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**THE EMPIRICAL RESEARCH OF THE
RELATIONSHIP BETWEEN INTEREST RATE AND
STOCK PRICE IN CHINESE STOCK MARKETS**

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Tallinn 2015

I declare I have written the master's thesis independently. All works and major viewpoints of the other authors, data from other sources of literature and elsewhere used for writing this paper have been referenced.

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ABSTRACT

Stock market always creates an economic forecast and also is the most important enterprise financing channel. Interest rate is one of the most important monetary policies. It is meaningful to investigate relationship between stock price and interest rate, an accurate estimation of the relationship between interest rate and stock price can allow investors to make better investment decisions, at the same time, it also can help policy makers to make more accurate and effective decisions to encourage more capital inflows into the capital monetary market and optimize the allocation capital resources.

The aim of this thesis is to figure out the relationship between interest rate and stock price in China's stock markets - Shanghai Stock Exchange and Shenzhen Stock Exchange for the period of 2009-2014, by using high frequency daily data. The empirical study includes event study and econometric evidence. Event study aims to observe how stock price reacts to the 8 times interest rate adjustments. The econometric evidence is based on model of VAR and VECM; additionally, is used unit root test, Johansen co-integration test, and Granger causality test and impulse response functions. The results indicated that interest rate and stock price have the significant influence on each other, and there exists a negative and long-term equilibrium relationship. In short term, there is little effect relation between interest rate and stock price.

Keywords: interest rate, stock price, VECM, Johansen co-integration test, Granger causality test, impulse response functions

INTRODUCTION

Reviewing the 20-years development history of China's stock markets, it is worth mentioning that China's stock market has developing rapidly, and now the stock market value of China's stock market has been among the world's top, in 2014, China's stock market took over of Japan stock market, become the world's second- biggest equity market by value, with a total capitalization of more than \$4.5 trillion (S.R 2014). Stock market has a great impact on economic development, it not only help enterprises financing, but also help residents savings into investment. It also creates an economic.

Since November 2014, China's stock ushered round of bull market, after cut interest one month, the Shanghai stock market is up 25% (Cendrowski 2014), and more than 10 million stock accounts have been opened, i.e. equivalent to the total number for all of 2012 and 2013 combined (Xie, Stapczynski and Cao 2015). This trend may tell that cut interest rate can boost stock price, meanwhile, it drives the author to study interest rate impact on stock price.

The aim of this thesis is to figure out the relationship between interest rate and stock price, the research questions raised in this thesis are following: a) how will the interest rate affect the stock market? b) Do they influence between them?

This thesis consists of three chapters, the first chapter is designed to cover the essentials of relative literature of relationship between interest rate and stock price, such as famous efficient market theory, and describe the mechanism about how monetary policy affects stock price; later is followed explanation of how interest rate affects stock price Then empirical literature is based on the pervious empirical studies both domestic and foreign.

The second chapter started with the introduction of stock markets and interest rate in China also will be introduced in this chapter; then describes empirical methodology and data. In this chapter, all used methods will be explained in detail, the empirical study includes event study and econometrics evidence. Event study aims to observe how stock price reacts to the 8 times interest rate adjustments. The econometrics evidence is based on vector autoregressive

(VAR) and Vector error correction model (VECM), additionally, using Phillips-Perron (PP) test, Johansen co-integration test, Granger causality test and impulse-response function analysis to examine the relationship between interest rate and stock price. There has been chosen high frequency data, the daily data covering January 2009 to December 2014 obtained from Shanghai and Shenzhen Stock exchange, and Shanghai Interbank Offered Rate official website. Furthermore, the author also will explain in detail the reason for choosing the variables.

The next chapter combines the results and analysis of empirical study; Analyze the econometrics outputs, and explain the relationship between interest rate and stock price. The thesis ended with the conclusion, which provides the summary of the research and answers to the research questions.

Reference are listed at the end of the thesis, the sources are form some relevant guidebooks, classical literature, research articles, studies which are published in English and Chinese.

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1. LITERATURE REVIEW

1.1. The Main Economic Factors Affect Stock Price

In the economist's usual benchmark case, a world of efficient capital market, movement in asset price simply reflects changes in underlying economic fundamentals (Bernanke and Gertler 1999). Bernanke and Gertler (1999) think, in efficient market, central bank should view price stability and financial stability as highly complementary and mutually consistent objectives, through the monetary policy to affect to stock price. Based on the modern monetary theory, stock price depends on the expected cash flow, and interest rate. Stock price is directly proportional to expected cash flow, and inversely proportional to interest rate. The underlying factor of the Efficient Markets Hypothesis is that the current stock price actually is the net present value of future cash flows.

1.1.1. The efficient market hypothesis

The Efficient Markets Hypothesis, developed by Fama, originates from Random Walk Theory. Fama (1970) stated that in efficient market all available information should be reflected in current stock prices. Jensen (1978) think efficient market hypothesis is in essence an extension of the zero profit competitive equilibrium condition from the certainty world of classical price theory to the dynamic behavior of prices in speculative markets under conditions of uncertainty, he also pointed out that there is no other proposition in economics which has more solid empirical evidence supporting it than the Efficient Market Hypothesis.

In efficient market, stock prices are fully reflecting all relevant information. All investments in efficient markets are fairly priced, so it is not possible to beat the market to obtain extra profit (Fama 1970). Malkiel (2003) has stated that, in efficient market, there are not allowed investors to earn above average returns without accepting above-average risks.

Fama (1970) extends and defends the efficient market, and classifies market into three forms: weak form efficiency, semi-strong form efficiency and strong form efficiency. Weak form efficiency is a kind of market in which the security prices fully reflect the all historical information. So in weak form efficient market, it is not possible to obtain extra profits by using technical analysis. Semi-strong form efficiency is a market in which the share prices fully reflect all historical information and all publicly available information. This means it is not possible to acquire abnormal profit through the publicly available company information or by using fundamental analysis. Strong form efficiency is a market in which the share prices reflect all the information including public and non-public information. If markets are strong form efficient, this means no one can make abnormal returns form share dealing, nor even investors who act on “insider information” (Watson and Head 2010, 37-38).

1.1.2. The evidence of efficient market in China

In previous stock market studies, each researcher’s research methods vary based on different point of view but they all use the efficient market hypothesis as a basic assumption.

There are not many studies examining the efficient market form in China and the results of the existing studies are not the same. Some results show that China’s stock market is close to weak form efficient market. In early studies some researchers mention that China’s stock market is inefficient market since China’s stock market is still young, and there is lack of the necessary hardware and sufficiently comprehensive legal framework (Mookerjee and Yu 1995). Zhang and Li (2003) examined if China’s stock market is the efficient market by using daily data from 1991 to 2001 based on Shanghai Stock exchange, they found that the period before 1997 is inefficient market; after 1997, the stock market shown weak form efficiency. Carpenter et al. (2014) found that the Chinese stock market is efficient in period of 1992-2012. However, many China’s economists agree with China’s stock market entered to weak form efficient market after 1997. In current year studies, many researchers, Chinese and foreign as well, have studied efficient market in Shenzhen Stock exchange and Shanghai Stock Exchange. They found both markets have a similar way to respond to change in macroeconomic variables and regulations. Most of researchers agree with Shanghai Stock exchange shows stronger level of efficient market, and believe Shanghai Stock exchange more mature and liquid.

Investors always look for investing in an efficient market, because a mature of the stock market efficiency level is perceived across the globe as a barometer of the economic health and prospect of a country as well as a register of the confidence of domestic and global investors (Alam and Uddin 2009). For this reason, the level of efficient measurement of the stock market is very important, it is to make sure stock market is able to reflect external information.

1.1.3. Impact of Monetary Policy on stock price

Monetary policy's objectives are usually expressed in terms of macroeconomic variables such as inflation and real output, policy actions affect these variables indirectly (Ioannidis and Kontonikas 2007). In many developed and emerging markets, the core objective of monetary policy is price stability (Pailwar 2009). The people's Bank of China as the Central Bank of China has stated that the objective of Mainland China's monetary policy is to maintain the stability of the value of the currency and thereby promote economic growth (PBC Website). The mainly policy instruments at the People's Bank of China are include reserve requirement ratio, central bank base interest rates, rediscounting, central bank lending, open market operations and other policy instruments specified by the State Council.

Mishkin (1995) has mentioned that monetary policy is a powerful tool, the manner in which this policy affects economic variables such as real interest rates, real gross domestic product, the unemployment rate and inflation, i.e. it influences real economic activities in a country (Espinosa-Vega 2002, 830). In recent years, monetary policy has been ever more at the center of macroeconomic policymaking. Both economists and politicians have been heard to advocate that the stabilization of output, lower unemployment and inflation, and also predictable exchange rates with other currencies be left to monetary policy (Mishkin, 1995). In the other words, monetary policy affects and controls the real economic activity and guide government to adjust of expected future economic activity to achieve the macroeconomic goal.

Basically, main monetary policy can be described either in terms of the money supply or in the terms of the interest rate. In other words, changes in monetary policy can be viewed either in terms of changing interest rate, exchange rate target or in terms of changing the money supply (Mankiw 2012). Blanchard and Fischer (1989) argued about whether the monetary authority should use money or interest rates to control output or/and price

developments. They think this question does not make much sense, both of them had same out come for out put or/ and price, by using money rule would have been equivalent to using interest rate rule. Mitlid and Vesterlund (2001) mentioned that almost all central banks apply interest rate steering without any direct aim to implement narrow measures for the quantity of money. Lamont, Polk, and Saá-Requejo (2001) recognized that modern monetary policy is actually based on interest rates rather than the monetary base. To be successful in conducting monetary policy, the monetary authorities must have an accurate assessment of the timing and effect of their policies on the economy, thus requiring an understanding of the mechanisms through which monetary policy affects the economy. Basically, the transmission mechanisms include interest rate effects, exchange rate effects, other asset price effects and the so-call credit channel (Mishkin, 1995).

Bernanke and Kuttner (2005) pointed out, some observers view the stock market as an independent source of macroeconomic volatility to which policymakers may wish to respond. Stock prices often exhibit pronounced volatility and boom–bust cycles leading to concerns about sustained deviations from their fundamental values that, once corrected, may have significant adverse consequences for the broader economy. Stock prices are among the most closely monitored asset prices in the economy and are commonly regarded as being highly sensitive to economic conditions (Ioannidis and Kontonikas, 2007). Fair (2002) also found out that one third of the changes in the stock prices are associated with news on monetary policy.

Monetary policy is widely believed to have a significant impact on asset prices. Many economists such as Bernanke, Gertler and Gilchrist (1996), Bernanke and Gertler (1999) and Goodhart and Hofmann (2000) pointed out that the monetary policy affects the stock prices through the wealth effect channel, which is influence on consumption, and the balance sheet channel that is influence on investment spending.

Among these transmissions, interest rate transmission mechanism is the key monetary transmission mechanism in the basic Keynesian model. Interest rate is a direct effect, which affects not only the cost of credit, but also the cash flows of debtors and creditors (Beblyv 2007). Interest rate and foreign exchange rate are the most important economic factors affecting the common stock (Vaz et al., 2008). In contrast, interest rate has a more direct effect on financial market, as variability in interest rates directly generates a momentum to the money market from capital market. However, the stocks are sensitive to interest rates, as the

changes in interest rates are inversely related to stocks (Alam, Uddin 2009). Besides, Taylor (1995), in his research argued that the interest rate channel of monetary transmission is a key component of how monetary policy effects are transmitted to the economy. He pointed, there are strong interest rate effects on consumer and investment spending, hence a strong interest rate channel of monetary transmission. There is also a famous monetary policy rule called Taylor rule, it prescribes how a central bank should adjust interest rate in response to change s in inflation, output, or other economic conditions.

The Figure 1 describes a comprehensive view of the transmission mechanism of monetary policy. First level, changes in the official interest rates are directly affect money market interest rates and expectations of future interest rates, inflation and economic growth. The second level, these changes reflect to specific positions, such as bank rates, exchange rate, as well as asset prices and money credit, which affect the consumption, saving, and investment behavior of firms and households. The third level is the influence on goods and labors market, the level of supply and demand of goods and labors, and also wages and price setting. The fourth level, it is adjusted price of domestic and import, changing exchange rates direct affect import price, as the domestic prices have affected by changes of second and third level.

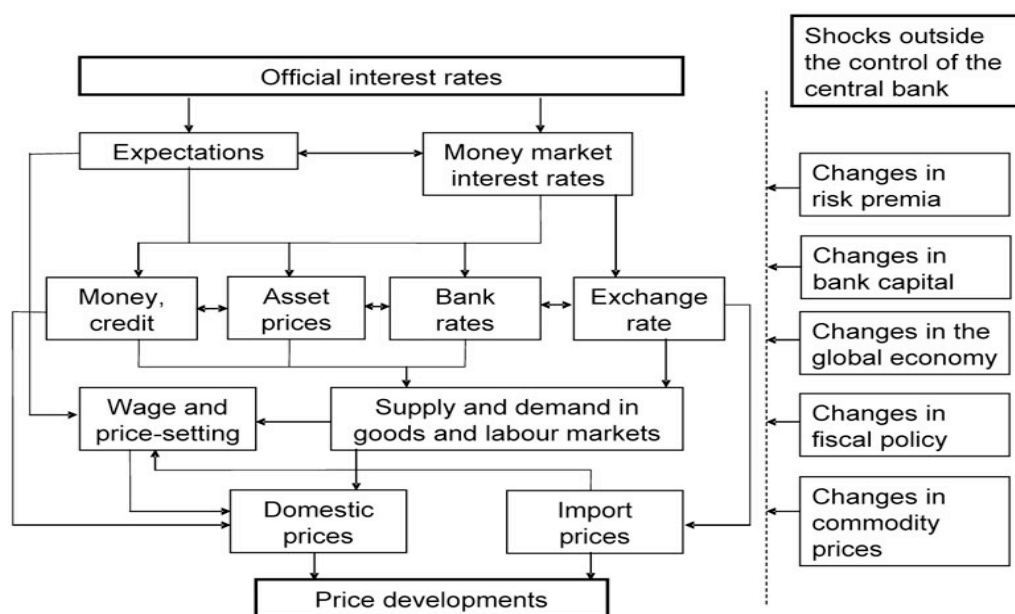


Figure 1. Transmission mechanism of monetary policy

Source: ECB Official website (2015).

