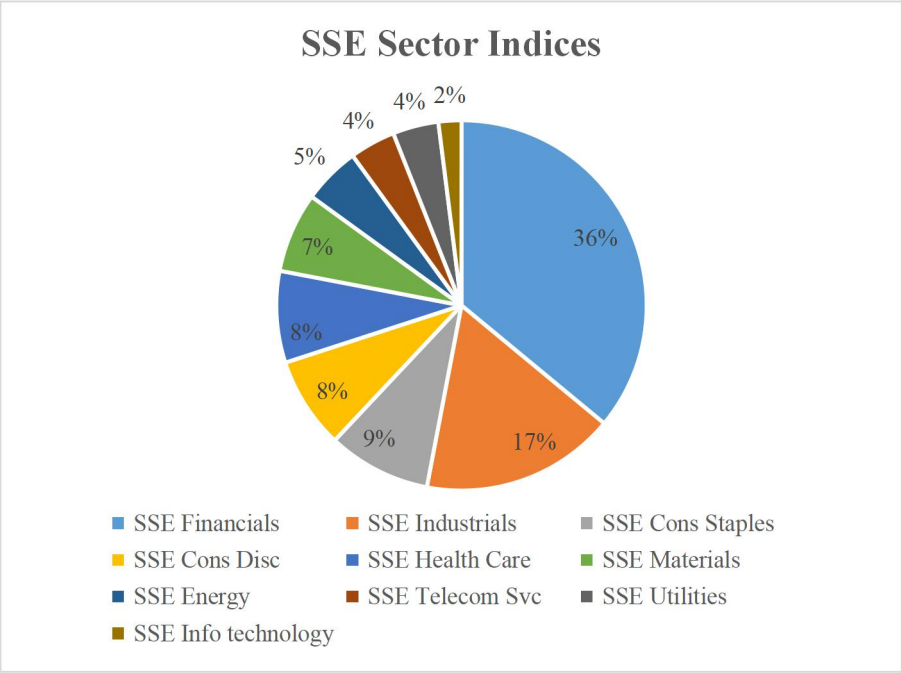


Figure 1. Sector classification of top 100 stocks based on market share on SSE

The main structure of the rest part is described as follows. Section two introduces the theoretical background of the relationship of interest rates and stock prices, and summarizes the contents and results of previous related research. Section three explains the VAR models and empirical methodology that are used in

[3] The methodology of SSE Sector Indices is in the appendix 2.

this paper. Part four carries out empirical analysis, including both impulse responses and variance decomposition of aggregate and sectoral stock markets, as well as robustness checks. In the end, part six gives out the conclusions of this paper.

2. Theory and Evidence

2.1 Theoretical Background

According to Keynes's theory of liquidity preference, when the interest rate adjustment is out of public expectations, if the current interest rate rises, more people will believe that interest rates will fall in the future, and buy stocks in order to sell them in the future, so the stock price increases. when the interest rate adjustment is lower than the public expectation, if the interest rate rises, people believe that the interest rate will rise higher in the future, then the public will sell the stock now to hold currency to be ready to enter the stock market in the future. As a result, the stock price falls. And when the interest rate adjustment is in line with public expectations, the demand for stocks will not change and the stock price will remain unchanged.

The asset selection theory of Tobin et al. gives another explanation for the influence of interest rate on stock prices: (1) Substitution effect: when the interest rates go up, the public is not willing to hold stocks with relatively higher risk, then stock price will go down. (2) Accumulation effect: As the interest rates rise, the

return on safe assets increase. Then the public do not need to buy high-yielding risky assets to achieve the goal of wealth accumulation which will lead to stock prices fall.

It is believed that the interest rate of monetary policy, in addition to affecting the interest rate of security assets such as deposit currency and treasury bonds, also exerts an important influence on stock prices from another channel: as an indicator of macroeconomic performance, the PBoC benchmark interest rate increase means the economic boom which will decrease investment risks and the let public become more willing to enter stock market, stock prices will rise. At the same time, the economic boom will also improve the growth of current income and forms an optimistic expectation of future income growth, thereby strengthen investment willingness, stock prices will rise. This is called "indicator effect."

Therefore, it is difficult to judge the impact of interest rate on the stock price trend only in theory, and the quantitative analysis based on actual situation should be conducted to get a clear answer.

2.2 Previous Empirical Evidence

According to different statistical methods, many empirical studies have been developed to analyze the interaction between monetary policy and stock prices. These studies generally in support of the belief that monetary policies can significantly influence stock prices, that is, contractionary (expansionary) monetary

policy decreases (increases) stock prices. Most studies rely on structural VAR (SVAR) methods, and initially focus on the US stock market and the Fed's monetary policy.

Christiano, Eichenbaum and Evans (1996) presented a framework that analyzes the monetary policy transmission mechanism to estimate the effect of the monetary policy shock on the U.S. real economy by employing SVAR models. They found that a contractionary monetary policy shocks bring a fall in the monetary aggregates and real activity and a rise in the federal rate.

Patelis (1997) used long-horizon and short-horizon vector auto-regressions and got the conclusion that monetary policy variables are important factors to affect future returns of stocks, even though they cannot fully explain the predictability of the observed return. Thorbecke (1997) conducted an event study of Federal Reserve policy changes and the evidence indicated that monetary policy imposes large effects on share returns while the effects on larger firms were smaller than small firms. The same conclusions are reached for the US by Ehrann and Fratzscher (2004) also used the event study approach to analyze the reaction of stock markets to U.S. monetary policy and found that a contractionary monetary policy reduces stock returns. They presented evidence that Individual stocks respond to the US monetary policy shock in a highly heterogeneous manner, and associated this heterogeneity with financial restraints and Tobin's q. Li, Iscan and Xu (2007) used structural VAR models to research the monetary policy of the United States and Canada with short-run restrictions and found that the openness

and macroeconomic interdependence maybe the significant elements to influence the transmission of monetary policy shocks to stock prices. Castelnuovo and Nistico (2010) supported the previous conclusion when they investigated the interaction of the U.S. monetary policy and stock markets by using a DSGE model.

Based on previous research, scholars further studied the impact of the monetary policy shocks on stock markets of other countries, especially for European countries or OECD countries. Ioannidis and Kontonikas (2007) studied the 13 OECD countries' stock markets by using ordinary least squares and found that their monetary policy shocks affect domestic stock returns obviously. In addition to the studies emphasizing the impact on the overall stock market, Bredin et al. (2009) adopted an event study method to investigate the stock market response to international monetary policy changes in the UK and Germany and got a result that the UK monetary policy shocks significantly affect the overall and industry-level returns of both countries while the impact of the German/Eurozone monetary policy shocks seems to be negligible. Similarly, Kholodilin et al. (2009) also applied the event study and found that the ECB's monetary policy has a different impact on the euro zone's sectoral stock market prices. Belke and Beckmann (2015) employed the co-integrated vector-autoregressive (CVAR) model to analyze the long-run and short-run relationships between stock markets and monetary policies of the five developed and three developing economies and found that the stock markets of the latter economies more often associated with money supply and capital flows.

