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RESEARCH ARTICLE

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Impact of Asset Price Fluctuation on China's Monetary Policy: An Empirical Analysis Based on Quarterly Data, 1994–2006

Abstract The strenuous fluctuation in global asset price in recent years has had a profound impact on the economic and social development of every country. An empirical analysis indicates that asset prices (the stock price index and real estate prices) are important endogenous variables affecting the interest rate reaction function of central bank monetary policy. With expected inflation as a given, each one percentage point rise in output gap will cause a 0.79 percentage point reduction in interest rates by the central bank and each one percentage point rise in real estate price will result in a 2.2 percentage point rise in interest rates. The stock price index does have an influence on the trends in monetary policy, but it is less salient than the impact of housing prices. We also show that monetary policy that employs asset price as an endogenous variable increases the central bank's control in seeking to attain its objectives. Therefore we suggest that the central bank should make asset price fluctuation an endogenous variable and incorporate it into its forward-looking interest rate rule, in order to facilitate the healthy development of China's markets for real estate, stocks and derivatives, energy and bulk commodities and maintain rapid, smooth, sustainable and harmonious economic development.

Keywords asset prices fluctuation, monetary policy, interest rate rule, Extended IS curve, Cointegration Test

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1 Introduction

Since the 1970s, the global capital market has seen a serious of risks and violent fluctuation of asset prices, which exert profound impacts on the economic and social developments of countries all over world. Among those it is Subprime Mortgage Crisis (SMC) in Wall Street in 2007 that eventually has evolved into a worldwide financial crisis. It can even be compared with the striking economic crisis of 1930s in terms of its direct and potential damage. The Wall Street SMC is just a typical representation of the crash of price bubbles of real estate in a number of countries and regions, which accompanied by dramatically drop of global stock prices and wide price fluctuation of international crude oil and other key raw materials. As to the stock market of China, although it has been unsurprising for its fluctuation since its launch, the fluctuation during last two years is still within a narrow range; it is accompanied by the fluctuation of real estate's price, which brings risk directly to financial security and economic development. What can be sure is that the wide fluctuation of asset price has played an important role in the formation and development of financial crisis.

Asset price fluctuation will exert structural influence on the supply of money, and change the conducting mechanism of monetary policy. Traditional conducting mechanism of monetary policy is based on the financial system with commercial banks as its core, and in such system the cost of bank lending and the supply-demand of money is the main conducting mechanism of monetary policy. Because of the rapid development of the stock market and the real estate market, they had become major variables in influencing the effects of the monetary policy. Asset price fluctuation, especially the crash of financial capital bubbles, has made a grave shock to the real economy, and then exerted impact on the ultimate target of the monetary policy. It can be seen that it is the inherent necessity to regulate asset prices for the central bank to reach its monetary policy objectives.

On the base of the monetary policy operation practices, the money supply has been taken as the intermediary goal of Chinese monetary policy. However, the capital structure changes and instable speed of money circulation caused by the capital market development has influenced the controllability and measurability of the central bank's money supply, and then the effectiveness of the monetary policy. On the other hand, the deepening of the integration degree of the money market and the capital market has created favorable conditions for interest policy to further play its role. The central bank can influence asset price by regulating the interest of money market so as to adjust macroeconomy. In realistic regulation, developed countries have taken the Taylor Rule or its mutant (modifications) intentionally or unintentionally as its benchmark to operate. At the moment, the central bank has not taken this as rule to regulate macroeconomy, but it is a tendency for monetary policy to act in accordance with some kind of rules.

Therefore, it is both theoretically and realistically important for us to test the application of Western well-developed monetary policy rules to China, and with this as the basis to make reasonable extension combining China's national conditions, and then to form interest reaction model of monetary policy employing asset price as its inherent factor, and to discuss the impact of asset price fluctuation on monetary policy, the central bank's effective regulation of the fluctuation of asset price which aims at maintaining the stable development of economy and society.