<https://www.ecb.europa.eu/mopo/intro/transmission/html/index.en.html>

Asset prices are indirectly affected by changing official interest rates, and directly affected by changing money market interest rates and expectations. There are several different transmission channels able to affect asset prices, monetary policy can be such like interest rate channel, exchange rate channel and the credit channel. Interest rate channel is the most direct channel affect asset price, as record Horngren (1995), he believe that interest rate channel is the most direct effect of an altered instrumental rate, changes in the official interest rates affects directly money market interest rates and indirectly, lending and deposit rates, it not only lead households investing or saving preferences because of cost of capital, but also lead to change the value of asset value, since the asset value is present value discounted by future cash flow; wealth channel by affect decisions of firms and households about saving and investment choice to influent asset price; exchange rate channel can affect inflation directly, it leads to changes in the relative price of domestic and foreign goods and services, and capital flow into or out, so to certain extent, it also affects supply and demand of capital in stock market, thus to affect asset prices. It is worth reminding that transmission channels and economic variables do not alone affect asset prices, they are interaction effect.

Smets (1997) has extension a simple model by Gerlach and Smets (1996), which used to analyze the optimal policy response to the exchange rate. The new model basically designs for general asset price analysis. He stated that this new model does capture the two most reasons why monetary authorities may want to respond to financial prices in their pursuit of price stability. First, shocks to financial prices that are not driven by fundamentals may destabilize the economy through their effects on aggregate demand. Secondly, asset prices are determined by arbitrage equations. The model consists of following six equations (Smets 1997):

$$p_t = E_{t-1}p_t + \gamma(y_t - \varepsilon_t^s) \quad (1.1)$$

$$y_t = -\alpha r_t + \beta f_t + \varepsilon_t^d \quad (1.2)$$

$$f_t = \rho E_t f_{t+1} + (1 - \rho) E_t d_{t+1} - r_t + \varepsilon_t^f \quad (1.3)$$

$$d_{t+1} = y_t \quad (1.4)$$

$$r_t = R_t - E_t(p_{t+1} - p_t) \quad (1.5)$$

$$f_t = F_t - p_t \quad (1.6)$$

Where all variables with the exception the interest rates are expressed in logarithms and the constants have been normalised to zero:

p_t : Price level
 r_t : Expected real interest rate
 f_t : Real asset price- real stock price
 y_t : Output
 ε_t^f : Time-varying risk premium
 d_{t+1} : Expected real dividend
 R_t : Nominal interest rate
 F_t : Nominal asset price

Equation (1.1) is a simple Phillips curve, it stated that price is determined by the last period's expectations of the current price level and output gap. The equation (2) shows aggregate demand depends negatively on the expected real interest rate and positively on a real asset price f_t , in this model, Smets (1997) mainly think of real asset price f_t as a real stock price. Equation (1.3) is an arbitrage equation that requires the real return on equities. According to Equation (1.4) the expected real dividend on equities is proportional to current output.

Combining equation (1.4) and (1.2)

$$d_{t+1} = -\alpha r_t + \beta f_t + \varepsilon_t^d \quad (1.7)$$

In equation (1.2) β captures the effect of the real asset price on aggregate demand; α captures the effect of real interest rate on aggregate demand. After combining equations, there in equation (1.7), β captures the effect of the real asset price on expect dividends, and α captures the effect of real interest rate on expected real dividend on stocks.

$$f_t = \frac{d_{t+1}}{\beta} + \frac{\alpha r_t}{\beta} - \frac{\varepsilon_t^d}{\beta} \quad (1.8)$$

Equation (1.8) clear shows that expected dividends and real interest rate affect on asset prices, interest rate is the one of monetary policy tools affect on asset price, in the other words, the share of demand in total wealth is a function of the real interest rate and expected dividend.

Combining above theories, many economy factors can affect on stock price, such like interest rate, exchange rate, inflation rate, money demand etc. For those factors, there is no literature has stated that which one is the most impact on asset price, all these factors in varying degrees impact asset prices. These eight equations have explained that the economy factors affect on stock price. Basically, asset prices are affected by expected dividend on stock and real interest rate. In this these, the author focuses on monetary policy affect on stock price through interest rate in China's stock markets.

1.2. How the Interest Rate Affects Stock Price

Classical theory thinks that, increase interest rates will decrease stock price, and decrease interest rates will increase stock price. Many economists have investigated the empirical link between interest rates and stock returns. Bernanke and Kuttner (2005), in their study of the inverse relationship between interest rate and stock return, they consider three cases. First, higher interest rates increase interest expenses of the firm, decreasing the cash flows available for future dividends. Second, a change in interest rates could drive an expected rise in the real interest rate, making future nominal cash flows less valuable to shareholders. Third, a tightening in monetary policy could increase the expected equity premium, as investors move away from stock investments.

In generally, Interest rates change impact on stock prices can explain by three parts: First, by affecting stock pricing – value of stock. Second, by affecting operating cost. Third, by affecting the substitution effect.

1.2.1. Stock pricing – Dividend Discount Model and NPV Model

In 1938, Williams in his book- the theory of investment value first explicitly connect the present value concept with dividends. He was using discount rate and expected dividend to make sure the stock value. He also raised the ordinary valuation formulas used to calculate the value of stock by discounting the future stream of dividends. There is basic dividend discount model.

$$P = \frac{D_1}{(1+r)^1} + \frac{D_2}{(1+r)^2} + \frac{D_3}{(1+r)^3} + \dots = \sum_{t=1}^{\infty} \frac{D_t}{(1+r)^t} \quad (1.9)$$

Where,

p -Stock price

D_t -Expected dividend per share in period t

r -Discount rate

Based on Williams' theoretical ideas, Gordon and Shapiro (1956) considered future growth, and then developed a new model called the Gordon growth model. This model assumes expected dividend growth as a constant growth rate. See equation (1.10).

$$\begin{aligned}
P &= \frac{D_0(1+g)^1}{(1+r)^1} + \frac{D_0(1+g)^1}{(1+r)^1} + \frac{D_0(1+g)^1}{(1+r)^1} + \dots \\
&= D_0 \sum_{t=1}^{\infty} \frac{(1+g)^t}{(1+r)^t} = \frac{D_0(1+g)}{r-g} = \frac{D_1}{r-g}
\end{aligned}
\tag{1.10}$$

Where,

p -Stock price

D_1 -Expected dividend per share in next year

r -Discount rate

g -Constant growth in expected dividend per share

Discount rate sets by central bank, it refers to the interest rate to commercial banks and other depository institutions financing from central bank, it also widely used to evaluation- discounted cash flow analysis to determine the present value of future cash flows (Thornton 1982). Changes in both short- term and long- term rates are expected to affect the discount rate in the same direction (Mukherjee and Naka, 1995).

From above two equations-equation (1.09) and (1.10), they are clearly show that stock price is positive relative to dividend, and negative relative to discount rate. Decrease interest rates will lead decrease discount rate, which impels stock price increase. Once stock price increase, investors gain more invest return, the levels of risk aversion amongst investors will decrease, so the risk premium also will decrease, in order to impelling stock price increase again.

In efficient market, the stock price can be considered to net present value of future cash flow.

$$P = NPV(i, N) = \sum_{t=0}^N \frac{C_t}{(1+i)^t}
\tag{1.11}$$

Where,

P : Stock price

t : The number of periods

C : The net cash flow

i : The discount rate

Based on NPV method, future cash flows are positive affect on stock price, and the discount rate is negative affect on stock price.

1.2.2. Operation cost- cost of capital

Gertler and Gilchrist (1994) studied by US manufacturing firms, they found that, in periods of rising interest rates, small firms reduce external borrowing, shed inventories, and experience sharp falls in sales growth. In contrast, larger firms maintain debt levels, increase inventories, and experience a substantially smaller decline in sales growth. The result shows difference size companies have difference reactions to rising interest rates. But ultimately, interest rate is a risk of company.

For most enterprises, change the interest rates will influence cost of capital, the consequence is direct to influence operation cost. Lower interest rate is good for enterprises to use financial leverage; it also means lower cost of capital, reduced cost of capital, and remission enterprises' debt pressures. On the other hand, it also means enterprises can generate more profits. The highly profitability shows enterprise has a good performance, it also boost stock price. In this circumstance, enterprises usually will distribute more dividends to investment. As discussed the dividend discount model above, dividend has positive relate to stock price, so higher dividend higher stock price. And vice versa. More generally, almost all companies are facing to interest rate risk, changing interest rates affect on cost of capital, thereby affect on total cost, as consequence is affect on profits, if the enterprise is not able to pay for interest, then it also may lead losses, the enterprise has to re-adjust the capital structure.

1.2.3. Substitution effect

Changes in interest rate affect on stock price though the substitution effect. Except speculator, almost investors focus primarily on capital preservation rather than capital appreciation. In this case, people have to make choices between investing and savings to achieve capital preservation and appreciation.

Interest rate is meaningful the opportunity cost of holding money, when you hold wealth as cash in your wallet, instead of as an interest-bearing bond, you lose the interest you could have earned (Mankiw 2012, 465). When interest rates cut, the cost of holding money goes down, and more money in circulation means more spending, which implies low opportunity costs of holding money, in this case, people would like to consumption or invest instead of saving. As a result, part of the money from bank go into stock market, raises the

quantity of money supply to stock market and quantity of stocks demand, stock prices will tend to rise. An increase in the interest rate, it raises the cost of holding money, people prefer saving than invest and consumption, part of money may from stock market go into the bank, reduce the quantity of money supply to stock market and quantity of stocks demand, stock price will trend to decrease.

As discuss above, interest rates affect on stock price though three ways, which include value of stock, operation cost of enterprise, and investing and savings behavior of enterprise and individual. Based on these three parts to explain how interest rate affect on stock price, combining the theoretical analysis of relationship between interest rate and stock price, Interest rate has been considering negative relation to stock price, increase interest rate will lower stock price, vice versa.

1.3. Empirical Studies Review

While developed countries fully usurp the benefits of the raising capital through the stock exchange, developing countries do not have effective stock exchange at the desired level. Being one of the most important pillars of the country economy, stock market has been carefully observed by government institutions, companies, and also investors (Nazir et al., 2010). There are numerous studies have been analyzed the relationship among stock market and macroeconomic variables, monetary policy. Extensive empirical literature on the developed markets exists, such like USA, EU, Canada, for emerging markets, the empirical literature is sparse. There are a limited number of studies in China.

1.3.1. Studies for other countries than China

In the early study, the evidence was presented that showed interest rates and stock prices responding to announcements of discount rate changes (Waud, 1970). Pearce and Roley (1985) found that changes in the discount rate had a negative effect on equity prices, but significant only in the post-1979 period. Later Hafer (1986) extended previous research on the reaction of stock prices to monetary “news” in several in September 1977 to December 1984. He found the same result, but only during the period October 1979 to October 1982 of

non-borrowed reserves targeting. Before and after this period he found a positive but statistically insignificant effect on equity price.

Mukherjee and Naka (1995) investigated the dynamic relationship between six macroeconomic variables and the Japanese stock market, by employing a vector error correction to a model of seven equations, the result points out changes in both short-term and long-term rates are expected to affect the discount rate in the same direction. The Japanese stock prices are positively related with short-term interest rate, negatively related with long-term rate. Bulmash and Trivoli (1991) also found same result in USA, negative relationship between long-term interest rate and stock price.

Omran (2003) was examining the impact of real interest rates as a key factor in the performance of the Egyptian stock market, both in terms of market activity and liquidity. The cointegration analysis through error correction mechanisms (ECM) indicated significant long run and short-run relationships between the variables, implying that real interest rates had an impact upon stock market performance.

Vardar et al. (2008) have analyze the impact of interest rates and exchange rate on volatility of different sectors- financial sectors, industrial sectors, services sectors and technology sectors and composite indices in Istanbul stock exchange. Daily data covering a period within interval 2001-2008 was analyzed using GARCH model, the results show strong power of prediction of interest rates and exchange rate on volatility of the composite index. Specifically exchange rate changes are strongly predictive for all the indices except technology index. Moreover interest rate volatility showed significant positive relationship with all indices except services sector, which shows a negative relationship.

Jawaid and Uihaq (2012) have investigated the effects of interest rate and exchange rate and their volatilities on stock prices of banking industry of Pakistan. The study based on CARCH model, monthly data from January 2004 to December 2010 are used. The results suggests the existence of significant negative long run relationship between exchange rate and short term interest rate with stock prices, on the other hand, significant positive relationship exists between volatilities of exchange rate and interest rate with stock prices. And causality analysis confirms bidirectional causality between exchange rate and stock price; unidirectional causality runs from short-term interest rate to stock prices. The sensitivity analysis results suggest that investors should invest in banking sector stocks when exchange rate and interest rates are highly volatile.

Stoica et al., (2014) by using structural vector error correction (SVEC) methodology to identify permanent and transitory stocks in CEE countries: Bulgaria, the Czech Republic, Hungary, Latvia, Lithuania, Poland, and Romania. The results indicate a noticeable effect of the international interest rate on stock market indexes in the Czech Republic, Hungary, Poland, and Romania. Since no monetary policy autonomy exists in Bulgaria, Latvia and Lithuania, the result shows inverse relationship between foreign interest rate and stock index prices.

Sensoy and Sobaci (2014) studied analyzes the dynamic relationship between exchange rate (against US dollar), interest rate and the stock market (both in local currency) of Turkey from January 2003 to September 2013, it based on VAR model, and though the ADF test to ensure stationary. The results showed interest rate negative effect on stock market.