These kinds of researchers are expanded to China, for the reason that China's stock market has been one of the biggest markets in the world. Initially, money supply as monetary policy instruments was considered more frequently for the Chinese economy because the degree of interest rate liberalization is relatively low in China until October 2015, the PBoC loosened both retail deposit and lending rate controls. Laurenceson and Hui (2011) used SVAR modelling techniques and selected the money base to represent monetary policy and their results indicate that a monetary policy shock has a significant impact on prices of assets, in particular stock prices. Wang and Zou (2011) also got the same result by using money supply M2 as the instrument of monetary policy. Besides, the effectiveness of price-based monetary policy instruments and quantity-based policy instruments is still debatable. He, Leung and Chong (2013) used a factor-augmented VAR method and show that the non-market-based measures such as growth rates of total loan and money supply are more effective in adjusting the real economy and price level including stock market (choosing Shanghai composite index as proxy variable) than market-based monetary instruments such as repo rate, benchmark lending rate. However, Cho, Huang and Kim (2018) investigated the transmission mechanism of China's monetary policy shocks to the other Asian countries through trade channel and financial channel by using SVAR models and found that he repo rate was likely to be more effective in explaining the transmission channels than the reserve requirement ratio. Sun, Ford and Dickinson (2010) suggested the existence of a bank lending channel, an interest rate channel and an asset price channel by estimating VAR/VEC models. Chen, Chow and Tillmann (2017) used a Qual VAR,

a conventional VAR system augmented with binary policy announcements, with sign restrictions and found that easing monetary policy shocks bring stock prices up sharply while a tightening shocks do not exert impact on stock prices.

Unlike the FED which announces the adjustment of rates in scheduled FOMC meetings, PBoC announces raising or lowering of interest rates and reserve requirement ratio as surprises without any schedules. However, the existing event-study literature measured the monetary policy shocks simply by the changes of policy rates on days of FOMC meetings (Ehrann and Fratzscher, 2004), which may not be appropriate for the situation in China. Therefore, in this paper, I choose SVAR models to analyze the effect of China's monetary policy on stock markets.

3. Methodology and Data

3.1 Variable Selection and Data

(1) Monetary policy variables. In this paper, I choose the 7-Day interbank bond collateral repo rate as the PBoC monetary policy priced-based indirect instruments because it has both a policy nature and marketability characteristic (Cho,2018). As for the money supply variable, I select M1 because there are few medium - and long-term investors in China's money market, and most investors are actually speculators. Therefore, I believe that M0 and M1 with strong liquidity can be used as indicators of money supply, and M1 has a more comprehensive explanatory power compared with M0.

(2) Stock price variables. I choose the Shanghai composite index(SCI) to reflect the aggregate stock price and 10 SSE sector indices (SEI, SMI, SII, SCDI, SCSI, SHCI, SFI, SITI, STSI, and SUI) mentioned above to reflect the price volatility and performance of various sectors of the Shanghai stock market. These sectoral indices include the largest A-shares of each industry in SSE stock market and were officially launched on January 2005, with the base day of December 31, 2003 and the base value of 100.

(3) Real economic variables. It is general to use real gross domestic product (GDP) to comprehensively reflects the actual macroeconomic situation of a country. However, considering the lack of monthly data of GDP in China, this paper chooses industrial production(IP) added value instead of GDP.

(4) Price variables. I select the commonly used consumer price index(CPI) as an indicator of inflation.

(5) Foreign variables. The federal funds rate is added as an exogenous variable to control for the influence of the US monetary policy. And no lags are assumed for the exogenous variable in order to save the degrees of freedom.[4]

The sample period is from August 2005 to December 2016, after which China abandoned its fixed exchange rate regime and adopted a managed floating system in July 21, 2005. The logarithm is taken for all variables except interest rates. IP, CPI, M2 and stock index are seasonally adjusted by using the Census X-12

[4] The data sources are displayed in the appendix 1.

procedure.

3.2 Baseline Model

My analysis is building on the estimation and identification of a Structural Vector Autoregressive (SVAR) model. SVAR models have a comparatively long history as an econometric model so I am not going to elaborate on their origins and general technical features. The main advantage of SVAR models compared to the traditional unrestricted VAR models is that the latter is a merely statistical model and not beneficial for policy analysis. While structural form VAR models can explain the economic theory better by imposing restrictions on coefficient values. Another attractive feature of SVAR models is that through impulse response functions deeper understand can be obtained into the combination of direct and indirect impacts over time of a shock to one endogenous variable on other variables in the system. For my purposes, I am primarily interested in the effect of a shock of monetary policies on aggregate stock prices and sectoral stock prices.

A structural form of the VAR model is considered:

$$B_0 Y_t = \sum_{i=1}^{l} B_i Y_{t-i} + \sum_{i=0}^{l} G_i Z_{t-i} + \varepsilon_t \qquad (1)$$

where Y_t is a $l \times 1$ vector of endogenous variables, Z_t is a $m \times 1$ vector of exogenous variables, and ε_t is a $l \times 1$ structural disturbances vector. ε_t is assumed to be serially uncorrelated, and $\mathrm{var}(\varepsilon_t) = \Lambda$, where Λ is a diagonal matrix

whose diagonal elements are the variances of structural disturbances. Therefore, ε_t is assumed to be mutually uncorrelated. B_0 is an $l \times 1$ contemporaneous coefficient matrix of endogenous variables in the structural form equation, and B_i contains a coefficient matrix of lagged endogenous variables. G_i is an $l \times m$ coefficient matrix of current and lagged exogenous variables.

Then the reduced form of the previous structural VAR model can be represented as follow:

$$B_0^{-1} B_0 Y_t = B_0^{-1} \sum_{i=1}^{l} B_i Y_{t-i} + B_0^{-1} \sum_{i=0}^{l} G_i Z_{t-i} + B_0^{-1} \varepsilon_t \quad (2)$$ [5]

Then I can first estimate the following reduced form VAR:

$$Y_t = B_0^{-1} \sum_{i=1}^{l} B_i Y_{t-i} + B_0^{-1} \sum_{i=0}^{l} G_i Z_{t-i} + u_t \quad (3)$$

u_t is an $l \times 1$ residuals vector, where $\mathrm{E}(u_t) = 0$, and $\mathrm{var}(u_t) = \Sigma$.

Thus the structural disturbances and the reduced-form residuals are related by $\varepsilon_t = B_0 u_t$

which implies

$$\Sigma = B_0^{-1} \Lambda (B_0^{-1})' \quad (4)$$

In the baseline model, the endogenous variable vector Y_t includes four Chinese macroeconomic variables of IP, CPI, RR, M2 and SCI. As I mentioned in

[5] For the sake of simplicity, I proposed a model without a constant vector which can be regarded as a deviation from its stable state.

the variable selection, IP specifies industrial production add value; CPI is consumer price index; RR is monetary policy instrument, repo rate; M2 is monetary aggregate M2; SCI represents Shanghai Composite Index. The exogenous variable vector Z_t includes variables that are likely to affect China and its stock markets. I use the Federal Funds rate (FFR) to control for the US monetary policy. 2 is selected as lag length for endogenous variables according to AI criterion. Conducting AR roots test and results show that no root lies outside the unit circle which means VAR satisfies the stability condition and it is efficient to establish impulse response function.[6]

3.3 Identification Scheme

Identification scheme is accomplished by Cholesky decomposition of the reduced-form residuals Σ following the method put forward by Sims (1980). In this case, B_0 becomes triangular, that is, a recursive structure is assumed. The right-hand side of the Eq. (3) has $\mathrm{n}(\mathrm{n}+1)$ unrestricted parameters to be estimated. Since Σ includes $\frac{\mathrm{n}(\mathrm{n}+1)}{2}$ parameters, by normalizing n diagonal elements of B_0 to 1's, at least $\frac{\mathrm{n}(\mathrm{n}-1)}{2}$ restrictions is required on B_0 to realize identification.