Foreign researches on the rules of monetary policy can be traced back as early as to Thomton (1802) and Fisher(1920). Thomton (1802) emphasized the mechanism of indirect money conduction: the change of money supply influences the interest rates of borrowing and lending, which further influences expenditure and inflation. Fisher (1920) proposed the famous Compensated Dollar Plan, and in 1945 proposed the rule of maintaining money stock per capita unchangeable and price stable, that is, central bank should expand the stock of money when price level is below than target level, and tighten the stock of money when price level is above target level. Simons (1948) raised the similar rule. For this reason, it is referred to as Fisher-Simons Price Level Rule in the literature. In 1960, Friedman raised the rule of fixed rate of money growth. Later, Taylor (1985) raised the rule of nominal GDP target and McCallum (1988) raised McCallum-Metzler base money rule. The rule which caused widespread concern of academy and administrative department and has great influence is Taylor Rule raised by Taylor (1993) and the rule of inflation target proposed by Svensson (1997).

Taylor Rule caused widespread concerns in academic circle. Scholars established the dynamic model of Taylor Rule, that is, lag interest reaction function and forward-looking interest reaction function. The former function demonstrates that money authority decides current interest rate level according to the inflation and output gap of previous period. The later one demonstrates that money authority's decision on interest rate mainly based on the expectation of future inflation and output gap, which means that the interest rate level is the function of expected inflation and expected output. In order to test the efficiency of interest responding function, economists carried out empirical researches on interest reaction function. For example, Taylor (1998) tested Taylor Rule using historical data of 1879–1914 and 1955–1997 in America, and reached the conclusion that responding function based on interest rate is an effective frame for the analysis of the effectiveness of monetary policy. According to this frame, sensitive interest rate policy is helpful for the stability of economy. Further more, analyzing the degree of diversity between the actual interest rate and the target interest rate, we can find the failures of monetary policy. Mehra (1999) estimated the reaction function of monetary policy of 1979–1997 in America by introducing expected inflation reflected by long-term bond interest into forward-looking model. In addition, a great number of literatures had explained researches on the extension of Taylor Rule.

Although Taylor Rule has very extensive application, it should be modified when it is applied into different economies in order to reflect the running characteristics of the particular economy. In 1997, Ball made a research on how to modify Taylor Rule, and believed that the change of exchange rate would exert temporary influence on inflation, so he suggested substituting interest rate with the weight of interest and exchange rate. Borio and Lowe (2002) thought that central bank should not only control the change of consumption price, but also the inflation of asset price. Bullard and Schaling (2002) suggested introducing the inflation of asset price into Taylor Rule directly.

In recent years, domestic scholars have carried on meaningful discussions on the rules of monetary policy operation. Xie and Luo (2002) firstly tested Taylor Rule by applying it to China's monetary policy, and drawed the conclusion that this rule can precisely measured the operation level of China's monetary policy. Zhao and Gao (2004) constructed the interest rule of stable monetary policy based on LWW Rule, which was more suitable for China's national conditions. Under considering standard Taylor Rule and the best monetary policy raised by Clarida (2002) in comprehensive way, Wang and Zou (2006) proposed the extensive Taylor Rule in the opening-up economic condition and made empirical test on Chinese monetary policy. To deal with the realistic situation of China, Yang and Wang (2006) have also made extension on Taylor Rule; they discussed the response of monetary policy to stock bubble by substituting interest rate with money supply. Through estimating non-liner responding function with media of optimal function, Zhao and Huang (2006) made empirical tests on non-liner characteristics of the impacts made by money monetary operation on the output gap and inflation. On this basis, they also examined the impact of non-liner responding rule aroused by non-liner preference on inflation.

The main objective of this paper is to examine the reaction system of monetary policy with asset price as its inherent factor, and to attempt to construct interest reaction model of monetary policy based on asset price in order to provide theoretical support and analytic framework for the effectively regulation of asset price for central bank, and for smoothening the dramatic and structural impact on economy and society aroused by the great fluctuation of asset price. To illuminate the issue more explicitly, we will place emphasis on two critical asset price factors: stock price and real estate price, while ignoring other asset price factors provisionally.