Alam and Uddin (2009) based on the monthly data from January 1988 to March 2003 to study relationship between interest rate and stock price on fifteen developed and developing countries, where four from Asia - Japan, Philippine, Malaysia, Bangladesh; three from Europe - Germany, Italy and Spain; three from North America - Canada, Jamaica and Mexico; three from South America - Chile, Colombia, Venezuela; one from Africa - South Africa and another one is Australia. This study use ADF to examine the market efficiency of fifteen countries tested by using market returns, the result shows that none of this stock market follows random walk model, it means there not efficient in weak form. Considering those markets is inefficiency, relationship between share price and interest rate, and changes of share price and changes of interest rate were determined through time series and panel regressions. The results show that interest rate has significant negative relationship with share price in all of countries, and eight countries like, Australia, Canada, Chile, Germany, Jamaica, Mexico, Spain, and Venezuela has no relationship between change of Interest Rate and change of Share Price.

1.3.2. Studies for China

Liu and Shrestha (2008) were using heteroscedastic cointegration to investigate the long-term relationship between macroeconomic variables and the index of Chinese stock market. They found that a significant relationship exists between the index of the Chinese stock market and macroeconomic variables, which exchange rate and interest rate have a

negative relationship with the index of Chinese stock market.

Wang and Deng (1999) by using the GARCH model and the theory of co-integration and the error correction model (ECM) to analyze the relation among the interbank interest rate, the securities' trading volume and the securities' return during April 1991 to March 1998 in China. They found that the money market has some significant affection on the securities market; the interbank interest rate and securities' trading volume all have affections on the securities' return; and Shanghai Stock market is more mature and steady than Shenzhen stock market.

Cheung (1990) based on the analysis of monthly data of Hong Kong from 1984 to 1989, pointed out there is no causal relationship between interest rate and stock price. Tang and Li (2000) studied the relationship between monetary policy and equality interest rate and explored the effects from monetary policy to stock market during the economic transformation period in China by using vector auto-regression (VAR) method. They pointed out the interest rate policy has the sensitivity effect, but reactions difference for each interest rate changing, lower interest rate did not increase stock price, instead decrease stock price.

Wang and Gong (2006) studied the impact on the stock market of Shanghai resulted from the adjustment of interest rates by using even study and error correction model (ECM) from 1996 to 2004. The results showed that the interest rate policy do not have significant effect on stock market in short term, but it has the certain sensitivity effect, the time-lag effect in short time and has significant negative effects on the stock market in a long time.

Liu and Shrestha (2008) have investigated the relationship between the Chinese stock market indices and a set of macro-economic variables – money supply, industrial production, inflation, exchange rate and interest rates. Considering most macro-economic time series are found to be non-stationary, this study is using heteroscedastic co-integration analysis, they found that the long-term relationship does exist between stock prices and macro-economic variables, industrial production and money supply are positively related to the stock prices, inflation, interest rate and the value of the Chinese currency are negatively related to the stock prices.

Cao (2012) investigated the time varying effects of changes in the interest rate and renminbi (RMB) exchange rate on the Chinese stock market from July 22, 2005, to January 13, 2012. Using the LTVP-VAR and LTVP-R models, the result indicated that the short-term effect on stock returns of changes in the RMB exchange rate is sensitive to the reform of the

increasing flexibility of the RMB exchange rate, in the long term, Chinese stock returns are negatively related to the interest rates and exchange rates in China.

As numerous previous studies, empirical methods vary in their approach and results. In overall, most results are following by theoretical argument of negative relationship between stock price and interest rate. But also existed some positive relationship results and no relationship.

Most empirical researches designed through vector error correction model (VECM) and vector autoregressive (VAR) model, in time series or panel data approach. ADF test is widely used to test stationary, Considering time series are usually non-stationary, in this case, some researchers use the co-integration analysis to avoid the problem of non-stationary data; and some researchers are prefer to pre- process data, in order to achieve the stationary, such like take log, and takes log first difference of time series. Granger causality test is widely used to determining whether has causal relationship among the focus variables and stock prices. Some researchers also use event study method to study more detail.

In this thesis, the empirical study includes event study and econometric evidence. Event study aims to observe how stock price reacts to the 8 times interest rate adjustments. The econometric evidence is based on model of VAR and VECM; additionally, is used unit root test, Johansen co-integration test, and Granger causality test and impulse response functions. Examine in Mainland China's stock markets, which include two stock exchanges- Shanghai Stock Exchange and Shenzhen Stock Exchange.

2. EMPIRICAL RESEARCH

2.1. Overview of China's Stock Markets

In recent years China has been experiencing enormous changes in its financial industry. With the step-by-step opening up of the financial market, the stock market in China has become one of the most active markets in the world (China Stock Market Handbook, 2008). The China's stock market was official set up in the early 1990s - Shanghai Stock Exchange and Shenzhen Stock Exchange were established in December 1990. They have become the most important enterprise financing channels in China. In contrast to the markets of developed countries, China's stock market is still young, but since their official established in the early 1990s they have been developing at a rapid rate; in 2014, China's stock markets took over of Japan stock market and become the world's second biggest equity market by value, with a total capitalization of more than \$4.5 trillion (S.R. 2014). Considering the Mainland China and Hong Kong use difference administrative and financial system, in this thesis the author examines stock markets only in Mainland China, which includes Shanghai Stock Exchange and Shenzhen Stock Exchange.

The history of China's stock markets can be reaching back to the 19th century. Following the First Opium War, the Treaty of Nanking in 1842 established an area in Shanghai known as the International Settlement. This development prompted the emergence of foreign markets in the area. Shanghai was the first city in China to see stocks, stock trading and stock exchanges, Stock trading started in Shanghai in the late 1860s. In 1891, the Shanghai Share brokers Association was establish, which was regarded as the primitive form of stock market in China. In 1920, the Shanghai Securities and Commodities Exchange was established. By the 1930s, Shanghai had emerged as the financial center of the Far East, where both Chinese and foreign investors could trade stocks, debentures, government bonds

and futures (Shanghai Stock Exchange official website, 2015). In 1941, the Japanese military took control of Shanghai and the stock market ceased operation, it reestablished itself shortly after the war, but it was closed again in 1949 during the Communist Revolution (Chavis, 2015). The Communist Revolution ended in the early 1970s, since then, China's stock market has evolved in tandem with the country's introduction of reform and opening up policy and the development of socialist market economy. In 1981, trading in treasury bonds was resumed. In 1984, stock and enterprise bonds were resumed. This ultimately led to the Shanghai Stock Exchange to be reopened, it started formal operations on December 19th 1990. Nest year, China opened a secondary exchange- Shenzhen Stock Exchange.

The stocks are listed in these two exchange are divided into A Share and B Share, with A Shares limited to domestic investors which not include Hong Kong and Macao, while B Share available to foreign investors and oversee Chinese investors. By the end of 2013, there were 953 listed companies on Shanghai Stock Exchange (SSE), there were 997 listed stocks on SSE with a total market capitalization of RMB 15116.53 billion (Shanghai Stock Exchange official website, 2015). There were 1536 companies listed on Shenzhen Stock Exchange (SZE), there were 2328 listed stock with a total market capitalization of RMB 807035.41 Million (Shenzhen Stock Exchange official website, 2015). Overall, there are more companies and stocks listed on Shenzhen Stock Exchange, but Shanghai Stock Exchange has bigger market capitalization. These because of two stock exchanges have difference focuses, large-capitalization companies usually listed on Shanghai Stock Exchange, and small- and mid-capitalization companies usually listed on Shenzhen Stock Exchange.



Figure 2. Historical trend of Shanghai Stock Exchange Composite Index and Shenzhen Stock Exchange Composite Index

Source: Yahoo Finance.

The China's stock market has experienced several ups and downs in the past decades. Especially during the global financial crisis in 2008. Shanghai Stock Exchange Composite index (000001. SS) and Shenzhen Stock Exchange Composite Index (399001. SZ) have fluctuated wildly, as shown in Figure 3. Those two exchanges enjoy high correlation; both of them reached the peak on October 2007, and then started off in a slump. Until one year later, on October 2008, it just started to recover.

The People's Bank of China cut its benchmark one-year lending rate by 0.4-percentage point to 5.6 percent and one-year deposit interest rate by 0.25-percentage point to 2.75 percent on November 2014. This is the first time China cuts the interest rate since July 2012 as leaders step up support for the world's second largest economy, sending global shares, oil and metals prices higher (Bloomberg 2014). Only in three months later, on March 2015, The People's Bank of China cut interest rates for the second time. The benchmark one-year lending interest rate and deposit interest rate are both lowered by 0.25 percentage point to 5.35 percent and 2.5 percent, respectively (PBC Website, 2015).

Since November 2014, China's stock ushered round of bull market, as shown in Figure 3. It was boosted by an interest rate cut, the Shanghai stock market is up 25% in a month as investors get excited by gains following gains (Cendrowski 2014). After second interest rate cut, by the end of April 2015, the Shanghai Stock Exchange Composite index goes up about 18% (QQ Finance, 2015). More than 10 million stock accounts have been opened since the December 2014, it equivalent to the total number for all of 2012 and 2013 combined. Individual investors are account for about 80% of China's stock trading (Xie, Stapczynski and Cao 2015).

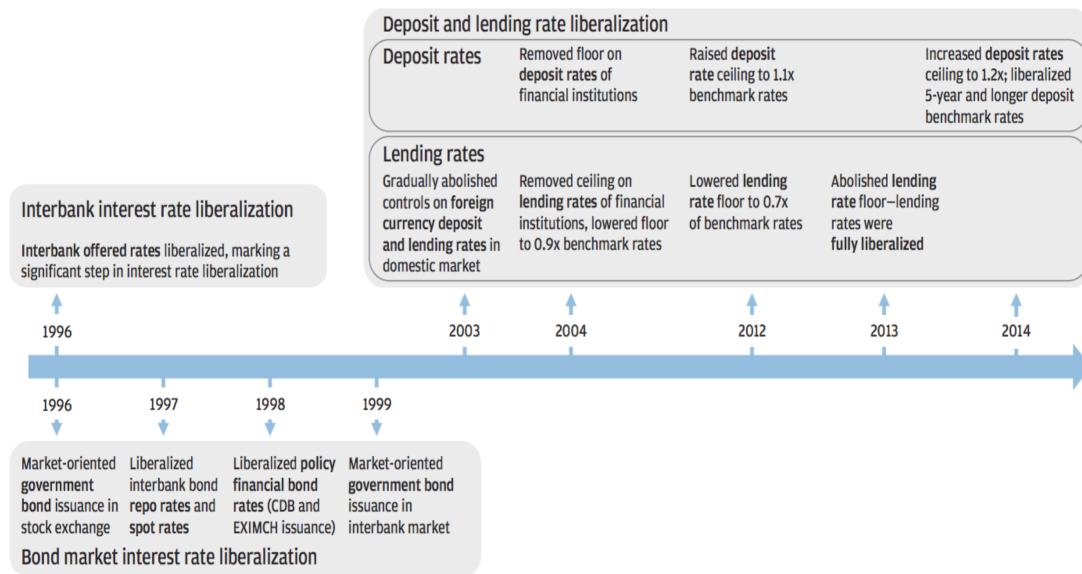
Right now, Chinese stocks rose, sending the stock benchmark index to a seven-year high, amid speculation the government will accelerate monetary stimulus to support the economy. On 22th April 2015, the Shanghai Composite Index rose to 4398.50. The gauge has jumped 87percent in the past six months, the most among benchmark indexes globally, as the government lowered borrowing costs to boost growth. According the People's Daily, the bull market is just getting started at the 4000 level (Kim 2015). Many media outlets commented to China's stock market, it is a crazy bull market, full of bubble. Over the past 6 months, China's

stock market has the really good shape, but it seems the same trend during the 2008 global finance crisis, it may drop anytime, history repeats itself again.

2.2. Overview of Interest Rates in China.

Since initiating market reforms and opening up in 1978, China's economy has greatly growth. China's financial sector has underwritten this remarkable rise and itself undergone major reforms. The major step in China's financial reform is interest rate liberalization. Normally, interest rates are a key instrument of monetary policy; this fundamental change in how Chinese financial institutions price interest rates and manage risk will have significant implications for investors (Shevlin and Wu 2014).

In China, interest rates controlled by the Peoples' Bank of China Monetary Policy Committee. China's Central Bank- the People's Bank of China is an only institution to administer interest rates. Other financial institution prohibited customizing the interest rates by themselves. Over the past two decades, interest rates have been steadily deregulated, while many interest rates have been liberalized, restrictions on deposit and lending rates are gradually relaxed, as shown in Figure 3. In 2006, China has embarked on interest rate reform by gradually liberalizing interbank interest rate and bond market interest rate. Since 2003, deposit and lending rate are gradually liberalizing. Including gradually abolished controls on foreign currency deposit and lending rates in domestic market; in 2004, the upper bound on lending rate and floor deposit rates were removed. Consequently, there remains a ceiling on one-year deposit rates, and a floor on one-year lending rate (Porter and Xu 2009). And the abolishment of the lending rate floor, and the launch of interbank negotiable certificates of deposit in 2013 (Kawai and Liu 2015).



Source: J.P. Morgan Asset Management, PBoC. CDB = China Development Bank; EXIMCH = Export-Import Bank of China.

Figure 3. Timeline of the People's Republic of China's Interest Rate Liberalization

Sources: Shevlin, A. and Wu, L. (2014). China: The Path to Interest Rate Liberalization. J.P. Morgan Asset management.

In many developed economies, such like USA, UK, the benchmark rate is interbank interest rate. In China, the People's Bank of China administrates two benchmark interest rates, one-year lending rate and one-year deposited rate. Despite these two benchmark interest rates, there also exist many interest rates and they are all based on the two benchmark interest rates: Such as discount rate, which the central bank charges on loans made to commercial banking institutions; Government bond rate, it is an example of short-term and long-term interest rate; Interbank interest rate, which charged on short-term loans made between banks, etc.

