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The Efficiency of the Chinese Stock Market with Respect to Monetary Policy

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Abstract:

Due to the bull stock market in China, the efficiency of the Chinese stock market has been one of the hot topics. Because monetary policy plays an important role in Chinese economy and there is a close relationship between stock returns and monetary policy, I test the efficient market hypothesis (EMH) for the Chinese stock market with respect to monetary policy. The vector autoregression (VAR) models are used to estimate the relations among stock returns and relative macroeconomic variables related to monetary policy. Due to the topic of the thesis, I focus on how stock returns are explained by macroeconomic variables to interpret the impacts of monetary policy on stock returns. The estimated VAR equation proves that there are significant impacts of lagged changes of interest rate, money supply and GDP on stock returns. Impulse Responses Functions (IRFs) and Variance Decompositions (VDCs) are then generated from the estimated VAR models to further assess the efficiency of the Chinese stock market. With significant bands conducted for IRFs and VDCs, the results support the semi-strong form of the EMH for the Chinese stock market.

Key words:

The efficient market hypothesis, monetary policy, VAR, impulse responses functions (IRFs), variance decompositions (VDCs)

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With the fast-growing and opening economy of the whole China and bull market from May 2005 to 2007, China's stock market has emerged to be a focus of the world. Issues about China's stock market have been the hot topics. One of these is the efficiency of the stock market, which is related to investors' investment returns and the government's governing efficiency.

In this thesis, I test the efficient market hypothesis (EMH) of China's stock market particularly with respect to monetary policy using the vector autoregression (VAR) techniques, based on the monthly macroeconomic variables related to monetary policy.

Ⅰ Introduction

Under the influence of the openness and reform policies, especially Xiaoping Deng's speech in the tour to the south of China in year 1982, more and more shareholding companies were set up and spontaneous security trading was everywhere. In order to govern the security markets, the government established the Shanghai Stock Exchange in December 1990 and the Shenzhen Stock Exchange in February 1991. Shares are classified according to issued companies and investors. The shares have been mainly traded are common stock issued by mainland Chinese companies, A shares and B shares, whereas A shares are traded in Chinese Renminbi and by domestic investors only, and B shares are traded in foreign currencies and by foreigners. In 1983, the basic central-bank system was built up, in which the People's Bank of China started to play the role of a central bank and several state-owned commercial banks were set up. As to the problems due to the combination of securities industry and banking, the Chinese Securities Regulatory Commission and the State Council Securities Committee were set up in 1992 to supervise the securities markets. In 1995, the Laws of People's Bank of China and the Laws of Commercial Banks were enacted and it confirmed the separation between securities industry and

banking.

With the development of the stock markets, the government constituted a lot of regulations. In order to transform from the planned economy to the market-oriented economy, more and more market-oriented fiscal and monetary policies were implemented. The tools of monetary policies, such as discount rate, reserve rate and open market operations, were used to influence interest rates and money supply. Especially, since year 1994, trading foreign exchange became one of the monetary policies; in 1996, the regulation of the interbank rate was released, which indicates the marketization of interest rates; in March 1998, the discount rate of the central bank was separated from the discount rates of commercial banks' loans, so that the latter could be determined by independent commercial banks.

Monetary policies have been used to influence the Chinese economy including the stock market since the basic market-oriented economy has been formed and the regulation system of securities industry has been set up. Since year 2006, due to continually increasing international favorite balance of payment, there has been excess liquidity in the Chinese market and thus increasing inflation rate. One of its representations is the bull stock market. In order to reduce the liquidity and cool down the economy, from year 2007 until April 2008, the People's Bank of China has increased the deposit reserve rate 13 times from 9% to 16% and has increased the benchmark deposit and lending rates 6 times.[1]

It is one of the government's concerns that how these restrictive monetary policies affect the stock market and whether the stock market is efficient enough to reflect all the public information of the policies in the stock prices. On the other hand, the government policies play an important part in Chinese market. Investors consider the government policy as one of the most important factors that influence the stock market. Therefore, it is investors' concern that whether the stock market is efficient enough that the stock returns are not predictable with respective to the government

[1] Source: Bloomberg, http://www.bloomberg.com/apps/news?pid=newsarchive&sid=aTMnp9Vfd2xM
People Net, http://finance.people.com.cn/GB/8215/79728/

policies.

Based on this motivation, this empirical research is aimed to test the efficiency of the Chinese stock market with respect to monetary policy, which lies in whether the stock prices fully reflect available information on monetary policy in particular. The *Market Efficiency Hypothesis* (MEH) contends that there should be no significant lagged relationship between money supply or interest rate and stock returns since current stock prices reflect all publicly available information on monetary policy changes.

This study focuses on how stock returns are explained by macroeconomic monetary policy variables in order to capture the channel through which the monetary policies influence the stock market in China. Beside the direct effects from monetary policy to stock price, the monetary policy could affect other macroeconomic variables and ultimately stock price. Thus, the variables used in the model are the mainland China stock returns, and macroeconomic variables covering various aspects of the Chinese economy that related to monetary policies, which are money supply, interest rate, gross domestic production (GDP), inflation rate, exchange rate. Money supply and interest rate are chosen to be representative of monetary policy.

For lack of the true model of the real economy, the vector autoregression model (VAR) popularized in econometrics by Sims (1980) is applied to test the efficiency of the Chinese stock market, because comparing to traditional structural models VAR models are more flexible without restrictions. The VAR models are used to estimate the system with all endogenous variables including stock returns and macroeconomic variables. But after VAR models are estimated, only a part that how the mainland stock market returns are influenced is interpreted in this thesis to seek impacts of monetary policy on stock returns.

In order to capture what effect a given change in a macroeconomic variable related to monetary policies would have upon the future values of stock returns, impulse response functions and variance decompositions are used to interpret the

VAR model in particular. In order to exam the efficiency of the Chinese stock market, impulse responses are used to seek the dynamic behavior of the stock return due to a one standard deviation random shock to one of the variables related to the monetary policy; variance decompositions give the proportion of the movements in stock returns that are due to there 'own' shocks, versus shocks to macroeconomic variables. After the confidence bands are applied around the impulse response functions and variance decompositions of stock returns due to a policy variable (money supply or interest rates), if the results turn out to be significant, then the stock market will be regarded as inefficient with respect to the monetary policy.

The assessment result shows that the semi-strong form of the efficient market hypothesis (EMH) is supported in the Chinese stock market by data, even though the effects of monetary policy on macro-economy are not effective enough.

The limitation of this paper is that it only focuses on impacts of monetary policies on the mainland China stock returns. The same model could also be used to test the influence of stock markets on monetary policies, which would be advises for the government about how to react with the performance of the stock market. Fiscal policies could also be included to seek the channel through which the overall economic policies affect the China's stock market.

The paper is organized as follows. The overview of previous researches is showed in section Ⅱ. Section Ⅲ reviews the basic theory of the efficient market hypothesis and the VAR models. In the beginning of the empirical tests, the choice of variables and data disposal will be explained in section Ⅳ. The examination and analysis of the Chinese stock market efficiency with respect to monetary policy will be addressed separately in section Ⅴ, including the estimated VAR models, impulse responses and variance decompositions. Afterwards, in the concluding section Ⅵ, I will summarize the important findings and discuss the implications of these results for the future development of the Chinese stock market.