For identification of China's monetary policy shocks, we follow those used in Christiano et al. (1999) and that I assume that IP and CPI are contemporaneously exogenous to the monetary policy instrument which implies that PBoC is used to

[6] The result of AR roots is showed in appendix 4.

formulate the monetary policies after observing current and lagged values of pivotal macro variables, for example, IP and CPI. Following the assumption in the essay of Kim (2001), I suppose that stock prices reflect all variables in the system contemporaneously.

$$\begin{bmatrix} \varepsilon^{IP} \\ \varepsilon^{CPI} \\ \varepsilon^{RR} \\ \varepsilon^{M1} \\ \varepsilon^{SCI} \end{bmatrix} = \begin{bmatrix} 1 & 0 & 0 & 0 & 0 \\ b_{21} & 1 & 0 & 0 & 0 \\ b_{31} & b_{32} & 1 & 0 & 0 \\ b_{41} & b_{42} & b_{43} & 1 & 0 \\ b_{51} & b_{52} & b_{53} & b_{54} & 1 \end{bmatrix} \begin{bmatrix} u^{IP} \\ u^{CP} \\ u^{RR} \\ u^{M1} \\ u^{SCI} \end{bmatrix} \tag{4}$$

Where ε^{IP}, ε^{CPI}, ε^{RR}, ε^{M1}, and ε^{SCI} are the structural disturbances, that is, federal fund rate shocks, industrial production shocks, CPI shocks, repo rate shocks, M1 shocks and Shanghai Composite index shocks, respectively, and u^{IP}, u^{CPI}, u^{RR}, u^{M1} and u^{SCI} are the residuals in the reduced form equations, which represents unexpected motions (given information in the system) of each variable through construction.

4. Empirical Analysis

4.1 Aggregate Stock Market Response

For the figure 1 showing the results of aggregate stock market, the horizontal axis indicates the number of lags of the shocks (unit: monthly), and the vertical axis indicates the change in the reaction variables. The solid line displays the real trend of the response function. Error bands are calculated using Monte Carlo

simulation procedure with 1000 replications, and the dashed lines exhibit the upper and lower bound of 68.3% confidence intervals.

The figure 2 shows the general characteristics of macroeconomic fluctuations caused by the contractionary monetary policy shocks (an innovation in repo rate).

The industrial production declines gradually which means that the repo rate is effective in stimulating real economy. The consumer price index shows a slight increase initially and decreases after the 5th month, manifesting a sign of price puzzle[7]. The repo rate sharply rises by 0.67 instantly when there is a positive shock to repo rate, and then the repo rate decreases gradually to a little lower than the original level. The impulse responses of M1 decreases by 0.004 immediately and reaches bottom after 14 months.

Meanwhile a positive interest rate shock (a tight monetary policy) brings the stock price down gradually. The impulse response of the Shanghai composite index reaches its bottom -0.021 until 13th month and then comes back to its original level in about 39th months. Increase in the repo rate will make speculators turn to buy risk-free government bonds or increase their bank savings which will lead to a reduction in the demand for the stock and thus, the stock price decreases.

From table 1, the result of variance decomposition due to interest rate shocks reveals that the repo rate shock accounts for 11.12% of the variations in the

[7] Price puzzle is a phenomenon that the contractionary monetary policy shocks bring a rise in price level. Sims (1992) explained that the conventional VAR models cannot include all the information that central bank considered in the determination of monetary policy.

aggregate stock price, 52.56% of the variations in industrial production and 50.77% of the variations in the CPI. What's more, a positive repo rate shock is responsible for 90.02% of the variations in itself and 68.02% of the variations money supple M1.

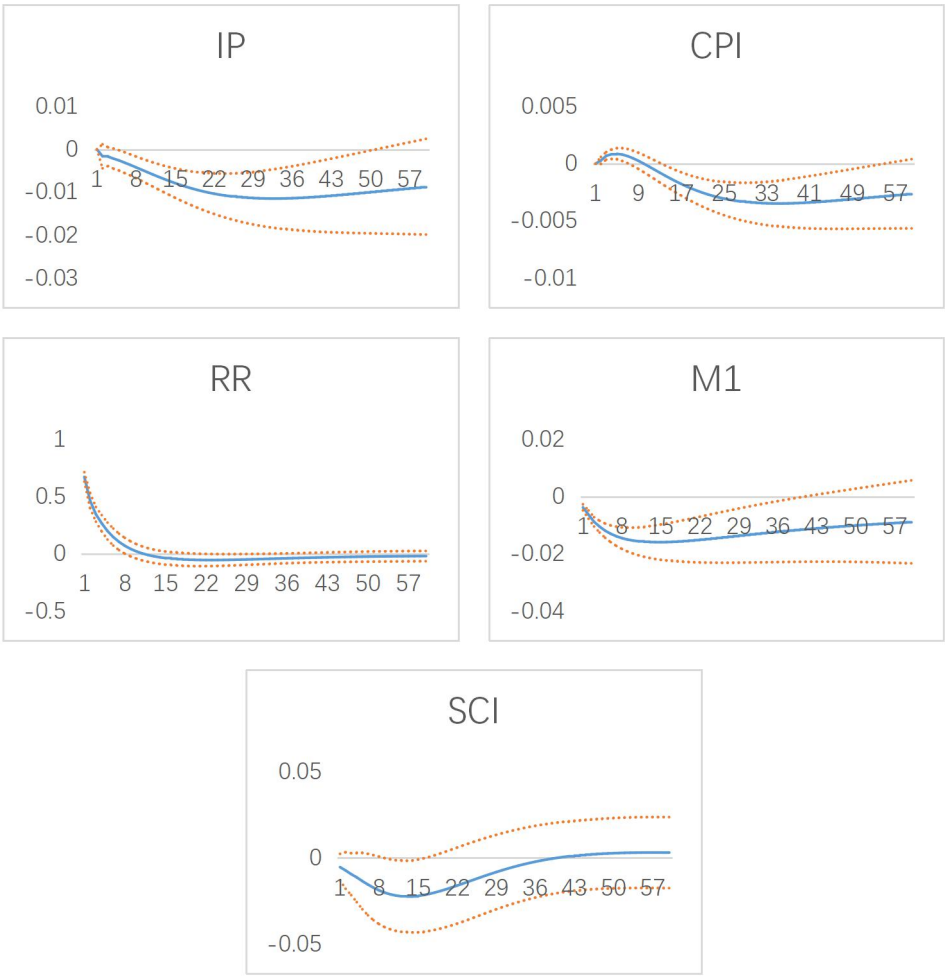


Figure 2. Impulse response of domestic variables to a positive repo rate shock (Contractionary Monetary Policy Shock): the aggregate stock market