All along, China's interbank market plays a crucial role. Which is a main sub-market of money market, and main market for People's Bank of China implements monetary policy. It aims to efficiently allocate liquidity among financial institutions and regions, shift funds to institutions and regions that need it most, and allow for a smooth working of the payment system (Cook and Laroche, 1993). Interbank interest rate is the most sensitive interest rates in monetary market; it more promptly and accurately reflects the supply and demand of money in monetary market. So it normally serves as an important benchmark for setting interest rates of other financial products, central banks actively interfere in interbank markets to guide their

policy interest rates (Furfine, 2001, p.1). Rising and volatile interest rates of the interbank market tend to add financial costs onto both banks and borrowers and therefore pose real threats to financial stability. Which complicated the situation are China's ballooning property price as well as heavy indebtedness of public and corporate sectors (Xia and Alicia. 2014). In a certain sense, interbank interest rate is direct effect on monetary market.

In 1996, the People's Bank of China established the first unified national interbank market, since then, China steps up market-oriented reform of interbank market, and short-term interbank interest rate were liberalized first. China's Interbank Offered Rate (CHIBOR) has become the first liberalized interbank interest rate. Later, in order to make interest rates better reflect market conditions and create a more stable benchmark yield curve at longer maturities, and also it's set in a similar way to LIBOR, in 2007, the People's Bank of China launched the Shanghai Interbank Offered Rates (SHIBOR) (Porter and Xu 2009). It has become the actual interest rate market benchmark, also a market index to measure the market liquidity and the market expectation to potent monetary policy change (Tang et al., 2013). SHIBOR is a no-guarantee, wholesale interest rate calculated by arithmetically averaging all the interbank RMB lending rates offered by the price quotation of group of banks with high credit rating, which consist of 18 commercial banks (SHIBOR official website).

According to the Bank for International Settlements (2013), the reference rates based on unsecured interbank term lending and borrowing are dominant types of reference rates used in the world. As for central banks, the reference rate serves as an operational target. Different from the actual policy rate, this operational target is used to guide monetary policy. The SHIBOR is considered a natural candidate for the reference rate for the China. Compare to CHIBOR, SHIBOR is seen as a more market-sensitive benchmark for interbank market than other interest rate (Asian Bonds Online). However, currently, the official interbank rate is reference as Shanghai Interbank Offered Rates.

Shanghai Interbank Offered Rates' tenors tend to short term, ranging from overnight to 12 months, there are 8 maturities: overnight, 7days, 14days, 1month, 3months, 6months, 9month, 12months. Thought the survey for difference China's Interbank Offered Rates' tenors based on trading volume, number of transactions and market shares over the past years. The result shows that the largest number of transactions and trading volume, and also the most activity's rate is overnight CHIBOR. It accounts about 70% market share in interbank market (Li et al. 2007). Since 2007, Shanghai Interbank Offered Rates take pace for China's

Interbank Offered Rates, most trading activities based on SHIBOR, while overnight SHIBOR is the most used daily rate by institutes in pricing financial products. Especially overnight SHIBOR, in 2014, in interbank market, total trading volume is 376626 billion RMB, overnight trading volume is 294983 billion RMB, it accounts about 78.32% of total; 7 days trading volume is 61061 billion RMB, it accounts about 16.21% of total (PBC Official website). Looking at major international central banks, the monetary operational target rates used by the US Fed and the Bank of Japan are both use overnight rates (Kawai and Liu 2015). The Bank of Canada main monetary policy tool is its policy interest rate, the target for the overnight rate (Bank of Canada, 2012). The ECB meanwhile acts as the calculation agent for the Euro Overnight Index Average (EONIA), which is also an interbank overnight rate, officially, the EONIA is not a reference rate or operational target for the ECB, but it plays a similar function (BIS 2008).

As discussed above, the author considers the interest rate affects market and accurately reflects the economics conditions. The author thinks SHIBOR is closely connected to stock market, it can more accurately reflect stock price by changing interest rate. Accordingly, interbank market trading and operational target rates are most used. The overnight interest rate is the shortest market interest rate, it normally comprises the alternative cost or yield for a bank's financing or investment, which affects the interest rates set throughout the economy (Mitlid and Vesterlund 2001). So in the following empirical analysis section, the author will use overnight Shanghai Interbank Offered Rates to do empirical analysis.

2.3. Methodology and Data

This section provides an overview of the model employed, the econometric tests performed, the type of variables selection, and the source of data. This empirical study combines the event study and econometric evidence.

2.3.1. Event study

Event study is widely used for examining the information content of the disclosures. The event study has many applications, and it has been applied to a variety of firm specific and economy wide events, such as mergers and acquisitions, earnings announcements, issues

of new debt or equity and announcements of macroeconomic variables such as the trade deficit, interest rate adjustment. The event study is also used in the field of law and economics to measure the impact on the value of a firm of a change in the regulatory environment and legal liability cases event studies are used to assess damages (Mckinlay 1997). The first event study is conducted by Dolley (1933) where he studies the impact of stock splits on the stock prices, and introduced by Fama et al (1969) where they study the adjustment of stock prices to new information.

The idea is based on efficient market theory, according to which effects of any event will be reflected on the stock price, in this event study is to measure the impact of an adjustment of interest rate on stock price. In order to examine of the impact of adjustment of interest rate announcement on stock, this study covers 8 events collated into 5 increase and 3 decrease interest rate events. It is designed to discuss with estimator-event window, on-event window, and post-event window. On event window is including the day of the announcement, and the day before and after the announcement. Considering the information will leak before announcement, a period before announcement is used for estimating the responses of stock price on interest rate adjustment, the period of estimator-event window is 7 days prior to the announcement. Post-event window is 7 days after the announcement. In this period it shows the exact responses of stock price to interest rate adjustment. The reactions of stock price at estimator-event window, on-event window, and post-event window can give a basic view of the relationship between interest rate and stock price, furthermore, how stock price reacts to the interest rate adjustment. The next subsection refers to the econometric evidence, which will examine relationship between them in detail in order to get more comprehensive view.

2.3.2. Econometric studies review

The empirical study uses vector auto-regressive (VAR) model, unit root test, co-integration test, Granger causality test, and impulse response functions to analyses the relationship between interest rate and stock price. It will be done step by step, the pre test is to ensure that the variables are stationary, the tools of the test stationary is unit root test employed by the Phillips –Perron (PP) test. Then proceeded to find whether there are any long term relationships, Co-integration test will be using to test if there has long-term equilibrium relationship between the interest rate and stock price. Then apply Granger causality test to measure Granger causality relation between interest rate and stock price, according to the

results of co-integration test, if there is a non-spurious long-term relationship between two series, and exist co-integration relationship in two series, the author will use Vector error correction model (VECM) to establish the direction of causality, and short term dynamic relationship. At the end impulse-response function analysis will apply to measures the dynamic linkages between stock price and interest rate in short term.

2.3.2.1. VAR model

Vector autoregression (VAR) is an econometric model used to capture the evolution and the interdependencies between multiple time series, generalizing the univariate autoregressive model for forecasting a collection of variables. In VAR model, there does not need to specify which variables are endogenous or exogenous, all variables are treated as endogenous (Brooks, 2008).

The basic VAR model of order p (VAR(p)) has the form

$$y_t = C + A_1 y_{t-1} + \dots + A_p y_{t-p} + \mu_t \quad (2.1)$$

Where y_t is a $K \times 1$ vector of endogenous variables, C is a $K \times 1$ vector constants, A_p is $K \times K$ matrix, and μ_t is $K \times 1$ vector error terms.

In this study, the two equations of VAR model are estimated:

$$R_t = C_R + \sum_{i=1}^p A_{RR,i} R_{t-i} + \sum_{i=1}^p A_{RS,i} S_{t-i} + \mu_{R,t} \quad (2.2)$$

$$S_t = C_S + \sum_{i=1}^p A_{SS,i} R_{t-i} + \sum_{i=1}^p A_{SR,i} S_{t-i} + \mu_{S,t} \quad (2.3)$$

Where R_t denotes the t_{th} observation of overnight offered rate (R), S_t denotes the t_{th} observation of stock index, $A_{RR,i}$ denotes the influence of the p_{th} lag of variable overnight offered rate on itself; A_{RS} denotes the influence of the p_{th} lag of variable stock index on overnight offered rate, it's the dynamic effect of stock price on interest rate; $A_{SS,i}$ denotes the influence of the p_{th} lag of variable stock index on itself; $A_{SR,i}$ denoted the influence of the p_{th} lag of variable overnight offered rate on stock index, it's the dynamic effect of interest rate on stock price, $\mu_{R,t}$ and $\mu_{S,t}$ are unobservable error terms.

To determine whether the fitted VAR provides a good representation of the time series set, in this study also test if there exist co-integration relationship, then it could be extended to the vector error correction model (VECM) where the model includes co-integrating relationship and first difference terms.

2.3.2.2. Unit root rest- stationary test

This test is to ensure that the variables are stationary. Stationary data fluctuates around a constant mean with no trend over time, it allows use past information to forecast future. Using non-stationary time series data, it may process unreliable and spurious results and leads to poor understanding and forecasting. This test is aimed to determine the order of integration of each of the variables and the number of times that a particular variable would have to be differenced for the series to achieve stationary (Adu. 2011).

The test for unit root involves the estimation of the following equation:

$$\Delta Y_t = \gamma Y_{t-1} + \sum_{i=1}^p \beta_i \Delta Y_{t-i} + \varepsilon_t \quad (2.4)$$

$$\Delta Y_t = \alpha + \gamma Y_{t-1} + \sum_{i=1}^p \beta_i \Delta Y_{t-i} + \varepsilon_t \quad (2.5)$$

$$\Delta Y_t = \alpha + \beta t + \gamma Y_{t-1} + \sum_{i=1}^p \beta_i \Delta Y_{t-i} + \varepsilon_t \quad (2.6)$$

Where is α a constant, p is the number of lags, t is the time trend, ε_t is the error term

The null hypothesis is $H_0 : \gamma = 0$, the alternative $H_1 : \gamma < 0$. The test will start from equation (2.6) to equation (2.4), if the test rejects the $H_0 : \gamma = 0$, then this time series data is stationary, if during those three equation test can not reject, then this time series data is non-stationary.

2.3.2.3. Co-integration test

According to Rautava (2004), the reasons of apply for co-integration test after unit root test, first, the risk of spurious correlation between variables and the second on is using only first differences of the variables runs the losing relevant information. Many time series

are non-stationary but move together over time, there exist some influences on the series, which imply that the two series are bound by some relationship in the long term; in this case, co-integration test should be applied to examine the actual behavior of the variables. Co-integrating test can be seen as an indirect test of long-term causality, the co-integrating relationship may be interpreted as a long-term equilibrium relationship between the variables. Considering macroeconomic time series are usually non-stationary, so it suggest there may have co-integration relationship exist.

To test whether the variables are co-integrated or not, there are three main methods, Engle-Granger two- step method, Engle and Yoo three-step method and Johansen procedure (Brooks 2008). Cheung and Ng (1998) has mentioned that the Johansen approach is more efficient, because the maximum likelihood procedure has large and finite sample properties. In this study, Johansen co-integration test will be employed to measure co-integration relationship.

The approach of Johansen (1988) is based on the maximum likelihood estimators of the co-integrating vectors for an autoregressive process with independent errors. The relationship among the variables is based on the following model:

$$\Delta y_t = C + \Pi y_{t-1} + \sum_{i=1}^{p-1} \Gamma_i y_{t-i} + \mu_t \quad (2.7)$$

Where $\Pi = \sum_{i=1}^p A_i - I$ and $\Gamma = - \sum_{j=i+1}^p A_j$

Π denotes information about the rank of the matrix, the matrix Π also called long-term matrix, define the long-term effects to the VECM, Γ denotes a vector of parameters which contain information about the short- term adjustment processes (Johansen, 1988).

In Johansen approach, there have two likelihood ratio tests for testing the number of co-integration vectors (r): the trace test and the maximum eigenvalue test.

The trace test is formed by following equation:

$$\lambda_{trace}(r) = -T \sum_{i=r+1}^n \ln(1 - \hat{\lambda}_i) \quad (2.8)$$

Where T is the sample size and $\hat{\lambda}_i$ is the i th largest canonical correlation, and is conducted sequentially for $r=k-1, \dots, 1, 0$. The null hypothesis is that there exist r co-integrating vectors at most against the alternative of there exist more than r co-integrating vectors.

Following equation forms the maximum eigenvalue test:

$$\lambda_{\max}(r, r+1) = -T \ln(1 - \hat{\lambda}_{i+1}) \quad (2.9)$$

Where T is the sample size and $\hat{\lambda}_i$ is the i_{th} largest canonical correlation. And is conducted sequentially for $r=0,1,\dots,k-1$. This test tests the null hypothesis that the co-integration rank is r, and against the alternative that the co-integration rank is $r+1$.

If the estimated λ value of those two tests large than an appropriate critical value, then the null hypothesis is rejected; otherwise, the hypothesis is accepted. Lütkepohl et al. (2000) found the local power of corresponding maximum eigenvalue and trace tests is very similar, but trace tests tend to have more distorted sizes whereas their power is in some situations superior to that of the maximum eigenvalue tests. So in this study, the co-integration test is based on trace test.

2.3.2.4. Granger causality test

Granger causality test is aimed to investigate the causality of the variables, to determine whether one time series is useful in forecasting another period or not. Granger causality test require the time series is stationary, non-stationary time series should have to be differenced, to achieve stationary, in this study, the Granger causality test is based on following VAR model equations:

$$R_t = C_R + \sum_{i=1}^p A_{RR,i} R_{t-i} + \sum_{i=1}^p A_{RS,i} S_{t-i} + \mu_{R,i} \quad (2.10)$$

$$S_t = C_S + \sum_{i=1}^p A_{SS,i} R_{t-i} + \sum_{i=1}^p A_{SR,i} S_{t-i} + \mu_{S,i} \quad (2.11)$$

This study tests the null hypothesis, for the first equation, $H_0 : A_{SR,i} = 0$ which implies that interest rate do not Granger cause the stock price, $H_0 : A_{SS,i} = 0$ stock price do not Granger cause the stock price. For the second equation, $H_0 : A_{RS,i} = 0$ indicates that stock price do not Granger cause the interest rate; $H_0 : A_{RR,i} = 0$ means interest rate do not Granger cause the interest rate. If the null hypothesis cannot be rejected, then there is no Granger causality.