Ⅱ Previous Research

As a subject of academic research, the relation of monetary policy and stock prices has been tested by Sprinkel (1964), Palmer (1970), Homa and Jaffee(1971), Keran (1971), Reilly and Lewis (1971) , Friedman (1988), and so on. The result has showed that changes in monetary variables do lead changes in stock prices. Based on these researches, a lot of studies have been conducted to test the efficiency of national stock markets with respect to monetary policy. Among these articles, some researchers used the VAR models. For example, Syed M. Ali and M. Aynul Hasan (1993) use VAR technique testing the efficiency of the Canadian stock market.

As the Chinese economy has been growing rapidly with great reforms to market-oriented economy, the efficiency of the Chinese stock markets has been one of the hot topics in the academic researches. Most studies are conducted in following four different perspectives. Firstly, most studies tests the predictability of the Chinese stock returns from a view of history performance. The popular methods used are autocorrelation functions and autoregressions, such as Mookerjee and Yu (1999) and Xu (2000), and tests of the Random Walk Hypothesis, such as Liu, Song and Romilly (1997), and Long, Payne and Feng (1999). Secondly, some articles study the trading characteristics of the Chinese markets to test the predictability of returns. The techniques mainly used are to test the presence of market seasonality, such as Chen, Kwok and Rui (2001), the effectiveness of asset-pricing models, such as Hart, Slagter and van Dijk (2003), and the technical trading rules, such as Nauzer J. Balsara, Gary Chen and Lin Zheng (2007). Thirdly, the correlations among different types of shares or different markets are induced to test the predictability of stock returns, such as Bailey (1994). Other empirical studies focus on the markets' reflects of individual shares around the information announcement, such as event study and IPO under-pricing gap. Most of these studies find some evidence that the EMH is violated both in its weak and semi-strong forms in the Chinese stock market.

As yet, academic studies are conducted from the view of the Chinese stock market itself, mainly the behaviors of stock prices. It has not been proceeded the study of the Chinese stock market efficiency in the perspective of monetary policy in particular. Most researches treat the reaction of stock prices to impacts of monetary policy as one semi-goal of the macroeconomic policies, where how the policies influence the financial markets and further the economic production. Some academic studies do examine whether there is a direct relation between monetary policy and stock prices in China, of which the recent studies are reviewed as following.

For the Shanghai stock market, Qiming Tang and Chuntao Li (2000) do the significance tests for the changes of stock prices' variance and expectation before and after the events that government cut down interest rates from May 1996 to June 1999. They find out that there is certain sensitivity of stock prices to the decreased interest rates.

Based on monthly data of the Shanghai stock market from Jan. 1995 to Oct. 2000, using vector error correction model produced by Johansen (1998), Dejing Wang and Liangping Xu (2001) conclude that there is negative relations between money supply, exchange rate and stock prices, long-term interest rate is negatively related to stock prices and short-term interest rate is positively related to stock prices.

With the cointegration and vector error correction models, Zhengsheng Jiang and Ge Jin (2001) bring forth that the interbank money market and the stock market have impacts on each other.

Yuancheng Hu and Jianwei Cheng (2003) use unit-root, Granger-causes and cointegration tests to analyze the mutual effects of monetary policy and security market. They find out that comparing to interest rate, the impact of money supply on the security market is higher.

Based on the quarterly data from year 1993 to 2002, Minggui Yu, Xinping Xia and Yixia Wang (2003) use the structural regression model for Shanghai stock market and conclude that Chinese stock prices are significantly positively related to money

supply.

Weirong Ha, et al (2004) apply VAR models separately on the relation of Shanghai stock returns and money supply from Jan. 1997 to July 2003, and the relation of Shanghai stock returns and interbank lending rates from Aug. 2000 to July 2003. The result is that changes of M2 and interbank lending rates have stronger impacts on stock returns, while the influences of M0 and M1 on stock returns are not significant.

The dissertation by Yuanyuan Cao (2004) tracks the relation of monetary policy and stock returns from year 1991 to 2003 using VAR models. The result shows that only from year 1998 to 2003 monetary supply and one-year deposit rate have significant impacts on stock returns in both stock markets, expanding monetary policy has positive effects on stock returns while restrictive monetary policy has negative effects on stock returns, and the influence on stock market from M1 is delayed comparing M2 and one-year deposit rate.

Based on quarterly A shares' values, money supplies and interest rates from 1996 to 2004, Xinsong Yang and Gesheng Long (2006) use Granger-causes test and bivariate VAR models separately for each monetary policy variable and A shares' value, and find out that there are relations between monetary policy variables and stock prices.

The dissertation by Heping Dong (2006) examines the long-term effects of macroeconomic variables on stock returns from Jan. 2002 to Oct. 2005. His research indicates that the impacts of the real economy on the variation of stock returns are not significant, and among various macroeconomic variables, only Fixed Asset Investment Completeness Ratio, Consumer Price Index, M1 and Open Market Operation have significant long-term effects on stock returns in Shanghai and Shenzhen stock markets.

The methods used to test the impact of monetary policy on stock market before are mainly the correlation test tools, which are not convincing to exploit the real

relations. The structural models are also used, but because of the correlation between macroeconomic variables and the lack of true models, there are some limits of these methods. Bivariate VAR models used for some two variables picked up separately from the economy, separate the related explanatory variables and could not capture the system with all variables in. As well, Granger-causes tests are limited as based on bivariate VAR models. In this thesis, the VAR models with all concerned variables will be applied in one system, same as Yuanyuan Cao (2004) and Heping Dong (2006). Furthermore, due to the drawbacks of possibly different signs of different lags with the same variable, the significant bands are used to interpret the coefficients of the explanatory variables and further the significance of the impacts of explanatory variables on the explained variable.

Besides, the period of data used in this paper starts from Mar. 1998, when the monetary policy started to be applied with market-orient economy and to be the main economic policy tool, and ends in Mar. 2008, which includes the bull market started from year 2006.

Moreover, this paper focuses on the efficiency of the Chinese stock market with respect to monetary policy not only the correlation of monetary policy and stock returns as in the previous researches.

Ⅲ Theory of the Efficient Market Hypothesis and VAR Models

1. Theory of the Efficient Market Hypothesis

As a main channel for the allocation of financial resources, the capital market plays an important role in economy. Defined by Fama (1970, 1991), a market in which prices always ‘fully reflect’ all available information is called ‘efficient’[2]. A market is said to

[2] Eugene F. Fama (1969), ‘Efficient Capital Markets: A Review of Theory and Empirical Work’, *The Journal of*

be efficient, or the Efficient Markets Hypothesis (EMH) is said to hold, if asset prices in the market immediately and completely incorporate relevant information, which also indicates that it is impossible to make economic profits by trading on the basis of the information. Thus, the arbitrage profits from exploiting the information gradually absorbed in stock prices should be all exploited in equilibrium. Based on an arbitrage argument, an implication of the EMH is that asset returns are not predictable with respect to the available information.

There are three levels of market efficiency by considering three different types of information sets. The weak form of the EMH asserts that prices fully reflect all information contained in the historical sequence of prices; the semi-strong form of the EMH asserts that current stock prices reflect not only historical price information but also all publicly available information relevant to the market as a whole or to any individual company's securities; the strong form of the EMH asserts that all information that is known by any market participant is fully reflected in market prices.[3] The weak form of the EMH is usually tested whether asset returns are predictable from past returns, such as autocorrelation functions and autoregressions. The semi-strong form of the EMH is typically assessed by event studies as to the information announcements or the relation with contemporaneous and past values of related variables.