The structure of the following part of this paper is: 2. the assessment of the applicability of Taylor Rule and its extension in China; 3. the variables selection and data processing; 4. the test of inter-variables Granger Causal relationship and Cointegration relationship; 5. empirical estimation of the extension of the Phillips curve and IS curve after adding asset price; 6. establishing monetary policy interest rate reaction model after adding asset price, and empirical estimation for China; 7. conclusions and recommendations.

2 Taylor Rule, Extensions and Their Applications in China

In the 1980s, the U.S. Federal Reserve accepted the "Single Rule" of monetarism basically, to take money supply as the main method to adjust and control the macroeconomy. In the 1990s, "Balance Budget Law" had been passed in America, so the federal government could not stimulate economy any more by means of traditional fiscal policies such as enlarging expenses, reducing tax revenue and so on. The law considerably impaired the function that fiscal policies regulate the operation of macroeconomy, and monetary policy has become the significant tool that the government regulates the macroeconomy. Facing up to new phases, the U.S. Federal Reserve had decided to give up the monetary policy rules that had adjusted and controlled the operation of economy by adjusting monetary supply for more than 10 years, Adjusting the real interest rate will become the main method to regulate the macroeconomy. From then on, The Taylor Rule henceforth marches into the monetary policy research palace.

Taylor considered that policy rules were not always a fixed enactment of policy or a mechanical formula, the rule-based behavior is systematic (rather than random) in accordance with a plan to implement monetary policy. The expression of the original "Taylor Rule" is:

$$R_t = \overline{r} + \Delta p_t^a + \frac{1}{2}(\Delta p_t^a - \pi^*) + \frac{1}{2}\tilde{y}_t \tag{1}$$

where R_t is the short term nominal interest rate used as tool or target of policy by the central bank; $\overline{r}$ is the real equilibrium long term interest rate; Δp_t^a is the mean inflation rate at the nearest term (anticipated inflation rate); π^* is the inflation rate target of the central bank; and $\tilde{y}_t$ is the output gap.

In 1993, Taylor tested American data between 1985 and 1992. when he specified: $\overline{r}$ =2%, π^* =2%, while Δp_t^a was the average inflation rate of the former four quarters, and the potential output was fitted in a linear trend by logarithms of real GDP, therefore the model became to:

$$R_t = 2 + \Delta p_t^a + \frac{1}{2}(\Delta p_t^a - 2) + \frac{1}{2}\tilde{y}_t \qquad (2)$$

Taylor's study revealed that if full employment was realized in a economy, namely a zero output gap and the inflation rate was controlled at target values, that is, $\Delta p_t^a - \pi^* = 0$, and $R_t - \Delta p_t^a = \overline{r}$. Then, the economy would remain at an ideal state of stabilization and increasing growth. If the inflation rate was higher than the target of the Federal Reserve by one percent point, the interest rate should be increased 1.5 percentage point. If real output was lower than the potential output by 1 percent point, then the interest rate should be reduced 0.5 percentage point. This rule fits the practical operation of monetary policy made by the Federal Reserve perfectly. Only in 1987, when Federal Reserve reacted to the stock disaster, there had been a large deviation between the regular value and the actual value. It can be said that the Federal Reserve's monetary policy is operated in accordance with the Taylor Rule on the whole.

Taylor Rule has definite policy significance, namely that the nominal interest rate should conform to the changes of inflation rate in order to maintain stability of the real equilibrium interest rate. If the growth rate of output was higher than potential level, or the unemployment rate was below the natural rate of unemployment, or the expected inflation rate was over the target inflation rate, then the actual interest rate $R_t - \Delta p_t^a$ would deviate from the equilibrium real interest rate. Monetary authorities should adjust nominal interest rates, and guide the direction of real interest rates so that the real interest rates would restore balance to the actual level of the equilibrium interest rates. In the guidance of Taylor Rule, America had adjusted its monetary policies greatly and carried out smooth monetary policy, namely that monetary authorities used the real interest rate as media objective of monetary policy, and made real interest rate shift gradually in the same direction slightly by means of controlling short-term interest rate. When the economic operations fluctuated turbulently and policy needed to be shifted, monetary authorities changed the direction of real interest rate by means of adjusting short-term interest rate slightly, which sent specific policy signals to market, and then urged market to adjust itself spontaneously and regress reasonably.