2.3.2.5. Vector error correction model (VECM)

Since the error correction methodology is warranted only if the variables are integrated to the first order, and exist co-integration relationship. Considering two sets time series are typical macroeconomic series, usually non-stationary at level, so there is possible to extend to Vector error correction model (VECM), this model is useful in this study as the dynamic effects that occur on the stock price and interest rate on the short term shocks. The two equations of error correction model are estimated:

$$\Delta S_t = C_s + \alpha_s e_{t-1} + \sum_{i=1}^p A_{SS,i} \Delta R_{t-i} + \sum_{i=1}^p A_{SR,i} \Delta S_{t-i} + \mu_{S,i} \quad (2.12)$$

$$\Delta R_t = C_R + \alpha_R e_{t-1} + \sum_{i=1}^p A_{RR,i} \Delta R_{t-i} + \sum_{i=1}^p A_{RS,i} \Delta S_{t-i} + \mu_{R,i} \quad (2.13)$$

Where $e_{t-1} = S_{t-1} - \beta_1 R_{t-1}$ it denotes error correction factor. S and R represent the stock prices and the interest rate respectively; Δ denotes the first differences of the time series variables. α is the coefficient of the error correction factor and measures the speed of adjustment to obtain equilibrium in the event of shocks to the system.

2.3.2.6. Impulse response analysis

Impulse response function (IRF) used to track the responses of a system's variables to impulse of the system's shocks. So at the end, in order to further verify the results of above tests, the author applies Impulse response function (IRF) to analyze the short-term dynamic relationship between interest rate and stock index and also to investigate the sensitivity degree the reaction of impulse.

2.3.3 The data

Considering the 2007-2008 sub-prime financial crisis led the stock price wildly volatile, as shown in Figure 3. Some researchers such as Zhu (2015), and financial institutions such as JP Morgan (2014) have pointed out during the 2007-2008, it shows one structural broken points. Since the existence of structural shifts would bias the result of stationary test, which could lead to mendacious result in co-integration analysis and misleading conclusion.

In order to get more accurate result in this study, the author decides to avoid financial crisis period, start from 2009.

This study uses the high frequency data as sample to study the relationship between interest rate and stock price, the daily data covering January 2009 to December 2014. The sample size has 1499 observations, two variables in each stock exchange, for Shanghai Stock Exchange, Shanghai interbank offered rate, Shanghai Composite index; for Shenzhen Stock Exchange, Shanghai interbank offered rate and Shenzhen Composite index. The data are obtained from official websites. The source of Overnight Shanghai Interbank Offered Rate is Shanghai interbank offered rate official website, the Shanghai Composite index is from Shanghai Stock Exchange, and the Shenzhen Composite index is from Shenzhen Stock Exchange.

The reason that author choose those three variables are: as representative of stock price, Shanghai Stock Exchange Composite index and Shenzhen Composite index are used, because Shanghai Stock Exchange Composite index and Shenzhen Composite index are used as a proxy of China's stock market prices, those two indexes are the most commonly used indicator to reflect the Shanghai Stock Exchange and Shenzhen Stock Exchange's market performance respectively, and they are market capitalization weighted index (Shanghai Stock Exchange Official and Shenzhen Stock Exchange website, 2015).

Also as representative of interest rate, Overnight Shanghai Interbank Offered Rate is used, Shanghai Interbank Offered Rate is a daily reference rate based on the interest rate at which banks offer to lend unsecured funds to other banks in the Shanghai interbank money market (SHIBOR official website). It has been treated as benchmark rate in China's money market, and also a market index to measure the market liquidity and the market expectation to potent monetary policy change (Tang et al., 2013). The reason of choose overnight SHIBOR, it because of overnight SHIBOR is the most used daily rate by institutes in pricing financial products, in 2014, in interbank market, total trading volume is 376626 billion RMB, overnight trading volume is 294983 billion RMB, it accounts about 78.32% of total (PBC Official website). Through the observation in interbank trading by amount of money lending and activity degree, it can well understand the status of the flow of money in the economy.

3. Empirical Analysis and Results

3.1 Event Study

For background information, the author will present the results of even study. From 2009 to 2014, The People’s Bank of China made 8 adjustments of benchmark rate, among them 5 times increase in benchmark rate, and 3 times lower in benchmark rate, the detail information of benchmark rate adjustments is shown in table 1.

Table 1. The adjustments of benchmark rate during 2009-2014.

| Date | Type of adjustment | R (T) | | R (T-1) | | R (T+1) | | R (T-7) | | R (T+7) | |
|-------------|--------------------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|
| | | Shenzhen | Shanghai | Shenzhen | Shanghai | Shenzhen | Shanghai | Shenzhen | Shanghai | Shenzhen | Shanghai |
| 20-Oct-2010 | Increase | 2.40% | -11.59% | 0.05% | 0.00% | -0.58% | 0.00% | -3.53% | -2.41% | 2.69% | 7.75% |
| 26-Dec-2010 | Increase | 2.80% | 1.06% | 0.53% | 1.34% | -0.38% | 1.07% | -0.72% | 0.33% | -2.79% | 1.49% |
| 9-Feb-2011 | Increase | 6.82% | -2.43% | 1.39% | 3.13% | 2.06% | 0.09% | -6.38% | 4.34% | 2.66% | 0.08% |
| 6-Apr-2011 | Increase | 0.46% | -2.12% | 1.58% | -0.13% | -0.35% | -1.41% | 1.85% | -1.18% | -5.08% | 0.37% |
| 7-Jul-2011 | Increase | 0.01% | -4.65% | -0.10% | 1.54% | -0.75% | -0.81% | 0.36% | 3.00% | -3.26% | 3.53% |
| 8-Jun-2012 | Cut | -1.42% | 4.52% | 0.40% | 0.21% | -1.64% | -0.52% | -1.62% | -1.53% | 2.33% | -4.33% |
| 6-Jul-2012 | Cut | -6.51% | -0.30% | 0.13% | 0.23% | 1.18% | -0.95% | 3.02% | 4.06% | 3.07% | 0.30% |
| 22-Nov-2014 | Cut | 31.33% | 5.31% | -1.15% | 2.44% | 0.33% | -0.24% | -2.69% | -4.13% | 4.37% | -5.38% |

Source: Drawn by the author

Where $R(T)$ denotes the stock index change rate at the day when central bank adjustment of interest rate, $R(T-1)$ and $R(T+1)$ are the stock index change rate at the day before and after central bank adjustment of interest rate. There are 3 days as the on-event window. The $R(T-7)$ and $R(T+7)$ present the stock index change rate before 7 trading days and after 7 trading days of central bank adjustment of interest rate, as the estimation window and post-even window

respectively. Usually, before official adjustment of interest rate, central bank will announce the report or sometimes the information might be leaked, and soon afterwards the stock market will react as soon as information is received. The 7 days period before adjustment of interest rate is considered as estimation window, to show a basic view the probable reaction of stock price in case of change interest rate; meanwhile; 7 days after the central bank announces the adjustment of interest rate, that is considered as post-even window to examine exact stock price responses to interest rate change.

In 2009, the China's central bank did not make any adjustments. From 2010 to 2011, within two years, the China's central bank increased benchmark rate 5 times, which implied that China was still under the shadow of 2008 global financial crisis, the economy was slowly recovering from the global economic downturn. In 2012, the China's central bank cut interest two times within one year, and two times very close, it was a sign China had already recovered from the global financial crisis, and the government authority tried to boost the economy. After quite 2013, in the end of 2014, the China's central bank cut interest again.

The table 1 shows that the stock index response to interest rate change do not follow the theory, i.e. increased interest rate lower stock price, lower interest rate increase stock price. But in China's stock markets, increased interest rate increased stock index, lower interest rate lower stock index. Overall, both stock indexes movements are out of rule.

Based on theory, the relationship between interest rate and stock price is negative, when increase interest rate the stock price decreases. The trend of increase interest rate event is shown in Figure 4. During the two times increase interest rate in 2010. At first both stock indexes are against the rule, the stock indexes trend to increase, the second time, they fluctuate wildly but in the end it trends to decrease. The reactions in 2011 is quite similar with 2010, in this year, in the even of 9th February, the Shanghai stock index is basically following the rule, trend to decrease, but the Shenzhen stock index increase, at the later adjustment, basically, both stock indexes are following the rule, trend to fall, however at the end of post event window, the shanghai stock index has a sign to increase, the event of 7th July, the third time increase in 2011, in the estimator window and on- even window, two stock indexes are trend to fall, but in the post even window, Shanghai stock index straight up, and Shenzhen stock index shows a increase sign.