In this paper, the semi-strong form of the EMH will be tested by assessing the predictability of returns as to the information from monetary policy. In an efficient market, monetary policy will not have systematic significant lagged effects on stock returns. If monetary policy significantly influences the stock returns and investors could predict stock prices and trade for economic profits based on the information of monetary policy, then the semi-strong form of EMH is violated in the stock market with respect to monetary policy.

Finance, 25, 383-417.

[3] Burton G. Malkiel (1989), 'Is the Stock Market Efficient?' *Science*, 243, 1313-1318.

2. VAR Models[4]

2.1 The Form of VAR Models

Vector autoregressive models (VARs) popularized by Sims (1980) are used in this paper. As a hybrid of univariate autoregressive models and simultaneous structural models, VARs are advanced because all the variables are endogenous and there is high flexibility for no restrictions.

In the VAR models, the current values of each endogenous variable depend on different combinations of the previous k values of all variables and error terms. For a bivariate VAR, the reduced forms of models are as following.

$$y_{1t} = \beta_{10} + \beta_{11} y_{1t-1} + \cdots + \beta_{1k} y_{1t-k} + \alpha_{11} y_{2t-1} + \cdots + \alpha_{1k} y_{2t-k} + u_{1t}$$

$$y_{2t} = \beta_{20} + \beta_{21} y_{2t-1} + \cdots + \beta_{2k} y_{2t-k} + \alpha_{21} y_{1t-1} + \cdots + \alpha_{2k} y_{1t-k} + u_{2t}$$

where u_{1t} is a white noise disturbance term with $E[u_{1t}] = 0 (i = 1,2), E[u_{1t} u_{2t}] = 0$.

For g variables, the VAR models could be written as

$$y_t = \beta_0 + \beta_1 y_{t-1} + \beta_2 y_{t-2} + \cdots + \beta_k y_{t-k} + u_t$$

where $y_t, y_{t-1} \cdots y_{t-k}, \beta_0$ and u_t are all $g \times 1$ vectors, and $\beta_1, \beta_2 \cdots \beta_k$ are all $g \times g$ vectors. In this thesis, g equals to six.

2.2 Lag Length Selection

As usual, the numbers of lags are deemed same for all equations in the VAR models. One approach to select the number of lags is the likelihood ratio (LR) test. The LR test for the joint null hypothesis that the last q lags have zero coefficients is given by $LR = T\left[\ln\left|\hat{\Sigma}_r\right| - \ln\left|\hat{\Sigma}_u\right|\right]$, where $\hat{\Sigma}_r$ is the determinant of the variance-covariance matrix of the residuals from the restricted model with zero coefficients of the last q

[4] Chris Brooks, *Introductory Econometrics for Finance*, Cambridge University press, 2002:330-343

lags, $\hat{\Sigma}_u$ is the determinant of the variance-covariance matrix of the residuals from the unrestricted model, and T is the sample size.

The test is asymptotically distributed as a x^2 variant with degrees of freedom as $g^2 q$, where g is the number of the equations and q is the number of the lags restricted.

Intuitively, if $\hat{\Sigma}_r$ and $\hat{\Sigma}_u$ are close enough, then the restriction is supported and the coefficients of the last q lags are not significant from zero.

2.3 Methods of the Interpretation

After the VAR models are estimated, Impulse Responses Functions (IRFs) and Variance Decompositions (VDCs) will be used to interpret the result. Due to the topic of this thesis, the analysis only focuses on how the mainland Chinese stock return is explained by some macroeconomic variables in the estimated VAR models. The influence on stock returns is used to interpret the real impacts of monetary policy on stock returns, and assess the efficiency of the Chinese stock market with respect to monetary policy, mainly the way in which monetary policy affects the stock returns and the length of the effects.

Impulse Responses Functions trace out the responsiveness of the dependent variables in the VARs to shocks to each of the explanatory variables. When a unit shock is applied to the error of each equation, the effects upon the whole VAR system over time are noted by impulse response functions, in which a VAR system is expressed into a vector moving average process. If the system is stable, the shock should gradually die away.

Variance Decompositions give the proportion of the movements in the dependent variables that are due to their ‘own’ shocks, versus shocks to the other variables. Because of the dynamic structure of the VAR, a shock to one explanatory variable should be transmitted to other variables in the system and finally the dependent

variable. Thus, Variance Decompositions offer the similar information as Impulse Responses but focus more on how much the effect is.

Due to the point estimates of IRFs and VDCs, the confidence band around the point estimates is applied to test the statistic significance of effects of explanatory variables on the explained variable using the Monte Carlo simulation technique, as described by Doan and Litterman(1986). If the point estimate is at lease twice the estimated standard error, it is considered to be 'significant'. In the plots of IRFs, if the significant band with two standard deviations around the point estimate includes zero, the effects are judged to be insignificant.

Ⅳ Choice of Variables and Data

1. Choice of Variables

In order to capture some of the indirect effects of the Chinese monetary policy on stock returns, a more elaborate VAR model is concerned here. The variables used in the model are the mainland China stock return (CSR) and macroeconomic variables covering various aspects of the Chinese economy that related to monetary policies, which are money supply (MS), interest rates (IR), GDP (GDP), inflation rate (INR), exchange rate (ER). The purpose of this paper is to analyze how the Chinese stock return is explained by macroeconomic policy variables from the estimated VAR models, to seek the channel through which the monetary policy in the macroeconomic system impacts stock returns. The reasons why these five macroeconomic variables are chosen as endogenous variables in the VAR models are as follows.

Money supply (MS) and interest rate (IR) are the proxies of monetary policy. In order to obtain a set of objectives oriented to the growth and stability of the economy, the government changes reserve rates and discount rates, conducts open market operations to adjust the monetary supply in economy and further influence interest

rates, or changes the benchmark interest rates directly. Normally, higher money supply and lower interest rates is a reflection of expansionary policy that is supposed to boost the economy, while lower money supply and higher interest rates is a reflection of restrictive policy that is supposed to cool down the economy. The changes of money supply and interest rates have impacts on the real economy and expected profits of individual firms, which will affect the stock prices; furthermore, the changes of money supply and interest rates could influence the expected return of liquid money in the market, which will affect the stock prices.

The GDP (GDP) reflects the state of the whole economy, which will influence firms' profits and residents' income. Firms' profits are directly related to stock prices; residents' income will affect deposit and the demand of investments, which influences stock prices by the demand. If the stock prices are sensitive to the economic conditions, the GDP could help explain the indirect effects of monetary policy.

The varying money supply will lead to the changes of the inflation rate (INR), which will influence firms' costs and profits, and the purchasing power of money and further the returns of investments. A lot of researches of the relationship between stock returns and the inflation rate have been assessed. In this paper, inflation rate (INR) is incorporated to capture the indirect affects of monetary policy on stock returns.

With the restrictive regulations in China, the government trade foreign exchange to help apply monetary policy. In this model, exchange rate (ER) is used to capture the indirect effects of monetary policy through value of the currency in a small open market. As the exchange rate in China is targeted to a basket of foreign currencies with U.S. dollar as the dominant currency, the exchange rate in this paper is the value of currency Yuan per US Dollar (USD/CNY).

Additionally, in order to eliminate the seasonal effects based on monthly data, 11 dummy variables are also included as exogenous variables in the model estimation.

2. Data

Focus on the efficiency of stock markets with respect to monetary policy, the time period starts from March 1998, after the basic reform to market-oriented economy has been fulfilled and monetary policy is conducted more efficiently. This study also covers the period of the bull market in the recent two years. Thus, the extended period ranges from March 1998 to March 2008 with 121 observations. Another important aspect is that monthly data are used, because when studying the efficiency of stock markets, a quarter is a fairly long time due to stock returns on a daily basis. In order to assess a good model to interpret the impacts of monetary policy on stock return, the data obtained from *Datastream* are adjusted as below.