	1st	6th	1st year	2nd	3rd	4th	5th

	month	month		year	year	year	year
IP	0.000	1.797	9.125	30.118	42.807	49.202	52.555
CPI	0.000	5.298	3.732	21.067	38.209	46.635	50.773
RR	99.910	94.604	93.084	90.789	90.219	90.089	90.016
M1	8.619	46.266	57.956	64.255	66.544	67.539	68.017
SCI	0.380	1.723	5.023	10.223	11.005	11.004	11.120

Table 1. Results of forecast error variance decomposition due to repo rate shocks: the aggregate stock market

4.2 Sectoral Stock Market Response

It seems that China's monetary policy shock cannot cause aggregate stock price to change considerably, so in this part, we will investigate the response of different sectors to the repo rate shock. These are sectors are energy sector, materials sector, industrial sector, consumer discretionary sector, consumer staples sector, health care sector, financial sector, information technology sector, telecommunication services sector, utilities sector index. The stock index of these sectors are substituted for the Shanghai composite index in the baseline model respectively with the other variables not changed. All industry-specific variables are subtracted the CPI inflation rate and taken the logarithms with seasonal adjustment, and the lag length of all variables is selected to be 2 according to AIC criterion.

From figure3, impulse response functions show that the repo rate shock has a

statistically significant negative influence to all the sectoral stock index except industrial sector index.

Generally speaking, industries with fierce competition are greatly affected by policies, and industries with strong monopoly are less affected by policies. In terms of industrial sector, by observing the constituent stocks in the SSE industrial sector, most listed companies belong to the state-controlled monopoly enterprises. This ownership structure determines that the business performance of these listed companies will not be too sensitive to the price of capital. Other explanations include that the underdevelopment of financial markets and frictions[8] in the stock markets distorts the normal transmission of policy signals in the stock markets.

As for the other 8 sectoral stock indices, from the perspective of the peak value of impulse response, all the industries are larger than the overall stock market except the utilities sector. Following the positive repo rate shock, utilities sector index declines immediately and reaches the bottom in the second month of -0.012. The reason that the utilities sector index has the weakest peak response to contractionary monetary policy shock probably in that most of the listed companies in utilities sector are state-owned enterprises, and on the other hand, it lacks demand elasticity so that monetary policy will not affect the utilities stock prices to a large extent. Besides, given a positive repo rate shock, the stock prices of the information technology sector, consumer discretionary sector, consumer staples

[8]Friction is the process involved in conducting a transaction. Friction includes both monetary and non-monetary costs. They are related to the relative difficulty of trading.

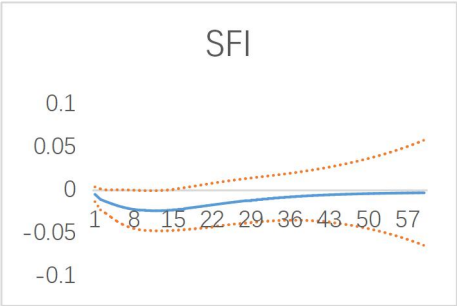
sector, telecommunication services sector, and health care sector decline relative actively than materials sector, financial sector and energy sector. Among which, the information technology sector has the highest peak response of -0.030 since it is a highly competitive industry and the energy sector index has the lowest peak response for the reason that China's materials sector has a high degree of industrial concentration.

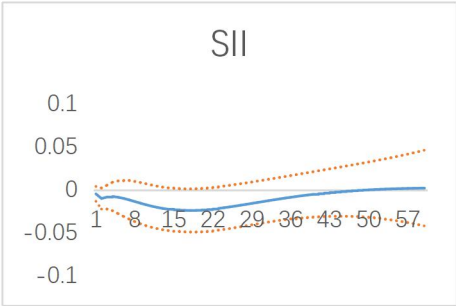
In terms of the peak time of the impulse response, financial sector, utilities sector, consumer discretionary sector and materials sector response quickly than other sectors. This result is similar to that of Ehrmann and Marcel(2004), whose analysis suggests that cyclical and capital-intensive[9] industries are affected most by the monetary policy surprises. Here in Shanghai stock market, materials and utilities sector are capital intensive sectors and financial sector is a cyclical sector. Besides, the consumer staples sector and consumer discretionary sector can be regarded as the non-cyclical and cyclical industry, respectively.

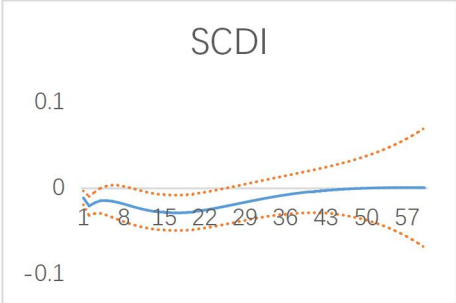
The 60-step variance decomposition in this case is displayed in table 2. A positive shock to repo rate contributes 4.69%, 8.78% and 9.77% to the change of the utilities sector, industrial sector and energy sector stock index, but the contribution to the telecommunication services sector, consumer discretionary sector, information technology, consumer staples sector, and health care sector are more considerable, which is 14.93%, 16.85%, 17.79%, 21.55%, and 26.67%,

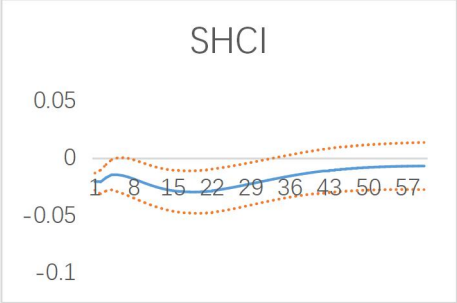
[9] Capital-intensive means some industries which need large investments of money for machinery and infrastructure to make a profit.

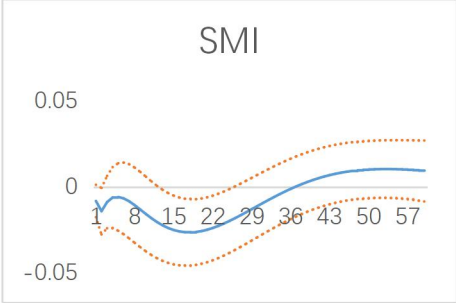
separately. The result of variance decomposition shows that a repo rate shock has the better explanatory power for the fluctuation in the health care index and consumer staples sector than utilities sector and industrial sector.