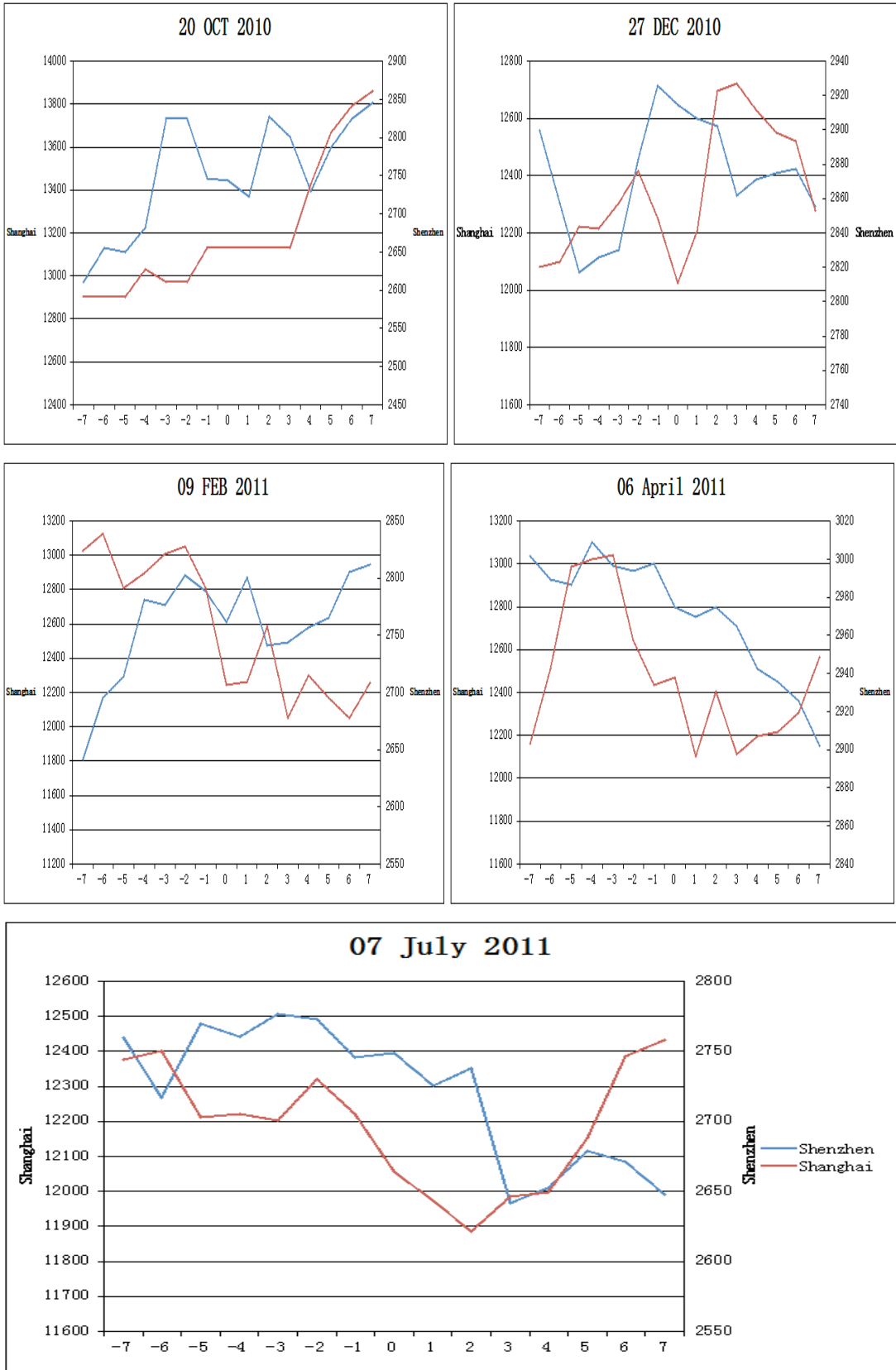


Figure 4. The responses of stock indexes to increase interest rate

Source: Drawn by the author

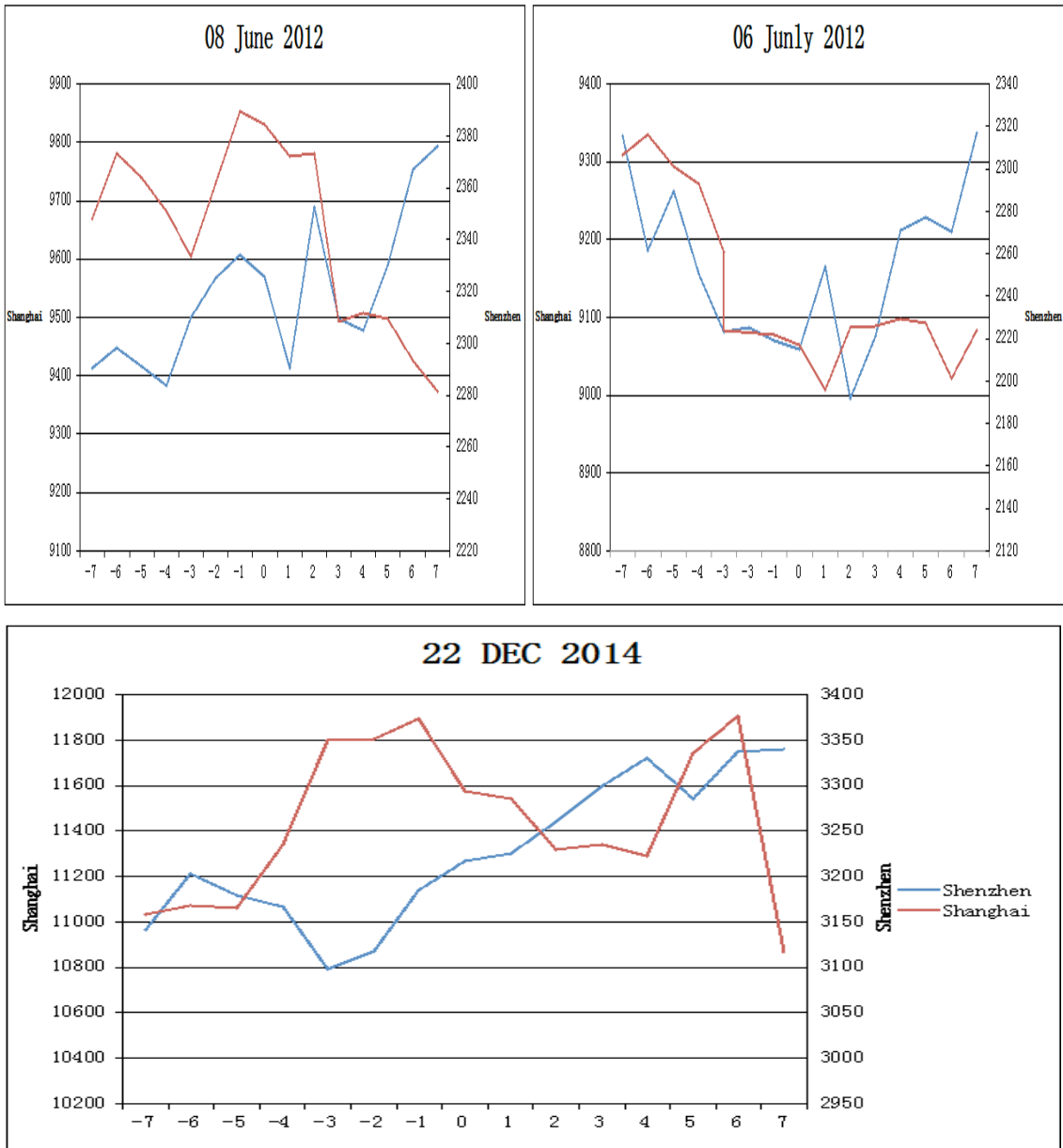


Figure 5. The responses of stock indexes to decrease interest rate

Source: Drawn by the author

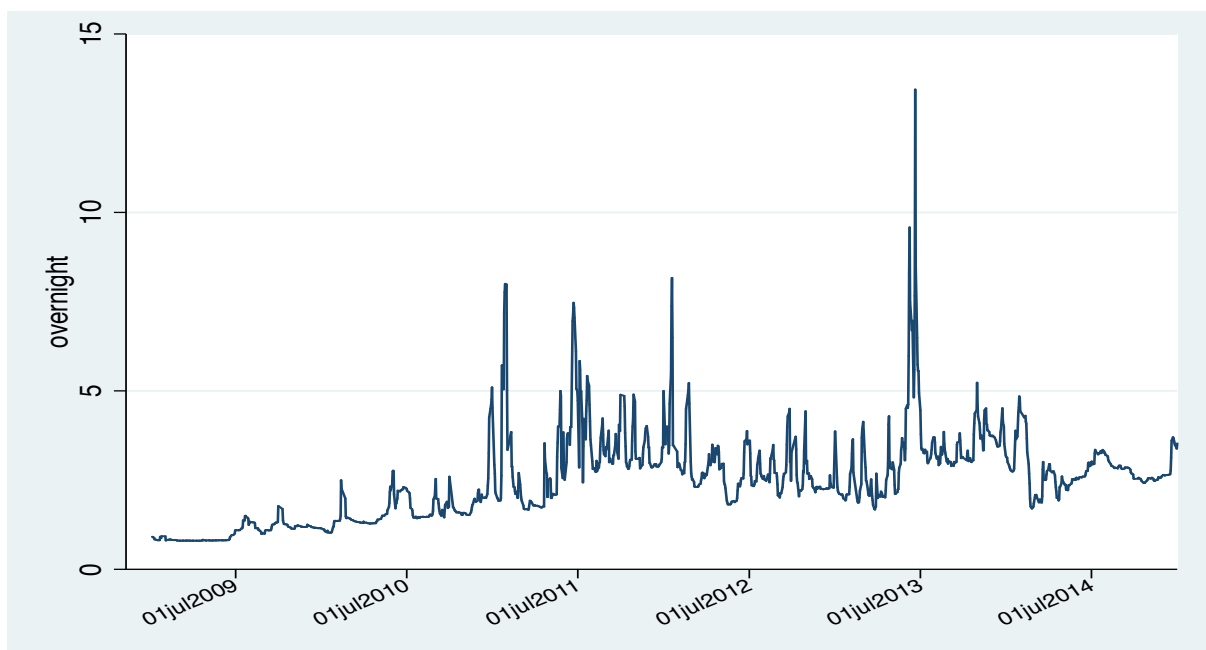
The responses of stock indexes to decrease interest rate are shown in figure 5. In 2012, the government authority seems try to boost the economy, cut the interest rate two times. Later in 2014, cut the interest rate again. In the event of June 8, 2012 and December 22, 2014, the Shenzhen stock index present increase trend with fluctuation, and Shanghai stock index shows irregular fluctuations. In the event of July 6, 2012, both stock indexes are on the decrease trend at estimator event window; in the post event window, Shanghai stock index shows a stable trend, but Shenzhen stock index increase.

Overall, having analyzed during the 7 days before, 7 days after the day announcement of adjustment interest rate, both stock indexes preform irregular fluctuations and almost are against the rule, but it is hard to identify the relationship between interest rate and stock index, in the next section, the author will analysis the relationship between them in detail by using econometric evidence.

3.2. The Results of Econometric Evidence

3.2.1. Data processing

Every variable have 1499 sample sizes. In order to analysis them, the author plot the figure 6 to contain the three linear graphs of variables, overnight Shanghai offered rate, Shanghai Stock Exchange Composite index and Shenzhen Stock Exchange Composite index, respectively.



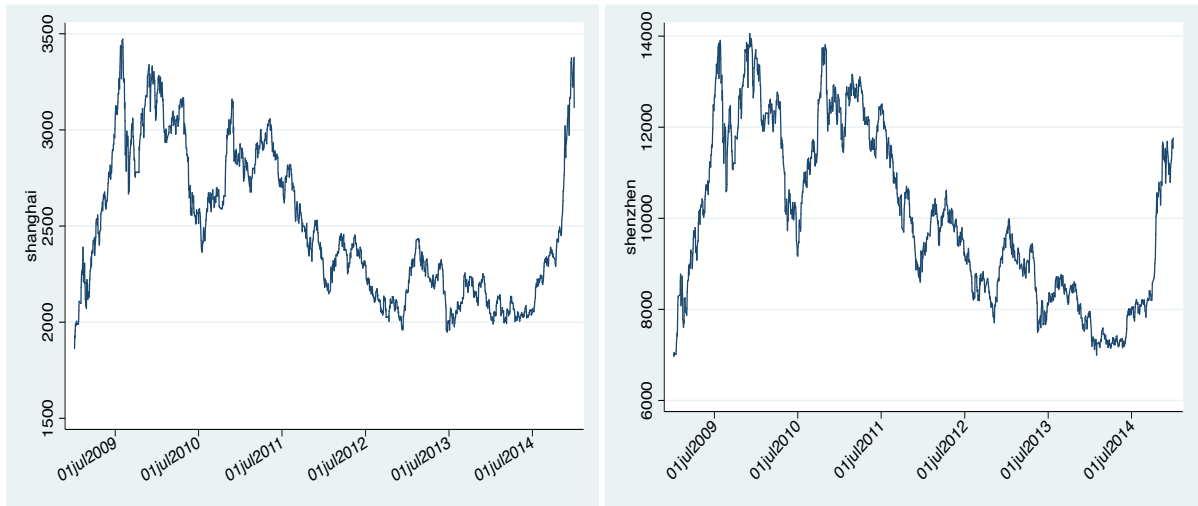


Figure 6. Graph of variables

Source: Drawn by the author

Considering the figure 6, it suggests the series are not stationary. So in this case, the author would like to pre-processing data before perform analyses. Lütkepohl, (2004) pointed out, for those non-stationary time series, apply a logarithmic transformation may help to move series closer to stationary. On the other hand, considering magnitude differences between interest rate and stock index are extraordinary disparity, interest rate account by parentage, and stock index account by thousands, it may misleading the statistic results, in order to improve the time series stability and results accuracy, the author will apply a logarithmic transformation to Shanghai Stock Exchange Composite index and Shenzhen Stock Exchange Composite index before perform analyses. After transformation, the new time series plot in Figure 7.

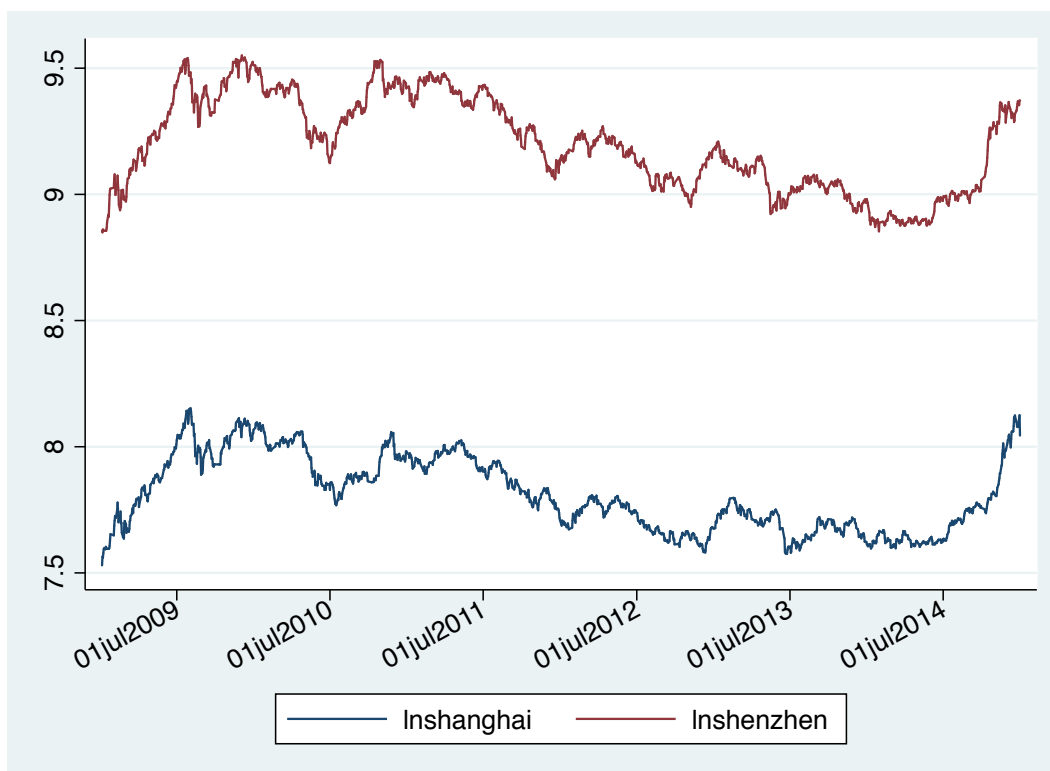


Figure 7. Graph of Shanghai stock index and Shenzhen stock exchange logarithmic
Source: Drawn by the author

The new Shanghai Stock Exchange Composite index and Shenzhen Stock Exchange Composite index series indicated as Inshanghai and Inshenzhen respectively, After taking log of time series of stock index shown in Figure 7, the series fluctuates still not around a constant mean, looks like non-stationary time series. In the following unit root test will examine the stationary of series, it maybe suggests that take difference to achieve stationary.

Symbol summary of variables:

shanghai = Shanghai Stock Exchange Composite index.

shenzhen = Shenzhen Stock Exchange Composite index.

Inshanghai = log Shanghai Stock Exchange Composite index.

Inshenzhen = log Shenzhen Stock Exchange Composite index.

Overnight = Shanghai Interbank Offered Rate

3.2.2. Unit root test

As high volatility exists in time series, which implies that the model may exhibit heteroskedasticity. Considering that Phillips-Perron test uses Newey-West (1987) standard errors to account for serial correlation, compare with the most popular unit root test- ADF test, PP test seems more suitable in this model.

The author begins the analysis by examining the stationary properties of the variables using the Phillips-Perron test (1988). The following equation is estimated for each of time series.

$$\Delta Y_t = \gamma Y_{t-1} + \sum_{i=1}^p \beta_i \Delta Y_{t-i} + \varepsilon_t \quad (3.1)$$

$$\Delta Y_t = \alpha + \gamma Y_{t-1} + \sum_{i=1}^p \beta_i \Delta Y_{t-i} + \varepsilon_t \quad (3.2)$$

$$\Delta Y_t = \alpha + \beta t + \gamma Y_{t-1} + \sum_{i=1}^p \beta_i \Delta Y_{t-i} + \varepsilon_t \quad (3.3)$$

The null hypothesis is $H_0 : \gamma = 0$, the variable contains a unit root.

The alternative is $H_1 : \gamma < 0$, the variable was generated by a stationary process.