The mainland China stock returns (CSR) are calculated as the value-weighted stock index of Shanghai composite index and Shenzhen composite index including A shares and B shares in both indices. The capitalization data are used to be weights to construct a value-weighted mainland China stock index. As one of the methods to examine the predictability of the stock returns in the Chinese markets, the relationships between A shares and B shares and between Shanghai stock returns and Shenzhen stock returns are researched. As a result, most studies show the high interrelationship between A share and B share and the close integration of Shanghai and Shenzhen stock returns.[5] Thus, the two markets are all incorporated in CSR to capture the characteristics of stock returns in the whole Chinese market. The composite indices including A shares and B shares are representative of the behavior of the whole stock exchanges, especially after B shares are open to domestic investors since year 2001. All the stock returns are the continuously compounded returns calculated by the change of the natural logarithm of the closing index as to the previous month.

As one of the important proxy of monetary policy, M1 is used to represent money supply (MS), because M1 is closer to the government policy due to its reserve

[5] Nicolaas Groenewold, Yanrui Wu, Sam Hak Kan Tang and Xiang Mei Fan, *The Chinese Stock Market-Efficiency, Predictability and Profitability*, Edward Elgar Publishing, 2004, 60-68

requirement. In order to make sure the data are stationary, the second difference data of monthly M1 are obtained to capture the status of money supply changes. The other proxy of monetary policy is interest rate (IR), which is represented by 1-year lending benchmark rate set by the central bank. This interest rate could show the direct tendency of the monetary policy. The time series of the changes of the lending rates as to the previous month are used to track the impacts of monetary policy changes on the stock returns.

Because the monthly GDP is unavailable, I simulate the monthly GDP data from the quarterly GDP data by the available monthly industry productions, whose monthly growth rates in one quarter could be the best proxy of the growth of GDP. The growth rates of GDP as to the last month are computed to attain the status of GDP changes.

To ensure the stationary, the data of exchange rate (ER) are the second differences of monthly average exchange rates of CNY to USD. The first differences of inflation rate (INR) data are used to represent the change of inflation rates.

Thus, in the following part of the study, the CSR, MS, ER, IR, GDP, and INR are representative of the mainland China stock return, the second differences of money supply M1 and exchange rate, the change of interest rate, the GDP growth rate and the change of inflation rate.

Also, the data of 11 dummy variables are obtained by setting value 1 for one month and value 0 for other months separately for each dummy variable.

The summary statistics of all data are showed in Table 1 in the appendix. After appropriate adjustment, the data of all variables are stationary based on the Augmented Dickey-Fuller unit root tests with 5% significance level, whose results are listed in Table 2 in the appendix.

Ⅴ Empirical Assessment

1. VAR Models

After the collection and adjustment of data, the VAR models with the six variables, including the mainland China stock returns (CSR), money supply (MS), interest rates (IR), GDP (GDP), inflation rate (INR), and exchange rate (ER) are estimated.

Before the estimation, the lag length is chosen according to the likelihood ratio (LR) test in EViews. Due to the property of no restrictions, the same number of lags of the variables is used in all equations. According to the LR test, showed in Table 3, the optimal lag length selected in this study is four months.

Thus, the VAR models are estimated, as the result in Table 4.

For the topic of this thesis, here only the first equation with CSR as the explained variable is analyzed in this system to seek the effects of the monetary policy on the mainland China stock returns. With significant level of 5% and the freedom degree of 81, the critical value of t-distribution is a little around 1.664 in the absolute term. Thus, from the first column in Table 4, it is clear that the coefficients of the one-lagged stock return (CSR(-1)), the one-lagged interest rate (IR(-1)), the four-lagged money supply (MS(-4)) and the four-lagged GDP (GDP(-4)) are significant. The first lag value of the mainland China stock return affects its contemporaneous value, which indicates the autocorrelation of the Chinese stock return at least in lag one. As to the macroeconomic variables, interest rate is the variable whose effect on stock return is the fastest; the influences of the change of money supply and GDP growth rate on stock return are delayed four months; the lagged changes of exchange rate and inflation rate do not affect the contemporaneous stock return.

Thus, comparing to money supply, changing the interest rate is the more effective monetary policy, which will affect the stock market in one month. The GDP growth rate will influence the stock return, but the effect is much delayed. The lagged

changes of exchange rate do not have significant impacts on the stock return because the circulation of Chinese currency has not been free enough due to the little open of Chinese economy. The lagged changes of the inflation rate do not affect the stock return significantly either.

However, because the equation with the stock return as the dependent variable is only a part of the system, which describes how the stock return is affected by macroeconomic variables directly implied by the VAR models, the interpretation of only this equation does not come out the really impacts of monetary policy on the stock return including the indirect impacts. Furthermore, due to the different signs of the different lag values of the same variable, the estimated equations themselves could not illustrate exactly how much and which way monetary policy affects the stock return. Thus the efficiency of the stock market with respect to monetary policy could not be assessed from the estimated equations directly. Therefore, Impulse Response Functions (IRFs) and Variance Decompositions (VDCs) are applied to test the efficiency of the stock market as following.

2. Impulse Response Functions (IRFs)

Impulse Responses Functions (IRFs) trace out the dynamic behavior of the dependent variables in the VARs to a one standard deviation random shock given to each independent variables. Due to the point estimation of the IRFs, the confidence band around the estimated impulse response coefficients is applied here to assess the efficiency of the stock market. If the confidence band around the IRFs of the stock return (CSR) due to the shock to monetary policy variables (IR or MS) turns out to be significant, then we could conclude that the stock market is not efficient with respect to monetary policy.

Before estimating IRFs, the ordering is chosen as CSR, IR, MS, GDP, INR and ER, because of the different effect extents of each macroeconomic variable on stock returns due to the estimated VAR equation as the stock return as explained variable.

Then the IRFs are estimated in EViews.

Figure 1 shows the IRFs of the stock return (CSR) due to one standard deviation shock given to the stock return and macroeconomic variables. From the figure, there are positive responses of stock returns due to shocks to monetary policy (IR and MS) in six months, and the shocks die away afterwards. However, with a two standard deviation band around the point estimates, the impacts of monetary policy on stock returns are not significant. This indicates that the stock market fully reflects the available information from public monetary policy, and there are not arbitrage economic profits from exploiting the information of monetary policy, which implies the support of the semi-strong form of the EMH for the Chinese stock market with respect to monetary policy. Of all the shocks, only a unit shock to the stock market itself is significant. Same as IR and MS, the impacts of GDP, INR and ER on CSR are not significant either.

Figure 2 and Figure 3 represents the IRFs of macroeconomic variables due to a given unit shock to the change of interest rates (IR) and the change of money supply changes (MS). Only when the shock is applied to MS, the response of the change of inflation rate (INR) is significant in the second month, which indicates that when the increasing money supply increases, the inflation rate will increase. However, there are not significant effects of IR on MS, GDP, INR and ER, or effects of IR on MS, GDP and ER. This reveals that the effects of the implied monetary policy on the economy are not effective enough.

In order to test the robustness of the model, the other two orders as following are implied to the IRFs. Ordering 2: CSR, MS, IR, GDP, INR and ER; Ordering 3: CSR, GDP, INR, IR, MS and ER. The results are the same that the Chinese stock market is efficient with respect to monetary policy. Due to the limited space of this paper, the figures of these IRFs are not showed here.