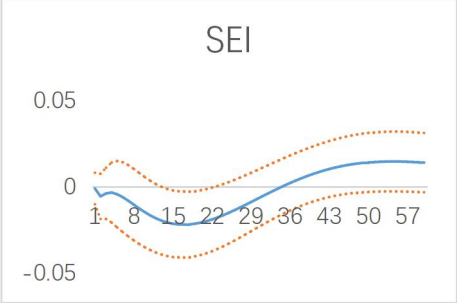


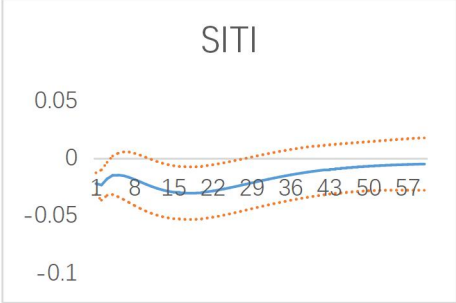












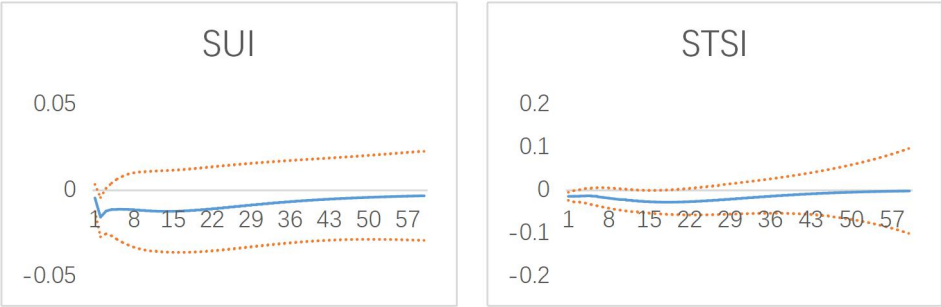


Figure 3. Impulse response to a positive repo rate shock: SSE industry-specific sector index

	1st month	6th month	1st year	2nd year	3rd year	4th year	5th year
SFI	0.258	2.300	5.108	8.927	10.121	10.449	10.586
SII	0.205	0.675	2.070	6.800	8.622	8.769	8.777
SCSI	3.388	2.697	5.051	16.158	20.942	21.533	21.546
SCDI	1.616	3.102	5.815	14.432	16.759	16.854	16.850
SHCI	5.319	4.857	8.289	20.147	24.968	26.172	26.665
SMI	0.562	0.738	1.991	8.309	9.288	9.490	10.342
SEI	0.008	0.200	1.614	6.567	6.979	7.764	9.768
SITI	4.342	3.276	5.306	13.295	16.688	17.526	17.791
SUI	0.274	1.715	2.154	3.454	4.194	4.524	4.689
STSI	1.946	2.184	4.418	11.010	14.110	14.817	14.927

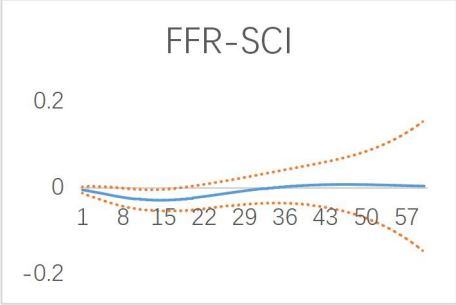
Table 2. Results of variance decomposition due to repo rate shocks: SSE financial and industrial sector index

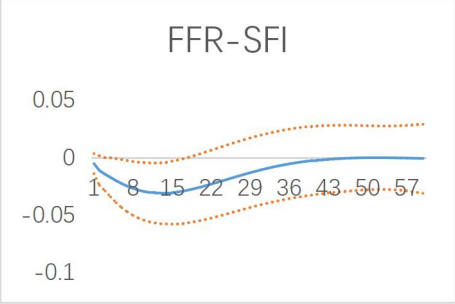
4.3 Robustness Checks

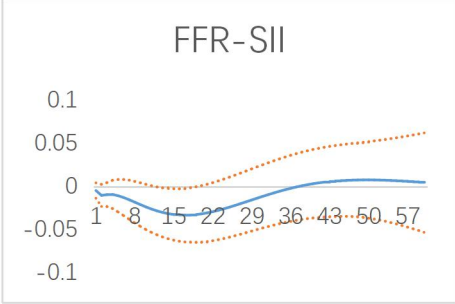
4.3.1 Adding Foreign Variable

Instead of setting FFR as an exogenous variable, I assume that FFR is an endogenous variable and contemporaneously exogenous to all China's variables according to Bjørnland (2009).

$$\begin{bmatrix} \varepsilon^{FFR} \\ \varepsilon^{IP} \\ \varepsilon^{CPI} \\ \varepsilon^{RR} \\ \varepsilon^{M1} \\ \varepsilon^{SCI} \end{bmatrix} = \begin{bmatrix} 1 & 0 & 0 & 0 & 0 & 0 \\ b_{21} & 1 & 0 & 0 & 0 & 0 \\ b_{31} & b_{32} & 1 & 0 & 0 & 0 \\ b_{41} & b_{42} & b_{43} & 1 & 0 & 0 \\ b_{51} & b_{52} & b_{53} & b_{54} & 1 & 0 \\ b_{61} & b_{62} & b_{63} & b_{64} & b_{65} & 1 \end{bmatrix} \begin{bmatrix} u^{FFR} \\ u^{IP} \\ u^{CPI} \\ u^{RR} \\ u^{M1} \\ u^{SCI} \end{bmatrix}$$