Table 2. Output of Phillips-Perron test

| | Test Statistic | 1% Critical Value | 5% Critical Value | 10% Critical Value | Result suggest |
|--------------|----------------|-------------------|-------------------|--------------------|----------------|
| Overnight | -12.528 | -13.800 | -8.100 | -5.700 | Accept |
| D Overnight | -1165.252 | -13.800 | -8.100 | -5.700 | Reject |
| lnShanghai | 0.063 | -13.800 | -8.100 | -5.700 | Accept |
| D lnShanghai | -1496.301 | -13.800 | -8.100 | -5.700 | Reject |
| lnShenzhen | 0.053 | -13.800 | -8.100 | -5.700 | Accept |
| D lnShenzhen | -1443.997 | -13.800 | -8.100 | -5.700 | Reject |

Source: Drawn by the author

The author used Phillips-Perron (PP) test for unit root in level and the first difference of the series. The results are shown in table 2, which indicate that overnight series can be

reject null hypothesis at 5% critical value, but cannot reject at 1% critical value. In Shanghai and Shenzhen's test statistic even bigger than 10% critical value, it means that the null hypothesis cannot be rejected even at 10% critical value. In this thesis, to measure the all time series are strictly stationary, the author requires all variables can be rejected at 1% critical value. So all variables are non-stationary at level. After first different, all variables' test statistic is clearly smaller than the 1% critical value of relevant null distribution, the null hypothesis can be rejected. The statistical output of stationary test suggests each time series are stationary. Overnight interbank offered rate, Shanghai Composite index and Shenzhen Composite index are stationary at first difference.

There is a necessary condition of test for a long term relationship in time series is that the variables are integrated of order one, the series are stationary in first difference, so the results also suggest the those two sets time series are satisfactory for performing test for a long term relationship – co-integration test.

3.2.3. Lag selection

Table 3 and Table 4 present the likelihood ratio (LR) tests to determine the lag length of the VAR and VECM. The selection of lag order is determined by final prediction error (FPE); Akaike's information criterion (AIC); Schwarz's Bayesian information criterion (SBIC) and the Hannan and Quinn information criterion (HQIC). The output of lag selection of Shanghai stock index shown in table 3, it is clearly indicating the most appropriated lag length is 3 lags, it suggests that the estimate VAR/ VECM model with 3 order lags. The same result of Shenzhen stock index as shown in table 4, it is also indicating the most appropriated lag length is 3 lags, suggesting that the estimate VAR/VECM model model with 3 order lags.

Table 3. The output of lag selection of Shanghai stock index

| lag | LL | LR | df | p | FPE | AIC | HQIC | SBIC |
|-----|----------|---------|----|-------|----------|-----------|-----------|-----------|
| 0 | -1594.54 | | | | .029141 | 2.14014 | 2.14279 | 2.14725 |
| 1 | 3561.09 | 10311 | 4 | 0.000 | .000029 | -4.76554 | -4.75759 | -4.74419* |
| 2 | 3573.59 | 25.003 | 4 | 0.000 | .000029 | -4.77694 | -4.76368 | -4.74136 |
| 3 | 3582.69 | 18.191 | 4 | 0.001 | .000029* | -4.78377* | -4.76521* | -4.73396 |
| 4 | 3584.06 | 2.7347 | 4 | 0.603 | .000029 | -4.78024 | -4.75638 | -4.7162 |
| 5 | 3584.23 | .3423 | 4 | 0.987 | .000029 | -4.77511 | -4.74594 | -4.69684 |
| 6 | 3588.99 | 9.5151* | 4 | 0.049 | .000029 | -4.77612 | -4.74165 | -4.68362 |
| 7 | 3591.77 | 5.5745 | 4 | 0.233 | .000029 | -4.77449 | -4.73472 | -4.66777 |

Source: Drawn by the author

Table 4. The output of lag selection of Shenzhen stock index

| lag | LL | LR | df | p | FPE | AIC | HQIC | SBIC |
|-----|----------|---------|----|-------|----------|-----------|-----------|-----------|
| 0 | -1958.62 | | | | .047474 | 2.62818 | 2.63083 | 2.63529 |
| 1 | 3285.95 | 10489 | 4 | 0.000 | .000042 | -4.39671 | -4.38876 | -4.37537* |
| 2 | 3296.68 | 21.462 | 4 | 0.000 | .000042 | -4.40573 | -4.39248* | -4.37016 |
| 3 | 3303.66 | 13.961* | 4 | 0.007 | .000042* | -4.40973* | -4.39117 | -4.35992 |
| 4 | 3306.53 | 5.7421 | 4 | 0.219 | .000042 | -4.40822 | -4.38435 | -4.34418 |
| 5 | 3307.19 | 1.3193 | 4 | 0.858 | .000042 | -4.40374 | -4.37457 | -4.32547 |
| 6 | 3311.9 | 9.4219 | 4 | 0.051 | .000042 | -4.40469 | -4.37022 | -4.31219 |
| 7 | 3316.27 | 8.7379 | 4 | 0.068 | .000042 | -4.40519 | -4.36542 | -4.29846 |

Source: Drawn by the author

3.2.4. Co-integration test

This co-integration test is used for testing of the long-term equilibrium co-integration relationships among the series. It is based on the trace test to determine the number of co-integrating vectors. The null hypotheses are following:

$$H_0 : r \leq 0$$

$$\text{or } H_0 : r \leq 1$$

or $H_0 : r \leq 2$

Table 5, Results of Johansen trace tests for co-integration

| Shanghai Stock Exchange | | | |
|-------------------------|------------|-----------------|-------------------|
| Maximum rank | Eigenvalue | Trace Statistic | 1% Critical Value |
| 0 | | 70.164 | 20.04 |
| 1 | 0.04342 | 3.7047 | 6.65 |
| 2 | 0.00247 | | |
| Shenzhen Stock Exchange | | | |
| 0 | | 62.7423 | 29.04 |
| 1 | 0.03829 | 4.2906 | 6.65 |
| 2 | 0.00286 | | |

Source: Drawn by the author

The result of co-integration test shown in table 5, in Shanghai Stock Exchange, the trace statistic of null hypotheses $H_0 : r = 0$ is 70.164, which is bigger than critical value of 20.04 at 1% significance level, thus it should reject the null hypotheses of no co-integration $H_0 : r = 0$. The trace statistic of null hypotheses $H_0 : r \leq 1$ is 3.7047, which is smaller than 20.04 of 1% critical value, it cannot reject the null hypotheses of the system contains at most one co-integrating vector. In Shenzhen Stock Exchange, the result of co-integration test shows the same result as Shanghai Stock Exchange, the null hypotheses $H_0 : r = 0$ can be rejected, because of trace statistic is 62.7423, which is bigger than critical value of 20.04 at 1% significance level. The trace statistic of null hypotheses $H_0 : r \leq 1$ is 4.2906, which is smaller than 20.04 of 1% critical value, so it cannot be rejected.

Overall, the trace test result indicates that there exists heteroscedastic co-integrating relationship between overnight offered rate and stock index in two stock markets, one co-integrating vector at 1% critical value in both stock exchanges. The results suggest there exist long-term relationship between interest rate and stock price, and they will achieve long term equilibrium, which implies that, the stock index maintains a stable equilibrium with overnight offered rate in the long term for the entire period of the study.

3.2.5. Granger Causality Test

Table 6. Results of Granger Causality Test

| Cause variable | Prob>chi2 | Null hypothesis | The result suggests |
|---|-----------|---|---------------------|
| Shanghai Stock Exchange | | | |
| Overnight (Shanghai interbank offered rate) | 0.000 | overnight does not Granger-cause lnshanghai | Reject |
| lnshanghai (log Shanghai Composite index) | 0.002 | lnshanghai does not Granger-cause overnight | Reject |
| Shenzhen Stock Exchange | | | |
| Overnight (Shanghai interbank offered rate) | 0.002 | overnight does not Granger-cause lnshenzhen | Reject |
| lnshenzhen (log Shenzhen Composite index) | 0.001 | lnshenzhen does not Granger-cause overnight | Reject |

Source: Drawn by the author

The results as shown in table 5, in each stock exchanges, p-value according to chi-square distribution shows that all sets are statistic significant, it suggests rejecting the null hypothesis, Therefore, the results indicate that overnight offered rate Granger causes stock index, and stock index Granger causes overnight offered rate, which imply that past value of interest rate significantly contribute to the prediction of current value of stock price, meanwhile past value of stock price significantly contribute to the prediction of current value overnight offered rate. On the other hand, the results clearly indicated that interest rate and stock are bi-directional causality. The results suggest that overnight offered rate and stock index have a high correlation, they are closely connected to each other, and also fully reflect that overnight offered rate and stock index can forecast each other in both stock exchanges.

3.2.6. Vector error correction model (VECM)

According to the results of co-integration test, there exist one co-integrating vector have been examined, in this step, the author uses vector error correction model (VECM) to study short-term dynamic linkage.

The VECM equation regressions of Shanghai Stock Exchange

$$\begin{aligned} \Delta \ln shanghai_t = & -0.00336 ce1 + 0.0123 \Delta \ln shanghai_{t-1} + 0.0003 \Delta \ln shanghai_{t-2} \\ & (-3.41) \quad (0.47) \quad (0.01) \\ & + 0.002 \Delta overnight_{t-1} + 0.0016 \Delta overnight_{t-2} + 0.00028 \\ & (0.27) \quad (1.92) \quad (0.82) \end{aligned} \quad (3.4)$$

$$\begin{aligned} \Delta overnight_t = & -0.1963 ce1 - 2.2929 \Delta \ln shanghai_{t-1} + 1.5167 \Delta \ln shanghai_{t-2} \\ & (-6.65) \quad (-2.93) \quad (1.94) \\ & + 0.1086 \Delta overnight_{t-1} - 0.0862 \Delta overnight_{t-2} - 4.83e06 \\ & (4.23) \quad (-3.35) \quad (0) \end{aligned} \quad (3.5)$$

Where $ce1 = \ln shanghai + 0.3148 overnight - 8.6058$ it denotes the error correction term, the statistic outputs show that the error correction term is statistical significance at 1%, and it also indicates negative relationship between overnight offered rate and stock index. The error correction coefficient is negative, indicating that the adjustment mechanism of the reverse does exist. In the equation of $\Delta \ln shanghai$ (3.4), the coefficient of the error correction term is -0.0036, it suggests that the system correct its short term disequilibrium to wards the long term equilibrium by 0.3% per day; in the equation of $\Delta overnight$ (3.5), the coefficient of the error correction term is -0.1963, it suggests that the system correct its short term disequilibrium towards the long term equilibrium by 19.63% per day, which implies that the system need time to correct its short term disequilibrium towards the long term equilibrium.

As the above two equations with varying statistical significance level for the coefficients, in the case of the equation of $\Delta \ln shanghai$ (3.4), most of coefficients are statistically insignificant, only coefficient of error correction term found to be statistically significant, the sigh for 4 explanatories coefficient all positive, it means overnight offered rate and stock index at first and second lag are positive impact on current value of stock index, however, none of coefficients of them is statistically significant, so it suggests that in Shanghai Stock Exchange, overnight offered rate and stock index at first and second lag can not explain current stock index in short term.

For the equation of $\Delta overnight$ (3.5), most of coefficients are statistically significant, which imply of stock price at first lag is negative affect on current value of interest rate in short term. Thus, interest rate at first lag is positive impact on current value of interest rate, and interest rate at second lag are positive impact on current value of interest rate in short term. Interest rate at first lag has larger effect on the current value of interest.

The VECM equation regressions of Shenzhen Stock Exchange

$$\begin{aligned} \Delta \ln shenzhen_t = & -0.00139 ce1 + 0.03762 \Delta \ln shanghai_{t-1} - 0.01146 \Delta \ln shanghai_{t-2} \\ & + 0.00159 \Delta overnight_{t-1} - 0.0014 \Delta overnight_{t-2} + 0.0003 \end{aligned} \quad (3.6)$$

(-1.69)
(1.45)
(0.44)
(1.55)
(-1.39)
(0.76)

$$\begin{aligned} \Delta \ln overnight_t = & -0.1396 ce1 + 0.7584 \Delta \ln shanghai_{t-1} - 0.0127 \Delta \ln shanghai_{t-2} \\ & + 0.1053 \Delta overnight_{t-1} - 0.0842 \Delta overnight_{t-2} - 3.24e05 \end{aligned} \quad (3.7)$$

(-6.62)
(1.17)
(0.02)
(4.10)
(-3.42)
(0)

Where $ce1 = \ln shenzhen + 0.439 overnight - 10.3036$ it denotes error correction term, the statistic outputs show that the statistical significance of the error correction term, and it indicates negative relationship between overnight offered rate and stock index. The error correction coefficient is negative, indicating that there exists adjustment mechanism of the reverse. In the equation of $\Delta \ln shenzhen_t$ (3.6), the coefficient of the error correction term is not statistically significant in this equation, but it close to significant level, consider error correction term is statistical significance at the 1%, so it also implies that the adjustment mechanism does exist, the coefficient of the error correction is -0.00139 which suggests that the system will take a long time for to corrects its short term disequilibrium to long term equilibrium state following a shock. The equation of $\Delta overnight$ (3.7), the coefficient of the error correction term is 0.1369, it less than one, it also suggests that the system corrects its short term disequilibrium to wards the long term equilibrium by 0.1360% per day.

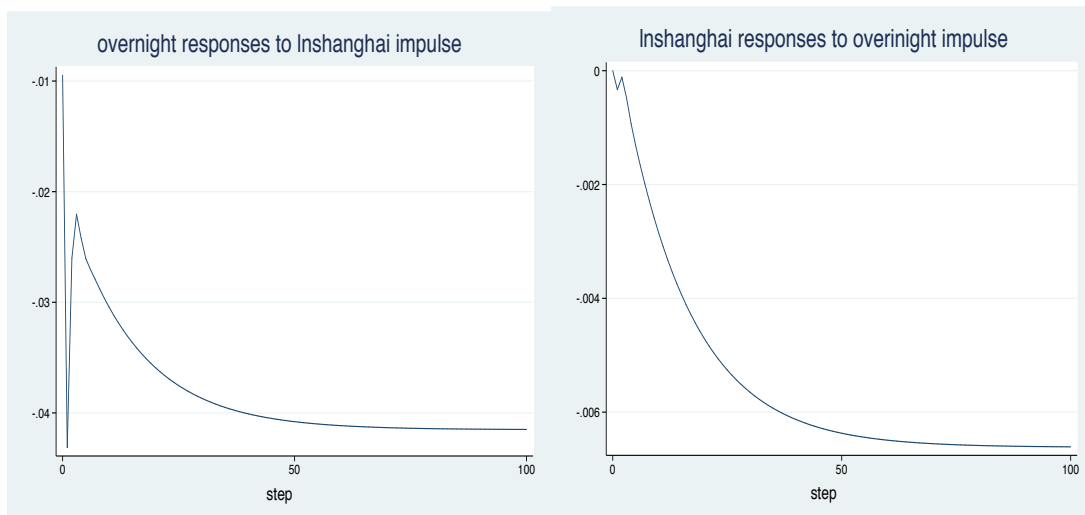
For the equation of $\Delta \ln shenzhen_t$ (3.6), none coefficients of explanatory are statistically significant, which implies of stock index and overnight offered rate at first lag and second lag are barely effect on current value of stock index in short term; the equation of $\Delta overnight_t$ (3.7) only show that overnight offered rate at first lag and second lag and error correction term are statistically significant, it suggests that overnight offered rate at first and

second lag are able to affect the current value of overnight offered rate, the stock index at first and second lag are not able to impact on current value of interest rate.