3. Variance Decompositions (VDCs)

Variance Decompositions (VDCs) show how much of the movements in the dependent variables are caused by their 'own' shocks and shocks to the independent variables.

The VDCs of CSR are generated in EView with the same ordering as in IRFs: CSR, IR, MS, GDP, INR and ER. The estimated result is showed in Table 5.

Table 5 reveals that shocks to CSR itself accounts for more than 79% even in 30 periods, shocks to IR and GDP account for more that 6% of the variance in CSR, and shocks to other macroeconomic variables only accounts for around 1% of the variance in CSR. However, when the significant band is applied, only the effects of the current and lagged shocks to CSR on itself are significant. As same as the result in IRFs, this indicates the efficiency of the Chinese stock market with respect to monetary policy. The robustness of the model is also tested for ordering 2 and 3.

In order to seek more of the reaction of monetary policy, VDCs are implied to macroeconomic variables. As presented in Table 6, shocks to 10 lagged and 20 lagged MS have significant explanations to the variances of GDP and INR. This is consistent with the result from IRFs that monetary policy influences the macro-economy, but the effects are not effective enough.

Ⅵ Conclusion

Due to the hot market of the Chinese stock exchanges and the importance of monetary policy in Chinese economy, I assess the efficiency of the Chinese stock market with respect to monetary policy based on monthly data from Mar. 1998 to Mar. 2008.

As to the topic, previous studies of efficiency of the Chinese stock market mostly focus on the behaviors of stock returns themselves, the relationships between stock

returns in different markets and the reactions of individual stocks to the announced information. Different from these, this thesis focuses on the efficiency of stock returns with respect to monetary policy particularly. Furthermore, the methodologies and data are also updated in this paper. Consistent with the researches for general economy or with focus on Chinese economy, there is a close relationship between monetary policy (mainly the interest rate and money supply) and stock returns. Thus, I model the VAR system with stock returns and macroeconomic variables covering various aspects of the Chinese economy related to monetary policies to capture both direct and indirect impacts of monetary policy on stock returns. In order to test the efficiency of the stock market, the analysis is only focused on how the stock return is explained by macroeconomic variables from the estimated VAR models.

The estimated VAR models show the existing impacts of lagged values of macroeconomic variables on stock returns. To interpret the estimated VAR models further and assess the efficiency of the stock market, IRFs and VDCs are generated and the significant bands are implied to the point estimates. The results indicate that there are not significant impacts of lagged monetary policy on contemporaneous stock returns, which supports the semi-strong form of the EMH. This means that the Chinese stock returns fully reflect the public information from monetary policy. Thus, investors could not predict the stock prices based on the information of monetary policy; the government could use monetary policy to regulate the Chinese stock market and further the whole economy in the process of the market-oriented economic reforms. However, there is a long way to go until monetary policy could impact the macro-economy effectively. As to the Chinese stock market, there are still a lot of problems to solve, for example the limited liquidity, the regulation, the large part of state-owned shares, the speculating characterize of investors' behaviors, and so on.

Appendix

Table 1: Summary statistics for all variables

	CSR	ER	GDP	INR	IR	MS
Mean	0.0093	-0.0007	0.0239	-0.0182	-0.0097	2.3803
Median	0.0066	0.0000	0.0388	0.2000	0.0000	34.1600
Maximum	0.3161	0.1180	0.3141	2.1000	0.2700	619.2200
Minimum	-0.1712	-0.0810	-0.4194	-3.5000	-0.9900	-704.8200
Std. Dev.	0.0766	0.0187	0.1420	0.9803	0.1554	236.4102
Skewness	0.6692	0.7785	-1.0775	-1.0101	-3.5617	-0.1617
Kurtosis	4.5867	20.3853	5.0375	4.6230	20.9992	3.1828
Jarque-Bera	21.7252	1536.053	44.3429	33.8549	1889.18	0.6961
Probability	0.0000	0.0000	0.0000	0.0000	0.0000	0.7061
Sum	1.1307	-0.0900	2.8967	-2.2000	-1.1700	288.0200
Sum Sq. Dev.	0.7042	0.0420	2.4207	115.3200	2.8966	6706772.0
Observations	121	121	121	121	121	121

In the table, CSR, MS, ER, IR, GDP, and INR are representative of the mainland China stock return, the second differences of money supply M1 and exchange rate, the change of interest rate, the GDP growth rate and the change of inflation rate. All variables are in monthly data series for the period from Mar. 1998 to Mar. 2008, totally 121 monthly data observations.

Table 2: Augmented Dickey-Fuller Unit Root Tests separately for each variable

Null Hypothesis: the time series of the variable have a unit root						
Exogenous: Constant						
Lag Length: Automatic based on SIC, MAXLAG=12						
Test critical values:	1% level	-3.485586				
	5% level	-2.885654				
	10% level	-2.579708				
Augmented Dickey-Fuller test statistic	CSR	ER	GDP	INR	IR	MS
Lag Length	0	2	12	10	0	10
t-Statistic	-8.5943	-10.2168	-3.1045	-13.5492	-11.5879	-12.3362
Prob.*	0.0000	0.0000	0.0291	0.0000	0.0000	0.0000
*MacKinnon (1996) one-sided p-values.						

The table shows that the t-Statistics are all smaller than the critical value with 5% significant level, and these Augmented Dickey-Full unit root tests indicate all data series are stationary.

Table 3: The lag length selection according to the LR test

Lag	0	1	2	3	4	5	6	7	8
LogL	-58.49	22.67	62.62	87.12	151.45	184.18	229.04	265.06	300.49
LR	NA	135.28	62.14	35.38	85.78*	40.00	49.84	36.02	31.49
Lag	9	10	11	12	13				
LogL	354.59	407.66	480.96	579.34	679.80				
LR	42.08	35.38	40.72	43.73	33.49				

* indicates lag order selected by the criterion

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

As the table showed, according to the LR test with the joint null hypothesis that the last q lags have zero coefficients and asymptotical x^2 distribution, lag length for the VAR models is chosen as four with 5% significant level.