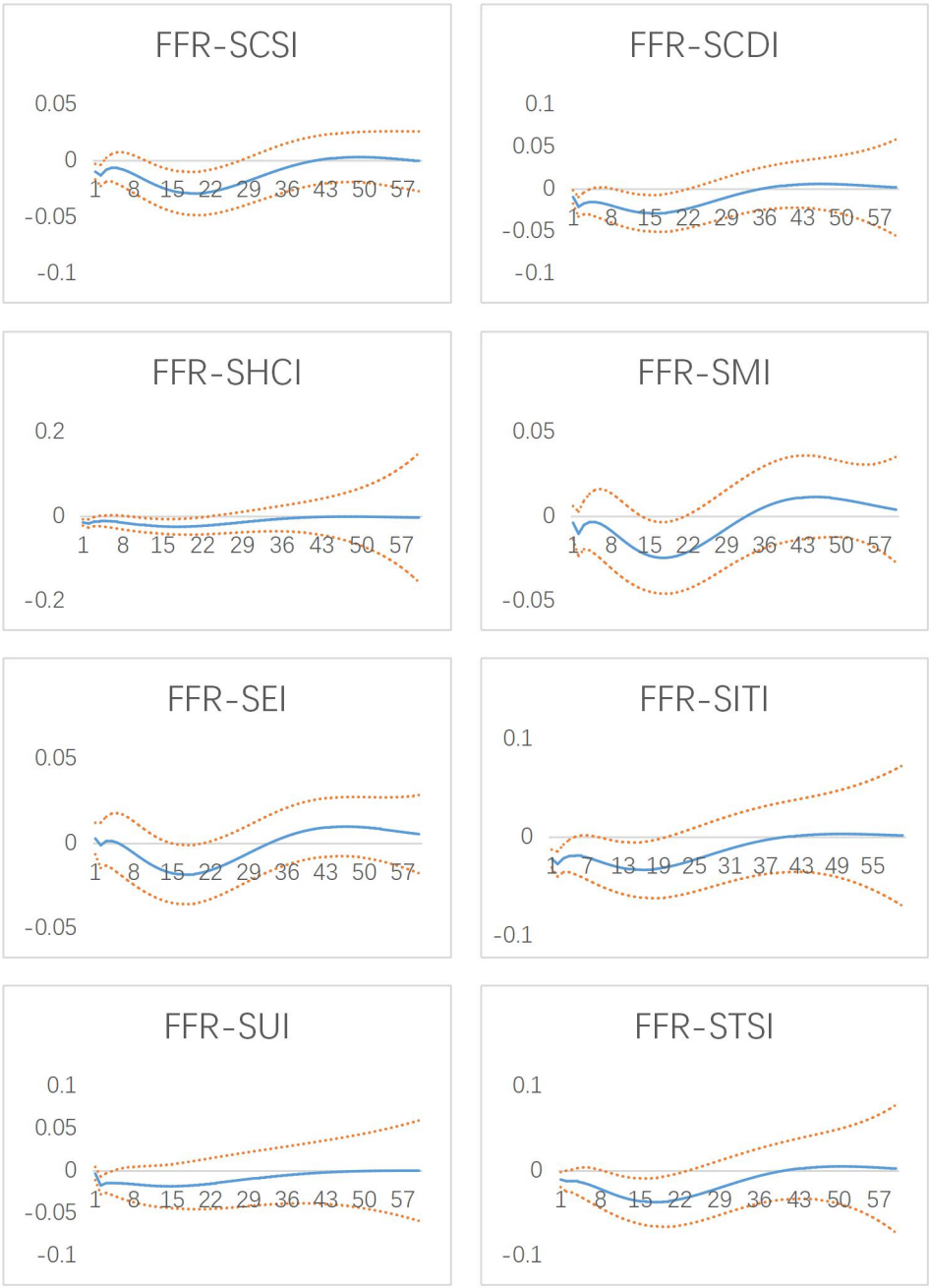


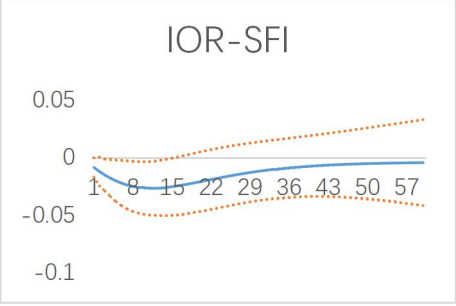
Figure 4. Impulse response to a positive repo rate shock: changing FFR as an endogenous variable

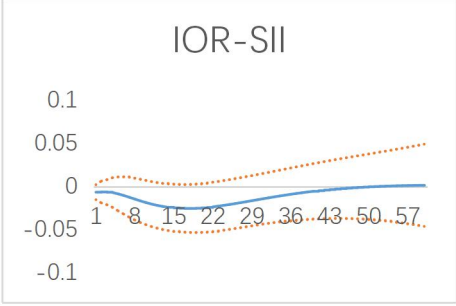
Figure 4 confirms the robustness of the previous empirical analysis result, that is, a tight monetary policy shock causes stock prices to decline. However, the

response of the industrial sector becomes statistically significant. This suggest that the U.S. monetary policy can affect the Chinese stock market to some extent.

4.3.2 Alternative Specification

To ensure the robustness of the empirical test results, I impose 7-day bank interbank offered rate which is more preferred by Chinese scholars to replace repo rate and conduct the estimation. China's 7-day bank interbank offered rate is a very market-based interest rate, and it is the basis of other interest rates. It initially reflects the market's supply and demand for funds and can then determine the central bank's monetary policy stance.





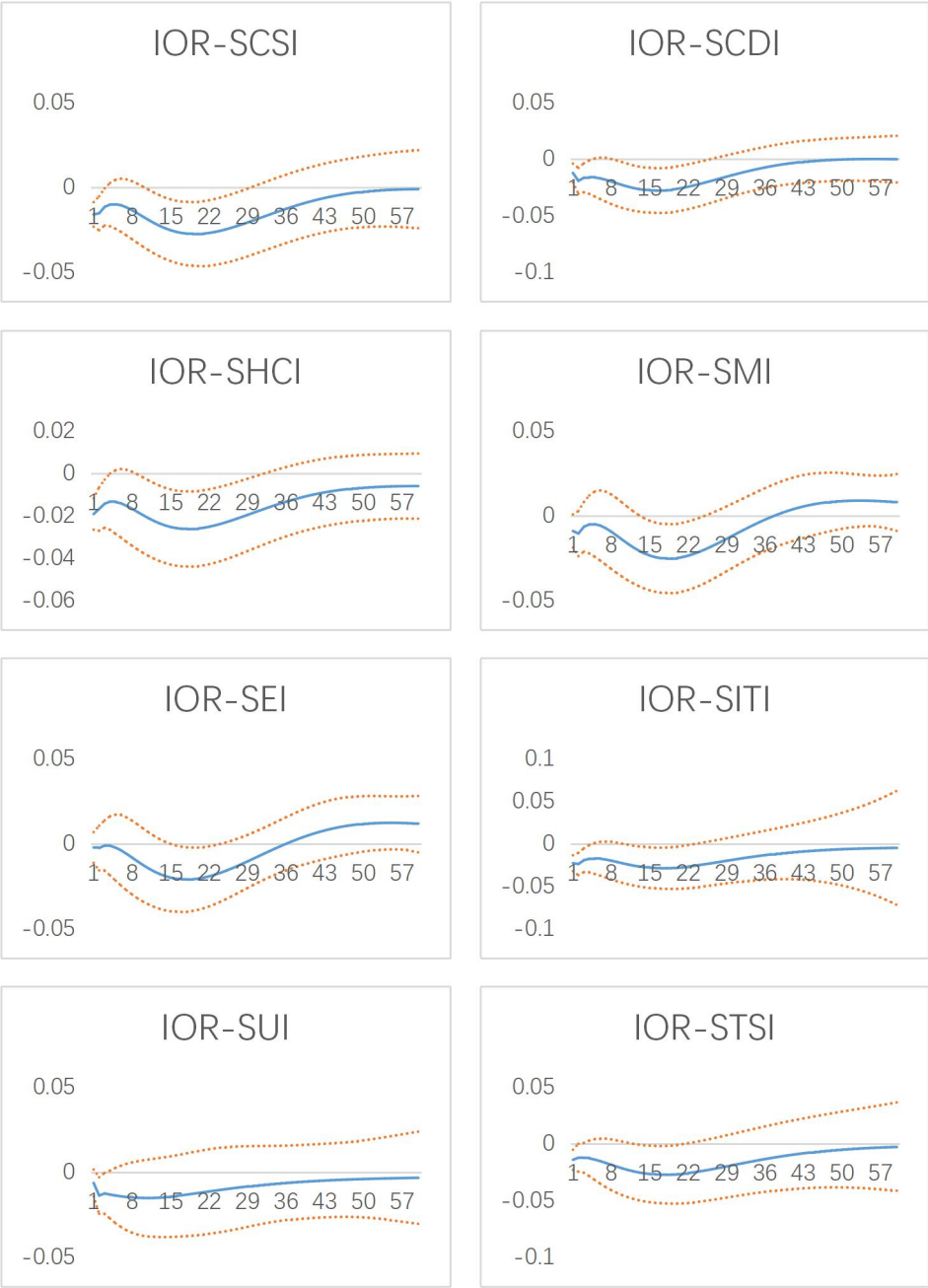


Figure 5. Impulse response to a positive repo rate shock: changing interbank offered rate as monetary policy instrument variable

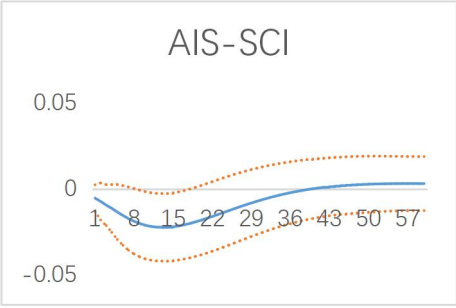
Figure 5 shows the results of the robustness test by replacing repo rate into the interbank offered rate, and the empirical results are robust. A sudden rise in the

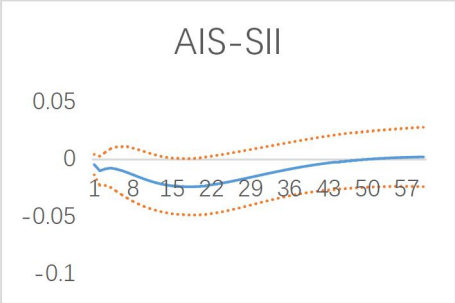
interbank offered rate caused a decrease in aggregate stock price, as well as most of the sectoral stock prices except industrial sector.