Taylor Rule reflects the successes of the western countries' monetary policy practices perfectly. Therefore, the Rule has actually become to the accordance of monetary policy operation of the Federal Reserve, European Central Bank, Bank of England and Bank of Canada. The initial introduction of Taylor Rule was from the empirical analysis of the economic data, which, however, lacks of solid theoretical foundation. Thus, with Clarida (2000) as the representative of some economists transferred the direction of research to the modern economic theory model, and obtained the interest rate reaction function which was similar to

Taylor Rule through rigorous derivation of mathematical model. This laid theoretical basis for the practice of Taylor Rule.

Whether Taylor Rule and its extensions meet Chinese national conditions and are worthy of consideration, as well as how to make reference and amendment of the rule have always been among the domestic scholars' concerns. Domestic researchers have noticed that the prerequisites of Taylor Rule itself cannot be fully satisfied under the present Chinese financial system. In addition, deepening and improvement are needed in the respect of research methods and variable selection, as well as the model parameter estimation, etc.

The core of the Taylor Rule is to impact anticipation through interest rates, then to regulate the economy indirectly. Therefore, the political transmission mechanism only can be properly established within the countries with developed economy, perfect interest rate system, high marketization of interest rate and high market-sensitivity. Then the currency policies under the guidance of Taylor Rule can be successfully implemented. As for the countries with underdeveloped economy or strict interest rates regulation, the effect of Taylor Rule will be undoubtedly diminished. However, this does not affect people to carry out research and exploration on the practices of the rule. Though Chinese interest rate liberalization is still in its infancy, the structure and flexibility of the interest rate are not quite rational, the relatively stable actual balance of the interest rate has not been formed yet, and China has been implementing the "Managed Floating Exchange Rate System" in the respect of exchange rate, still the old financial system has been reformed for many years, interest rate liberalization and currency system are under development and perfection. The researches on Taylor Rule and its extensive influences in practice will play a guiding role in the further revolution of the financial system in our country.

3 Variables Selection and Data Processing

3.1 Calculation of Inflation Rate

The academic world has not reached the consensus at present about which variables would be encamped and how long inflation term would be chosen in Taylor Rule. Taylor (1993) measured inflation rate level through yearly Curtailment Index of GDP, and subsequently, other scholars adopted some other substituting price indexes. Kozicki compared Taylor Rule through four different methods to measure the United States' inflation level (yearly inflation rate and expected inflation rate). He measured yearly inflation rate by CPI, core CPI and Curtailment Index of GDP and measured expected inflation rate level by private department average anticipation. The conclusion revealed that there had been obviously different federal funds interest rates using different methods, and the differences scaled from 0.6% at minimum to 3.8% at maximum.

There are two methods to scale inflation rate at home, namely Consumer Price Index (CPI) and Retail Price Index (RPI). The greatest difference is that service prices are included in CPI. Thus, we choose CPI to scale inflation rate in this paper.

We calculate quarterly data of CPI by use of a moving average because CPI data were issued monthly in China, [1] and then we calculate inflation rate as follows:

$$\text{inflation rate} = (\text{quarterly CPI}-1)\times 100\%$$

Target inflation rate is calculated according to government report data between 1994 and 2006, and we choose average 4%. We substitute expected inflation rate by four quarterly average inflation rates in the future.

3.2 Calculation of Output and Output Gap

GDP and potential GDP are regarded as macroeconomic variables that influence liberalized interest rates and there had been indirect conduct relation among them. Hereinafter, we will measure synthesis Phillips curve in China by using output gap as an important variable. Therefore, this paper firstly offers the method to calculate output gap at first so as to establish base for the following empirical analysis.