Table 4: The estimated VAR models

	CSR	IR	INR	MS	GDP	ER
CSR(-1)	0.240479*	0.093880	0.237404	172.8187	0.021825	0.011561
CSR(-2)	0.111535	-0.129670	-0.652950	94.06673	0.127352*	0.001810
CSR(-3)	-0.042766	0.248528	0.633784	163.3330	-0.137807*	0.038344
CSR(-4)	0.094742	0.596797*	0.210145	-139.8572	0.130328*	-0.017925
IR(-1)	0.122103*	-0.091276	-0.265683	97.44750	-0.029167	-0.000598
IR(-2)	0.092172	0.025419	-0.791549*	-114.6731*	0.055322*	-0.024063*
IR(-3)	-0.082452	0.145401	0.003920	71.39642	-0.042332	0.006451
IR(-4)	0.001449	0.362222*	0.105400	-104.5488*	0.038425	-0.020260
INR(-1)	-0.017987	0.022887	-0.475987*	-43.14139*	0.001508	-0.004909
INR(-2)	-0.008904	0.091052*	-0.409586*	12.94870	-0.020049*	-0.002042
INR(-3)	-0.023174	0.052359*	-0.297555*	-35.44307*	0.014037*	-0.005274
INR(-4)	-0.018446	0.036107	-0.270236*	-56.25245*	-0.019264*	0.006371*
MS(-1)	-1.73E-05	0.000127	0.001388*	-0.806388*	-6.19E-05	1.92E-05
MS(-2)	5.28E-05	-4.37E-05	0.000814	-0.569388*	6.49E-05	2.04E-05
MS(-3)	5.61E-05	-0.000121	-0.000992	-0.486841*	1.76E-05	3.84E-05
MS(-4)	0.000157*	-6.68E-06	-0.000911	-0.499882*	-2.23E-05	2.60E-05
GDP(-1)	-0.236834	-0.076545	6.071705*	-573.3861*	-0.370989*	-0.084148
GDP(-2)	-0.200631	-0.138350	2.494338	-187.5655	-0.439603*	0.023902
GDP(-3)	-0.034184	-0.769653*	0.459102	-595.9167*	-0.116722	0.017605
GDP(-4)	-0.482703*	-0.067755	1.263271	-381.3200	-0.323162*	0.068667
ER(-1)	-0.048728	0.004129	-2.351657	53.02294	-0.153018	-0.516690*
ER(-2)	0.172757	0.065634	-0.790994	98.70501	0.074024	-0.273180*
ER(-3)	-0.183927	-0.174710	0.204059	-430.6340	0.035295	-0.363583*
ER(-4)	0.329177	0.253384	5.139130*	-252.8450	-0.194371	-0.026979
C	0.012276	0.014954	2.018755*	-563.2804*	-0.119106*	-0.037118*
D1	-0.053795	0.029476	-1.507167*	650.2019*	0.207082*	0.044747
D2	0.091647	-0.306354	-3.695306*	431.2923*	0.215647*	0.051119
D3	-0.112604	0.074996	-3.101330*	447.7725*	0.050067	0.060729*
D4	-0.007122	0.175767	-2.859478*	795.9924*	0.246318*	0.021714
D5	0.069162	-0.046410	-3.006797*	611.8905*	0.162370*	0.019901
D6	-0.003538	0.091470	-0.639275	654.3383*	0.127770*	0.023296

D7	-0.020171	0.005155	-1.045078*	727.8225*	0.228693*	0.037055*
D8	0.023052	-0.134081	-2.983991*	551.9465*	0.327001*	0.053146*
D9	0.079531	-0.033175	-2.765397*	651.7193*	0.233175*	0.046302
D10	0.048023	0.011802	-2.250371*	1026.663*	0.319351*	0.027217
D11	0.077594	0.120183	-2.899997*	669.4227*	-0.100551*	0.024630
R-squared	0.305593	0.444051	0.841298	0.915307	0.955197	0.426755
Adj. R-squared	0.005541	0.203826	0.772723	0.878712	0.935838	0.179057
Sum sq. resids	0.473678	1.327478	17.57464	564749.6	0.106187	0.024097
S.E. equation	0.076471	0.128018	0.465801	83.49980	0.036207	0.017248
F-statistic	1.018466	1.848481	12.26828	25.01140	49.34091	1.722881
Log likelihood	156.2841	95.99945	-55.11635	-662.2107	243.7607	330.5228
Akaike AIC	-2.056139	-1.025632	1.557544	11.93523	-3.551466	-5.034578
Schwarz SC	-1.206239	-0.175732	2.407444	12.78513	-2.701566	-4.184678
Mean dependent	0.010562	-0.003846	0.009402	0.398803	0.022136	-0.000778
S.D. dependent	0.076684	0.143472	0.977063	239.7596	0.142940	0.019036

Determinant resid covariance (dof adj.)	4.30E-08
Determinant resid covariance	4.74E-09
Log likelihood	125.2123
Akaike information criterion	1.551926
Schwarz criterion	6.651325

Note: the mark * denotes that the coefficient is statistically significant with 5% level.

The table indicates that the estimated VAR models include six endogenous variables and 12 exogenous variables, of which are constant and 11 dummy variables based on monthly data. These estimated equations are reduced forms of VAR models with four lagged values of each variable. For CSR, only the impacts from CSR(-1), IR(-1), MS(-4) and GDP(-4) are significant. With focus on the monetary policy, IR(-2) has significant influence on INR, GDP, ER and MS separately; the effects of MS(-4) on CSR and of MS(-1) on IR are significant.

Table 5: The Variance Decompositions of CSR

Period	CSR	IR	INR	MS	GDP	ER
1	100.0000	0.000000	0.000000	0.000000	0.000000	0.000000
	(0.00000)	(0.00000)	(0.00000)	(0.00000)	(0.00000)	(0.00000)
2	94.66665*	3.728494	0.995149	0.079519	0.519493	0.010699
	(4.45144)	(3.34842)	(1.86016)	(1.17655)	(2.02336)	(1.24677)
3	90.12760*	6.506868	0.930841	0.361810	1.768385	0.304496
	(5.86559)	(4.34319)	(1.93012)	(1.75625)	(3.24638)	(2.06626)
4	89.59936*	6.641944	1.088090	0.388377	1.773480	0.508746
	(6.14274)	(4.24879)	(2.14154)	(1.92201)	(3.41074)	(2.53498)
5	84.80871*	6.170447	1.086692	0.796412	6.140438	0.997301
	(6.64184)	(3.90988)	(2.06428)	(2.25676)	(4.65394)	(2.77929)
10	80.29022*	8.195661	2.338910	1.057199	6.338858	1.779150
	(7.82973)	(4.43439)	(2.44266)	(2.61398)	(4.64950)	(3.33438)
15	79.90142*	8.182389	2.434413	1.122274	6.480660	1.878840
	(8.40704)	(4.64720)	(2.61901)	(2.84783)	(4.70423)	(3.60660)
20	79.84638*	8.187456	2.438079	1.133209	6.492478	1.902395
	(8.91240)	(4.97419)	(2.77615)	(3.04233)	(4.80502)	(3.74072)
30	79.83777*	8.188575	2.439384	1.137284	6.494372	1.902620
	(9.79930)	(5.49483)	(3.06337)	(3.35403)	(4.95358)	(4.16686)

Note: the estimated standard error is in (), and the mark * denotes that the estimate is statistically significant.

The table shows the variance decompositions of CSR. Two standard deviations bands are implied around the point estimates. If the point estimate is at lease twice the estimated standard error, it is considered to be ‘significant’. The variance decomposition shows that only the shocks to CSR itself are statistically significant for the movement of CSR.

Table 6: The Variance Decompositions of IR, GDP, INR, and ER

Variance Decomposition of IR:

Period	CSR	IR	INR	MS	GDP	ER
1	7.216822	92.78318*	0.000000	0.000000	0.000000	0.000000
5	12.65098*	78.93224*	5.126460	1.253788	1.772736	0.263791
10	14.80940*	73.28494*	5.721970	2.420159	2.800652	0.962878
20	15.50238*	71.66345	5.846832	2.608564	3.021462	1.357309

Variance Decomposition of MS:

Period	CSR	IR	INR	MS	GDP	ER
1	0.102894	0.017542	0.000000	99.87956*	0.000000	0.000000
5	1.257823	10.95032	11.88654	72.87704*	1.544715	1.483558
10	1.231523	9.714241	21.91384*	61.31554*	3.433141	2.391720
20	1.421605	9.384122	22.48154*	58.59809*	4.923778	3.190873

Variance Decomposition of GDP:

Period	CSR	IR	INR	MS	GDP	ER
1	1.880963	0.398732	0.000000	2.162216	95.55809*	0.000000
5	10.96969	4.921269	6.516226	10.86938	65.46990*	1.253544
10	10.85704	5.030068	6.776294	11.96487*	63.86381*	1.507925
20	10.76640	5.084328	8.011715	12.00401*	62.45253*	1.681021