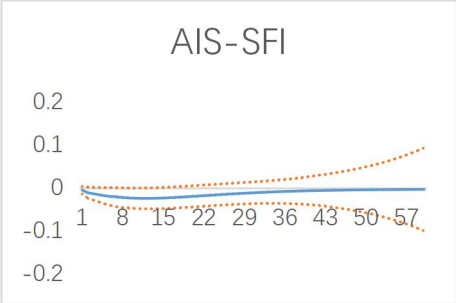
4.3.3 Alternative Identification Scheme

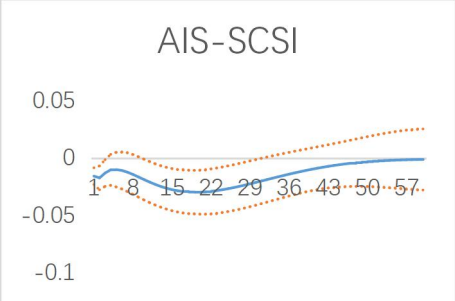
Recursive short run restrictions are used in the baseline models to identify the SVAR model, now I will change it to the non-recursive short run restrictions according to Kim and Roubini (2000), and Laurenceson and Hui (2011). Assuming that PBoC cannot observe the current values of output, the price level when they set the interest rate. The choice of this monetary policy feedback rule can be explained by the assumption of information delays which emphasizes it is unrealistic that monetary policies can respond the change of the price level and output within the same period.

$$\begin{bmatrix} \varepsilon^{IP} \\ \varepsilon^{CPI} \\ \varepsilon^{RR} \\ \varepsilon^{M1} \\ \varepsilon^{SCI} \end{bmatrix} = \begin{bmatrix} 1 & 0 & 0 & 0 & 0 \\ b_{21} & 1 & 0 & 0 & 0 \\ 0 & 0 & 1 & 0 & 0 \\ b_{41} & b_{42} & b_{43} & 1 & 0 \\ b_{51} & b_{52} & b_{53} & b_{54} & 1 \end{bmatrix} \begin{bmatrix} u^{IP} \\ u^{CP} \\ u^{RR} \\ u^{M1} \\ u^{SCI} \end{bmatrix}$$




AIS-SII
0.05
0
-0.05
-0.1
1 8 15 22 29 36 43 50 57


AIS-SFI
0.2
0.1
0
-0.1
-0.2
1 8 15 22 29 36 43 50 57


AIS-SCSI
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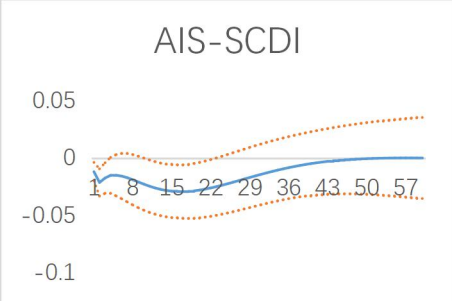
AIS-SCDI
0.05
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-0.05
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AIS-SHCI
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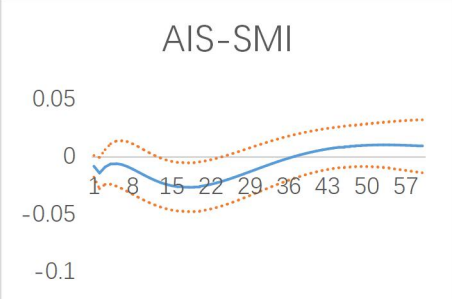
AIS-SMI
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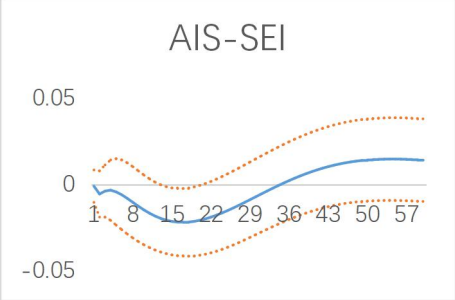
AIS-SEI
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0
-0.05
1 8 15 22 29 36 43 50 57


AIS-SITI
0.05
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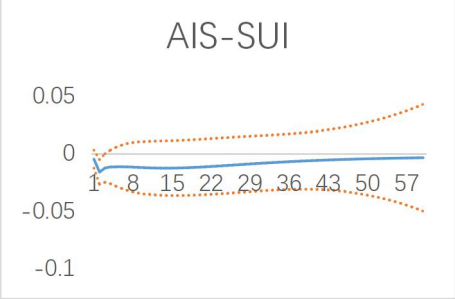
-0.05
-0.1
1 8 15 22 29 36 43 50 57


AIS-SUI
0.05
0
-0.05
-0.1
1 8 15 22 29 36 43 50 57


AIS-STSI
0.05
0
-0.05
-0.1
1 8 15 22 29 36 43 50 57

Figure 6. Impulse response to a positive repo rate shock: changing the identification restriction

Figure 6 shows that there is no much variation comparing with the result of the baseline model when using different identification restriction which manifests that the previous empirical results are robust.

5. Conclusion

Previous researches show that contractionary monetary policies shock in developed economies such as the US or OECD countries have a significant and usually negative effect on stock markets. In this study, I have analyzed the impact of China's monetary policy shocks on Shanghai stock markets.

I impose short-run recursive restrictions in a structural VAR model and then estimate impulse response functions as well as variance decompositions. Using monthly data from 2005, the year when the PBoC abandoned the fixed exchange rate regime and adopted a managed floating system. I estimate structural VAR models for the aggregate and sectoral stock markets. Impulse response functions indicate that contractionary monetary policy has a significant effect on both aggregate and most of the sectoral stock markets except industrial sector, but the magnitude is limited. The reason of the heterogeneous response of different sectors can be attributed to the degree of the monopoly and sensitivity to the change of interest rate. Moreover, forecast error variance decompositions show that a repo

rate shock has the better explanatory power for the fluctuation in the health care sector than utilities sector.

The analysis of this paper shows that the impact of tightening monetary policy shock can partially explain the decrease of stock prices in some sectors and the degree of response is different. Investors can, refer to the research conclusions of this paper, rationally arrange the asset allocation of different industries under the condition of continuous adjustment of monetary policy, and adjust the asset allocation in advance according to the time lag effect of the impact, so as to obtain excess returns. On the other hand, the central bank still needs to actively promote the process of interest rate liberalization and further dredge the transmission channel of interest rate policy on asset prices because monetary policy has no significant impact on some sector prices. Besides, PBoC can consider setting sectoral interest rates for various sectors according to the sensitivity of different sectors. For example, for industries with higher sensitivity, such as the information technology sector, it may consider shortening the period of interest rate adjustment. For industries with lower sensitivity, such as the utilities sector, it is considered to lengthen the interval of interest rate adjustment to make stock prices fully adapt to the change of interest rate.