We use the data source of GDP: *China Statistical Yearbook* and *People's Bank of China Statistical Report*. Quarterly GDP uses the same year accumulative total of the same quarter less the same year accumulative total of the former year. We transform nominal Quarterly GDP to real values in order to eliminate the influence of inflation. The formula is as follows:

$$\text{Real Quarterly GDP} = [\text{nominal Quarterly GDP} / (\text{CPI})] \times 100$$

Furthermore, we avoid seasonal influence in the analysis by X-11 method, and we have the real GDP in the end.

There are many methods for calculating potential GDP, such as Dummy Variable Method, Trend Method, Piecewise Linear Regression, Two Linear Regression Method, Filtering Method and Structure Method that is used by Capitol Hill Budget Office. There are differences with different methods. Kozicki and Sharon (1999) concluded that there were differences from 0.9 percent point to 2.4 percentage point in interest rate with different calculation

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[1] Before 2000, Chinese official only announced the monthly and yearly CPI that compared to the same time period of previous years. The monthly chain relative data were not available. Since 2000, the Economy Forecast Department of the National Information Center began to issue "China Data Analysis" and started to announce the CPI link from 2000 January.

methods.

Potential GDP is always a controversial topic in China because of the soft budget constraints for Chinese investment main bodies as well as the moral risk bestir caused by this. Therefore, there are many estimation methods in China.[2]

In this paper, we use linear trend methods that were used by Xie and Luo (2002) to estimate potential GDP for reference. There is a deficiency in Xie's data processing, that is they took nominal GDP as real GDP without seasonal and inflation adjust in their paper. In some other cases, although the data was processed with seasonal adjustment, they were not processed with eliminating inflation influence. In conclusion, in this paper, we made inflation adjust based on nominal GDP and seasonal adjust by X-11 method so as to overcome their shortcomings because GDP had been affected by season and inflation strongly.

We add three dummy variables in linear regression because the output level shows seasonal fluctuation strongly, as follows:

$$D_1 = \begin{cases} 1 & \text{first quarter} \\ 0 & \text{others} \end{cases}, \quad D_2 = \begin{cases} 1 & \text{second quarter} \\ 0 & \text{others} \end{cases}, \quad D_3 = \begin{cases} 1 & \text{third quarter} \\ 0 & \text{others} \end{cases}$$

Then, we make linear regression of real GDP, constant and dummy variables, and results are showed as follows:

$$\begin{aligned} \text{LN}GDP = {} & 9.600 + 0.027\,T - 0.445\,D_1 - 0.315\,D_2 - 0.301\,D_3 \qquad (3) \\ & (0.051)\ (0.001)\quad (0.053)\quad (0.052)\quad (0.054)\text{—S.E.} \end{aligned}$$

$$R^2 = 0.917,\ \text{adjusted}\ R^2 = 0.910,\ F(4, 50) = 124.131,\ D\text{W} = 1.050$$

Fig. 1 shows the real GDP and potential GDP between 1994Q1 and 2006Q2 (in the following, LN*GDP* denoted real GDP and LN*GDPF* denoted potential GDP). Fig. 2 shows the output gap (in the following, LN*GDPQK* denoted output gap). Specially, data in charts are processed with seasonal and inflation adjustment. Therefore, there are differences between the output gap we get and what was mentioned in the literatures above. In addition, we get different sensibility perceive between output gap and what was calculated with nominal GDP in literatures because CPI fluctuated strongly in China in the sample time period. Technically speaking, our processing results can reflect the intrinsic characteristics of the variables objectively. We also adopt HP filter to calculate output gap in this paper so as to ensure the reliability of data, as a result, we get the same output gap with what is calculated in this paper with linear trend method.

In the end, we also want to emphasize that our sample time period selection

[2] Song (1998) estimated potential GDP based on the capital and society laborer variables. Xie and Luo (2002) estimated potential GDP based on the time trend and dummy variables, etc.