Variance Decomposition of INR:

Period	CSR	IR	INR	MS	GDP	ER
1	0.031387	1.338945	88.39457*	0.350881	9.884221	0.000000
5	3.677173	3.291448	54.07927*	10.91966	26.12756*	1.904887
10	3.888815	3.372624	50.38833*	12.75325*	25.33130*	4.265680
20	3.935817	3.319817	49.92772*	13.75223*	24.83038*	4.234042

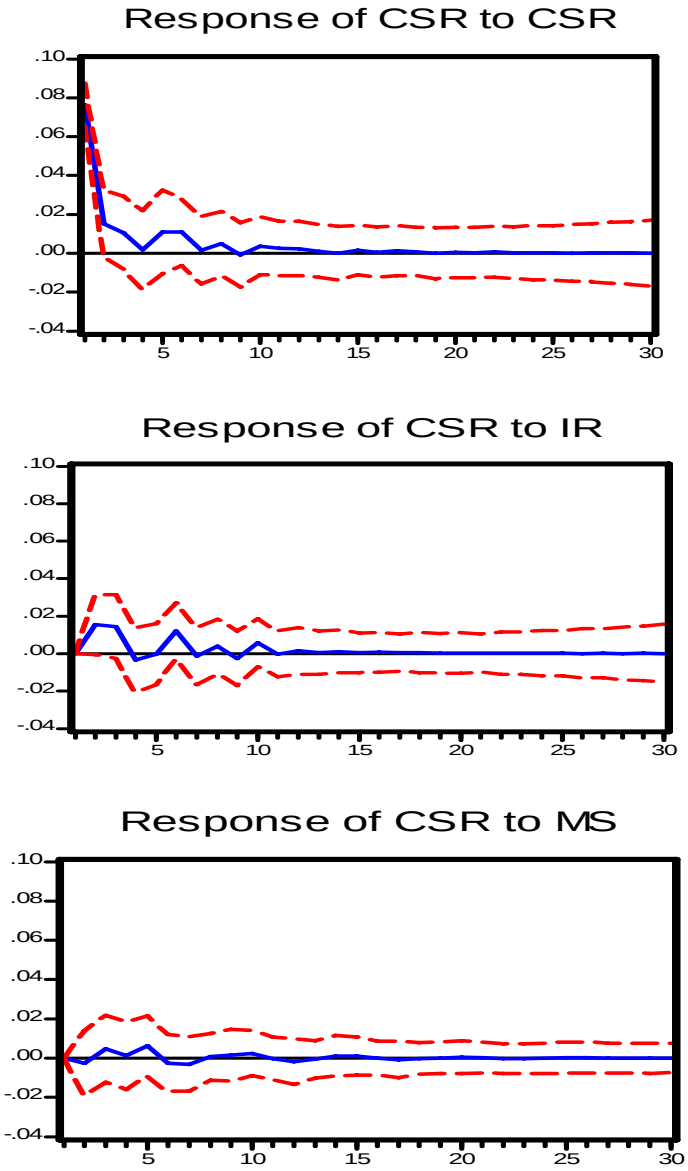
Variance Decomposition of ER:

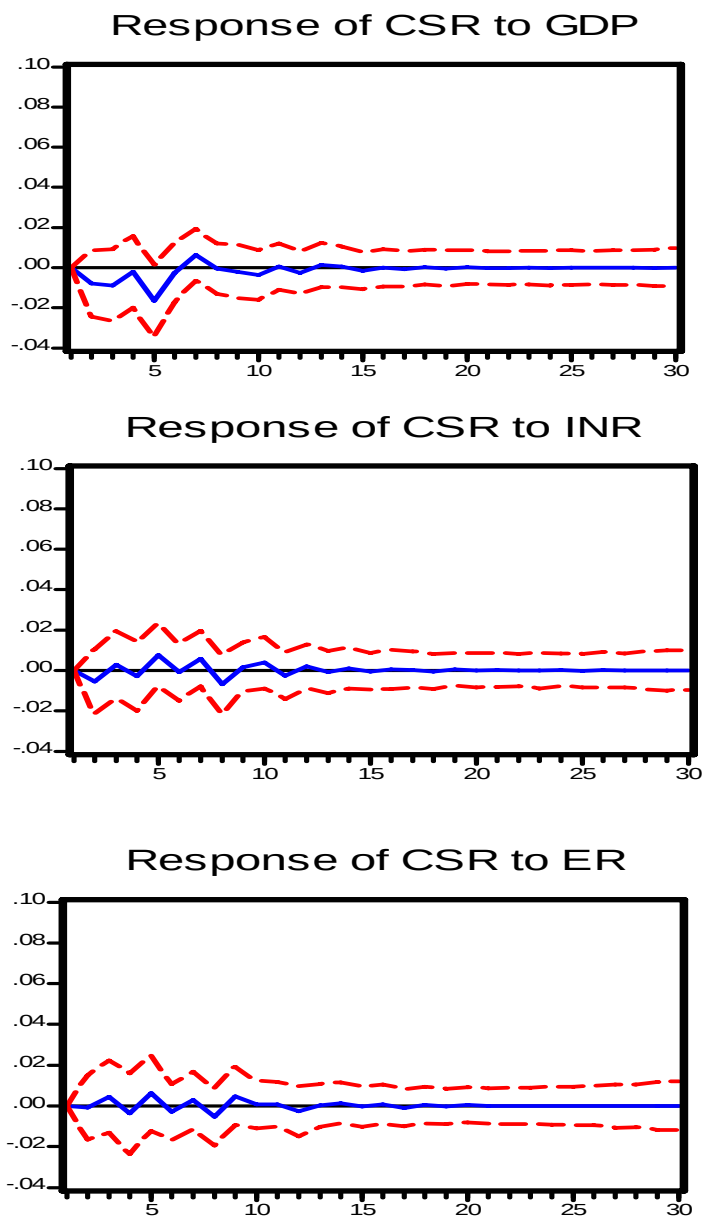
Period	CSR	IR	INR	MS	GDP	ER
1	0.217333	0.156176	1.879425	0.421401	0.098853	97.22681*
5	0.922543	2.502186	6.448949	0.528549	2.221222	87.37655*
10	1.251191	4.097757	7.735261	0.839091	2.591217	83.48548*
20	1.323541	4.508616	7.925912	1.118800	2.764116	82.35901*

Note: the mark * denotes that the estimate is statistically significant.

From the table, with focus on monetary policy, except shocks to the other macroeconomic variables themselves, the shocks to MS are significant for the variances of GDP and INR, but shocks to IR are not significant for the movements of any other macroeconomic variable.