Overall, both stock exchanges have similar output, in short term. In both stock exchanges, the error correction terms are statistically significant, and the sign of error correction coefficient is negative, indicating that the adjustment mechanism of the reverse does exist. It suggest that the negative relationship between overnight offered rate and stock index in long term, this also confirms the finding in Johansen co-integration test presented previously; however, the speed of adjustment to equilibrium is relatively slow in all equations, which in indicator of weak-form of efficiency in Shanghai and Shenzhen Stock Exchange. And also suggests that there is little effect relation between overnight offered rate and stock index in short term. The short-term dynamic relationship of the model will be analyzed by examining the following impulse response functions.

3.2.7. The impulse response function

Two sets of impulse response functions were computed in the study, one set illustrates a generalized innovation of the overnight offered rate on stock index and the other illustrates the generalized innovation in the stock index on overnight offered rate.



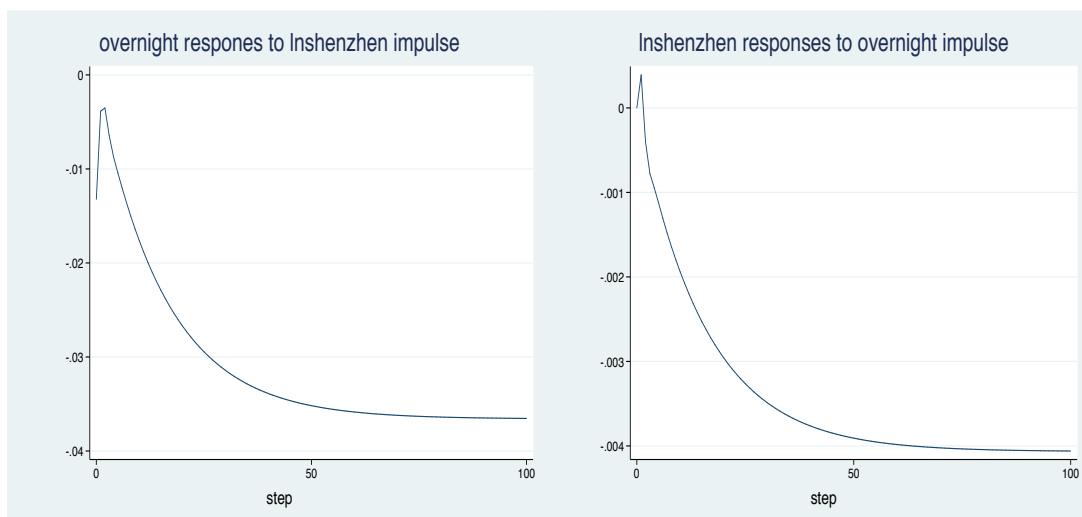


Figure 8. The output of impulse responses analysis

Source: Drawn by the author

As the results shown in figure 7, basically, every response is negative responses, and the effect will not disappear. After about 50 days surge with a tremendous response and they remain substantial in the long term, all responses do not appear to return to their baseline, once the responses achieve a certain level, the degree of responses will remain around that certain level, this result is supported by theory of negative relationship between interest rate and stock price, and also explain the results of regression of VECM equations.

Interest rate responses to shanghai stock index impulse

The results of the impulse response function show a negative effect on overnight offered rate from a shock to stock index at each time responsive period. At the beginning, it shows big fluctuation, the negative effect is rapidly increasing, but it decreases immediately, then gradually increase negative effect, until about 50 days, the response remain substantial in the long term. Which implies that interest rate is sensitive to stock index change.

Interest rate responses to shenzhen stock index impulse

The results of the impulse response function also show a negative effect on interest rate from a shock to stock index at all time responsive period. At the first days, the negative effect to

overnight offered rate is gradually decrease, after reached to the lowest level, then it starts to smoothly increase negative effect, then tends to be stabilized.

Shenzhen stock index responses to Interest rate impulse

The results show that the response of Shenzhen stock index is negative at almost responsive period. At the first day, a positive effect on stock index after receiving a shock of interest rate. But the second day, the positive effect disappears, the negative effect appears, and gradually increase, about 50days, the response will remain no change.

Shanghai stock index responses to Interest rate impulse

The results show negative impact in shanghai stock index at all examine period. Stock index response immediately followed after a shock in overnight offered rate, it gradually increases negative effect and then tends to stabilize.

Overall, the results of impulse responses function does not show much fluctuations, at the beginning the effect is small and it exhibits an smoothly increase negative effect, those responses will not disappear, and also not back to baseline, about received shock 50 days, the effects trend to be stabilized and remain substantial at a negative certain level in the long term. These results are following the theory, the negative relationship between stock price and interest rate; results here confirm the VECM estimates, there is little effect relation between overnight offered rate and stock index in short term, and stable negative relationship between them. Meanwhile, the results also confirm the results of Granger causality test, overnight offered rate and stock index have a high correlation, they are closely connected to each other, and also fully reflect that overnight offered rate and stock index can influence each other in both stock exchanges.

3.2.8. Findings

Based on event study and the statistic outputs above, the results of empirical study supplies supply a series of useful information for the research. The results I have received coincide with the results of the scholars who did similar assessment before.

Overall, the results of Shanghai Stock Exchange and Shenzhen stock change are same, as the previous Studies, many researchers also mention that both markets (Shanghai and Shenzhen) have a similar way to respond to change in macroeconomic variables and regulation.

According to the results of co-integration test and the regression of vector error correction model (VECM), which indicate a long-term relationship among the series, and it has been identified a negative relationship between overnight offered rate and stock index. These results are consistent with the earlier studies, such as Jawaid and Uihap (2012), Liu and Shrestha (2008). The negative sign follow the theory precisely, as discussed in the literature reviews, interest rate can influence the level of corporate profits, future cash flow and dividends payments, which in turn influence the investors' investment behavior. When interest rate increases, the stock price will be dampened. Which is negative relationship between interest rate and stock price.

Granger causality test suggests overnight offered rate and stock index are bi-directional causality, which implies that past value of overnight offered rate can affect current value of stock index, and also past value of stock index can affect current value of overnight offered rate, on the other hand, both series can predict each other well.

In short term, the equations of VECM indicate that the stock index cannot make a timely adjustment to overnight offered rate change. There is less effect relation between overnight offered rate and stock index in short term The same results are found by Wang and Gong's study (2006). This result also confirms event study result. The results of impulse responses functions suggest that stock index responses negatively to overnight offered rate impulse, and overnight offered rate responses negatively to stock index impulse. Both responses are progressively enhancing, about 50 days after impulse, the negative responses will remain substantial in the long term.

In summary, all results indicated that interest rate and stock price have the significant relationship of interaction, and it is a negative and long-term relationship. In short term the stock price cannot make a timely adjustment to interest rate change, but it has the certain sensitivity effect, it also indicates that China's stock markets in week form efficient market, the stock price cannot make adjustment of interest rate change fast and accurately.

CONCLUSIONS

Previous part analyzed dynamic linkages between stock index and overnight interbank offered rate based on two stock exchanges in China. Though analyzing the collected data and considering the empirical study outputs the research questions were answered, and the research aim is achieved.

This study uses the high frequency daily data as sample to study the relationship between interest rate and stock price, the daily data covering January 2009 to December 2014 obtained from Shanghai and Shenzhen Stock Exchange, and Shanghai Interbank Offered Rate official website. As representative of stock price, Shanghai Stock Exchange Composite index and Shenzhen Composite index are used; Overnight Shanghai Interbank Offered Rate is presented as interest rate.

The author has considered the empirical methodology included event study and econometrics evidence.

Event study is performed the study background, and examine the stock price responses to 8 times interest rate adjustments events. The results showed that Shenzhen and Shanghai stock indexes were performing irregular fluctuations; the trends are not following the theory during the 7 days before, 7 days after the day announcement of adjustment interest rate.

The econometrics evidence is based on vector autoregressive (VAR) and Vector error correction model (VECM), by using Phillips-Perron (PP) test, Johansen co-integration test, Granger causality test together with the impulse-response functions analysis to examine the short term and long term relationship between interest rate and stock price.

Phillips-Perron (PP) test is used to examine the unit roots of the involved variables, two stock exchanges got the same result, the result indicated that time series are not stationary at level.

After finding the unit roots, the author proceeded with Johansen co-integration tests to find whether there are any long and short-term relationships. The test indicates that there exists a long-term equilibrium relationship between the stock price and interest rate in both

stock exchanges. The VECM suggests that the negative relationship between stock price and interest rate, and there is little effect relation between interest rate and stock price in short term.

The results of Granger causality test implies that interest rate and stock price are bi-directional causality, past value of interest rate can effect on current value of stock price, and also last value of stock price can effect on current value of interest rate, on the other hand, both series can predict each other well.

Impulse response functions, which investigate the short-term dynamic linkages between the stock price and interest rate, indicate that the negative responses of stock price to interest rate shocks, and also negative responses of interest rate to stock price shocks. The responses will not disappear, both responses exhibit a smoothly downward trend, remain substantial at a negative certain level in the long term.

Overall, in short term, there is little effect relation between interest rate and stock price, stock price has the certain sensitivity for interest rate adjustment, but the trend of stock price does not follow the theory; in long term, interest rate and stock price have the significant negative relationship of interaction.

Due to the limit of time and resources, the author could not do an in-depth investigation of relationship between stock price and interest rate. The thesis studied of relationship between overnight interbank offered rate and stock index. In the future the author may study of the relationship between other macroeconomic factors and stock price, aspects to get more comprehensive view of dynamic linkages between stock price and macroeconomic variables.

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APPENDICES

Appendix 1. The results of unit root test-Overnight offered rate.

Unit root test at level

Phillips-Perron test for unit root Number of obs = **1498**
Newey-West lags = **7**

| Test Statistic | Interpolated Dickey-Fuller | | | |
|-------------------|----------------------------|----------------------|-----------------------|---------------|
| | 1% Critical Value | 5% Critical Value | 10% Critical Value | |
| Z(rho) | -12.528 | -13.800 | -8.100 | -5.700 |
| Z(t) | -2.437 | -2.580 | -1.950 | -1.620 |

Unit root test at first difference level

Phillips-Perron test for unit root Number of obs = **1497**
Newey-West lags = **7**

| Test Statistic | Interpolated Dickey-Fuller | | | |
|-------------------|----------------------------|----------------------|-----------------------|---------------|
| | 1% Critical Value | 5% Critical Value | 10% Critical Value | |
| Z(rho) | -1165.252 | -13.800 | -8.100 | -5.700 |
| Z(t) | -36.255 | -2.580 | -1.950 | -1.620 |

Appendix4. The results of Johansen's co-integration test- Shanghai Stock Exchange

Johansen tests for cointegration

Trend: constant

Number of obs = **1497**

Sample: **3 - 1499**

Lags = **2**

| maximum | | | | trace | 5% |
|----------|-----------|------------------|----------------|----------------|--------------|
| rank | parms | LL | eigenvalue | statistic | critical |
| 0 | 6 | 3553.8085 | . | 70.1640 | 15.41 |
| 1 | 9 | 3587.0381 | 0.04342 | 3.7047* | 3.76 |
| 2 | 10 | 3588.8904 | 0.00247 | | |

Appendix 5. The results of Johansen's co-integration test- Shenzhen Stock Exchange

| Johansen tests for cointegration | | | | | | |
|----------------------------------|-----------|------------------|-----------------------------|----------------|--------------|--|
| Trend: constant | | | Number of obs = 1497 | | | |
| Sample: 3 - 1499 | | | Lags = 2 | | | |
| <hr/> | | | | | | |
| | | | | | 1% | |
| maximum | | | | trace | critical | |
| rank | parms | LL | eigenvalue | statistic | value | |
| 0 | 6 | 3280.5769 | . | 62.7423 | 20.04 | |
| 1 | 9 | 3309.8027 | 0.03829 | 4.2906* | 6.65 | |
| 2 | 10 | 3311.948 | 0.00286 | | | |

Appendix6. The results of Granger causality test-Shanghai Stock Exchange

Granger causality Wald tests

| Equation | Excluded | chi2 | df | Prob > chi2 |
|------------|------------|---------------|----------|--------------|
| overnight | lnshanghai | 9.6477 | 1 | 0.002 |
| overnight | ALL | 9.6477 | 1 | 0.002 |
| lnshanghai | overnight | 27.646 | 1 | 0.000 |
| lnshanghai | ALL | 27.646 | 1 | 0.000 |

Appendix7. The results of Granger causality test-Shenzhen Stock Exchange

Granger causality Wald tests

| Equation | Excluded | chi2 | df | Prob > chi2 |
|------------|------------|---------------|----------|--------------|
| overnight | lnshenzhen | 11.14 | 1 | 0.001 |
| overnight | ALL | 11.14 | 1 | 0.001 |
| lnshenzhen | overnight | 9.2531 | 1 | 0.002 |
| lnshenzhen | ALL | 9.2531 | 1 | 0.002 |