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7. Appendix

Appendix 1. Data Sources

The sample period is from August 2005 to December 2016, after which China abandoned its fixed exchange rate regime and adopted a managed floating system in July 21, 2005.

Variable	Description	Source	Notes
Industrial Production (IP)	Real value added of industry based on year-on-year growth. Seasonal adjusted using census X-12 ARIMA.	CEInet Statistics Database	Rebased with 2010=100
Consumer price index (CPI)	Seasonal adjusted using census X-12 ARIMA.	IMF	Rebased with 2010=100
Repo rate(RR)	Weighted average interbank bond collateral repo rate (7 Day).	CEIC	
Interbank offered rate(IOR)	Weighted average interbank offered rate(7day).	CEInet Statistics Database	
Money base (M1)	Money supply M1. Seasonal adjusted using census X-12 ARIMA.	CEInet Statistics Database	
Shanghai composite index(SCI)		CEIC	Rebased with 2010=100
Sectoral stock index(SEI, SMI, SII, SCDI, SCSI,		CEIC	Rebased with 2010=100

SHCI, SFI, SITI, STSI, and SUI)			
Federal Funds rate (FFR)		CEIC	

Appendix 2. Methodology of SSE Sector Indices

1. Index Name and Index Code

Index Name	Short Name	Index Code
SSE Energy Sector Index	SEI	000032
SSE Materials Sector Index	SMI	000033
SSE Industrial Sector Index	SII	000034
SSE Consumer Discretionary Sector Index	SCDI	000035
SSE Consumer Staples Sector Index	SCSI	000036
SSE Health Care Sector Index	SHCI	000037
SSE Financial Sector Index	SFI	000038
SSE Information Technology Sector Index	SITI	000039
SSE Telecommunication Services Sector Index	STSI	000040
SSE Utilities Sector Index	SUI	000041

2. Index Eligibility and Calculation

The sector classification standard is decided by China Security Index Co., LTD.

The constituents of those sector index are all A shares in the Shanghai Stock Exchange, exclude the stocks that are considered inappropriate by Advisory Committee.

The sector index was officially launched on January 2005, with the base day of December 31, 2003 and the base value of 1000.

Then they rank the stocks based on the daily average trading value and daily average market cap and choose the largest 30 stocks in each sector.

$$Current\ Index = \frac{Current\ Total\ Adjusted\ Market - Cap}{Divisor} \times Base\ Level$$

Appendix 3. The Fluctuation of 7-Day Interbank Bond Collateral Repo Rate and Shanghai Composite Index

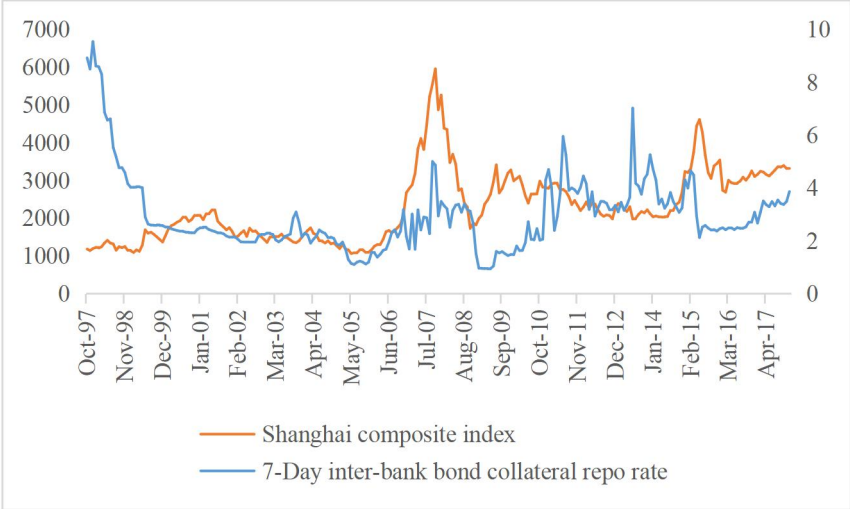

Figure 8. 7-Day interbank bond collateral repo rate and Shanghai composite index trend from 1997.10 to 2017.12

Figure 8 displays that the repo rate fell from 9% in 1997 to merely 1% in 2005. This rate has been rising since 2005, for the purpose to control the overheating and the ascending inflation in the Chinese economy. In addition, the decrease of the repo rate in 2008 and 2015 afforded abundant liquidity for the economy.

The Shanghai Composite Index rose from the initial 1000 points to about 3,000 points now. Since 2005, the Shanghai and Shenzhen stock markets have shown increased volatility. The Shanghai Composite Index rose from 1060 points in May 2005 to 5954 points in October 2007, more than quadrupling, and then fell back to 2000 points in one year. 6 years later, the index once again rose from 2039 points in May 2014 to 4,611 points in May 2015, before falling to 2,800 in just half a year.

Appendix 4. The result of AR roots test of baseline VAR model

Roots of Characteristic Polynomial

Endogenous variables: LNIP LNCPI RR LNM1 LNSCI

Exogenous variables: C FFR

Lag specification: 1 2

Root	Modulus
0.988517	0.988517
0.920334 - 0.063261i	0.922506
0.920334 + 0.063261i	0.922506
0.765578 - 0.024760i	0.765978
0.765578 + 0.024760i	0.765978
-0.583316	0.583316
-0.291100	0.291100
-0.032527 - 0.091808i	0.097400
-0.032527 + 0.091808i	0.097400
-0.044011	0.044011

Table 6. Results of AR roots test

Table 6 show that AR roots are all smaller than 1 so the baseline VAR model is valid.

국문초록

중국 통화정책 충격이 주식 가격에 미치는 영향

본 연구는 구조적 벡터자기 회귀모형(SVAR)을 적용하여서 중국의 유동화 환율제 도입 이후 (2005 년 7 월 21 일) 중국의 통화 긴축 정책 충격이 중국 국내 주가에 미치는 영향에 대하여 실증분석하였다. 레포 율(repo rate)을 중국의 통화 정책 수단으로 선정하고 상하이종합지수(SCI)와 10 개 SSE 섹터 지수를 선택하여서 전체 및 분야별 주식 시장의 주가를 반영한다. 주요 실증분석의 결과는 다음과 같다. 첫째, 긍정적인 레포 율 쇼크는 전체 주가와 산업부문을 제외한 대부분의 부문별의 주가에는 통계적으로 유의 한 음의 영향을 미친다. 또한 여러 산업에 대한 레포 율 쇼크의 영향은 비대칭 적이며 그 이유는 독점력의 정도와 이자율 변동에 대한 민감성에 기인할 수 있다. 예를 들어, 정보기술 부문은 전력회사 부문보다 통화 긴축 충격에 더 적극적으로 반응한다.

주요어 : 주식 가격, 통화 정책 충격, 구조적 벡터자기 회귀모형, 중국

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