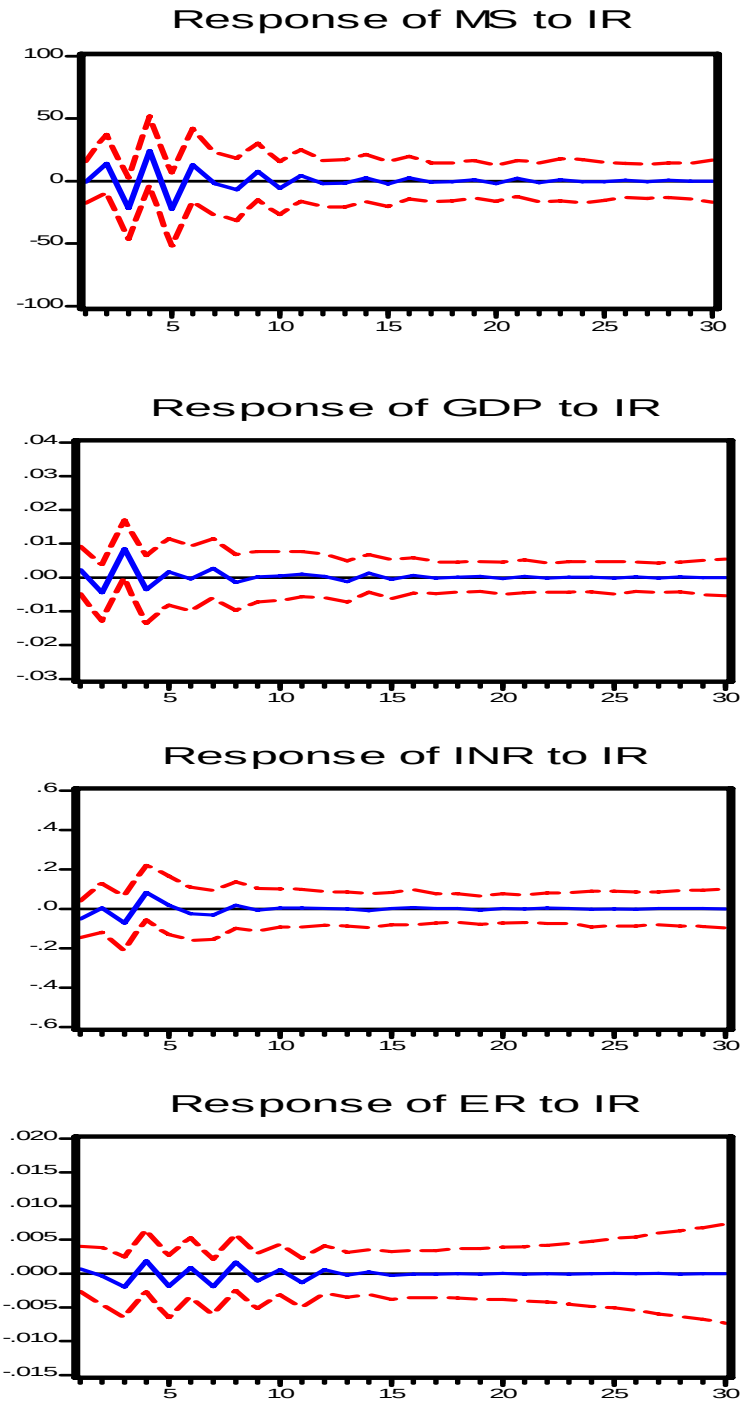
Figure 1: The Impulse Response Functions of CSR





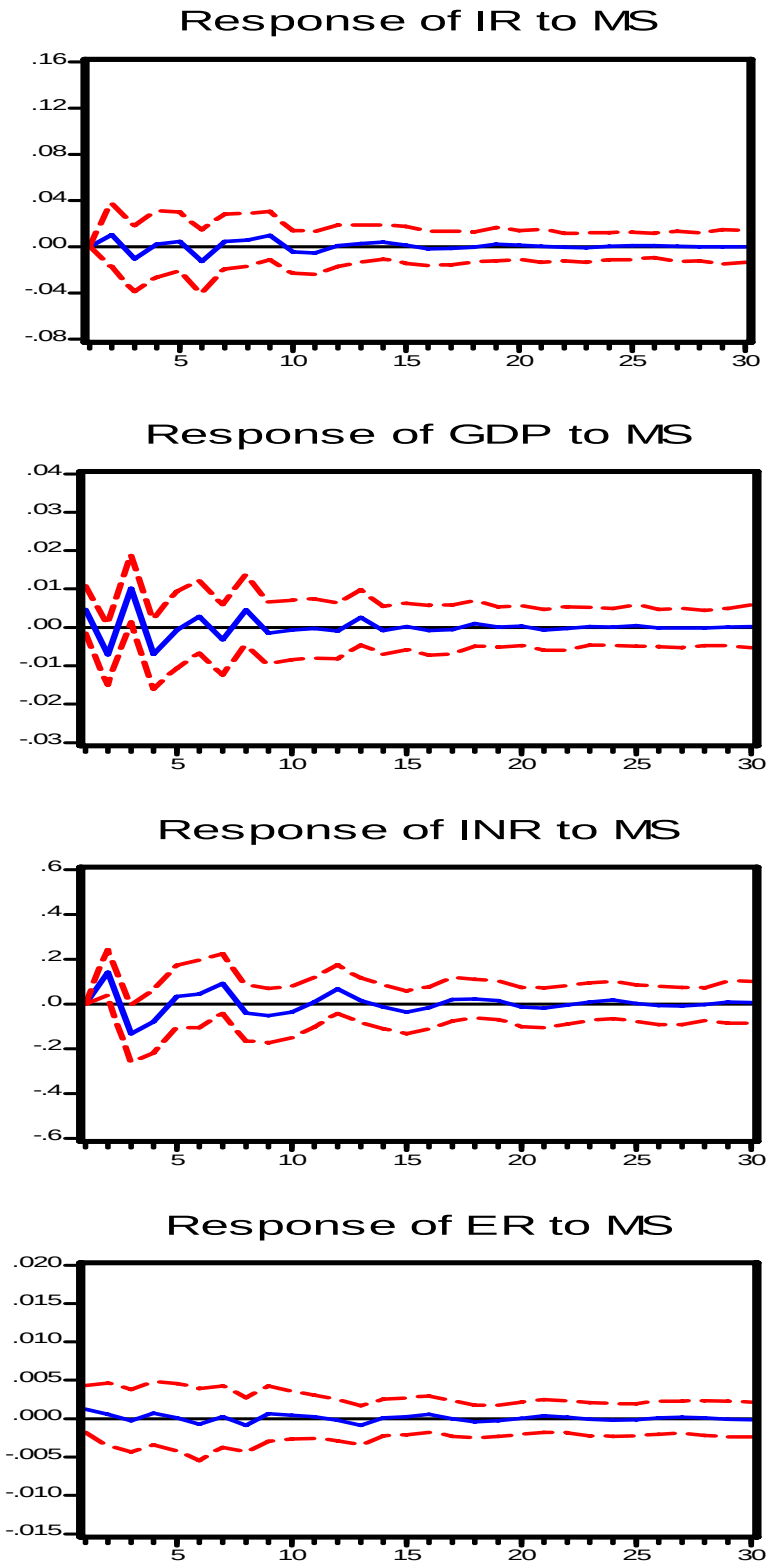
These are plots of responses of CSR to all endogenous variables. The dotted lines in the figure are significant bands with two standard deviations around the point estimates. If the significant band around the point estimate includes zero, the effects are judged to be insignificant. Only the first-lagged CSR has significant impacts to CSR. Impacts of lagged macroeconomic variables on CSR are statistically insignificant.

Figure 2: The Impulse Response Functions of macroeconomic variables due to IR



This figure shows the IRFs of other macroeconomic variables due to shocks to IR, one of monetary policy tools. With two standard deviations bands around the point estimates, the influences of shocks to IR are not significant to other macroeconomic variables.

Figure 3: The Impulse Response Functions of macroeconomic variables due to MS



This figure shows the IRFs of other macroeconomic variables due to shocks to MS, another important monetary policy tool. With two standard deviations bands around the point estimates, the influences of shocks to MS are only significant to INR.

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