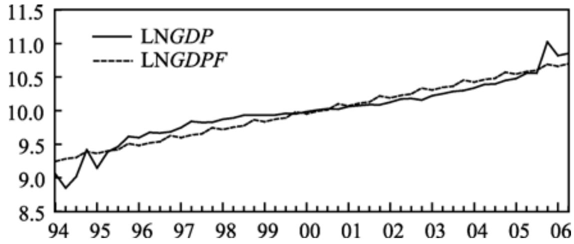

Fig. 1 Real GDP and Potential GDP

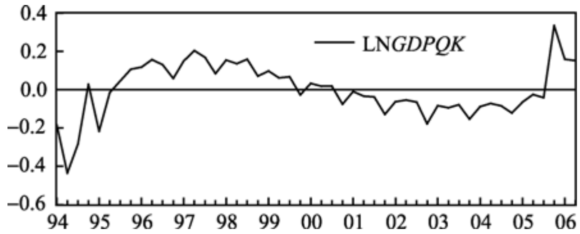

Fig. 2 Output Gap

was limited by Chinese statistical system. For example, there was only yearly GDP but no quarterly GDP in China before 1992. But then, there were considerable basic data of quarterly GDP through several years accumulation. In this paper, there were fifty groups of sample data between 1994Q1 and 2006Q2. These data conform to the technology requirements of statistical and model-building completely, which provides the powerful guarantee so as to build empirical fitness and backward-forward extend model. We only took 1994Q1 as our start point is because the house price indexes were not issued until that time in China.

3.3 Selection of Interest Rate and Calculation of Equilibrium Real Interest Rate

The market rate is a foundation for the entire interest rate system. It can serves as the price signal and coefficient of reference for central bank to decide the benchmark interest rate. The system of market rate is composed of deposit and lending rate, market rate of bond issuing, yield of bond in circulation market, China inter-bank offered rate (CHIBOR), repurchase rate in China, discount rate, market rate of bill and negotiable certificate of deposited. Interest rate of bond is the benchmark interest rate of financial market in developed market economy countries because of its flexible issuing rules, active secondary market and open-market operation of Central bank.

Although China has established the market economy frame basically, the market system and mechanism are imperfect. In recent years, after the reform of national debt market, the release mechanism of bonds gradually moved towards the marketability and the secondary markets obtained certain development. However, the secondary markets were insufficient to guide the marketability interest rate because the overall scale still was small. On the other hand, the inter-bank borrowing market in China has been developed since 1984. It can reflect the supply and demand conditions in money market. Thus, CHIBOR (China inter-bank offered rate) may be taken as the proxy variable of liberalized interest rate. We choose the seven day CHIBOR rate as proxy variable of liberalized interest rate.

During the data collection process, because of the chaos of inter-bank money market in 1990s and for the high quality of data, we use CHIBOR between 1993 and 1995, as reported from the financial center of Shanghai and we choose the seven day CHIBOR rate between 1996 and 2006 as benchmark interest rate of marketable rate, data from the *People's Bank of China statistical report* and the financial center of Shanghai.[3]

It is difficult to calculate the equilibrium real interest rate. The extension of Taylor Rule involves to the estimation of benchmark interest rate level. A typical Taylor Rule composed of the non-observed equilibrium real interest rate level and non-observed inflation target in most situations. There is a method to solve this problem in the international world, that is, we suppose one variable value at first among them, and then we estimated another one. Kozicki and Sharon (1999) took the equilibrium real interest rate as the difference between average federal funds rate and average inflation rate. In this paper, we take the difference between average federal funds rate and average inflation rate as the equilibrium real interest rate.

3.4 Selection and Calculation of Real Estate Price Index

The validity of the real estate price index establishment method lies in the data quality as well as the data appropriateness. At present, there are commonly used index types in the overseas real estate research such as character price index, repetition transaction price index and synthesis index of these two. The empirical study of Henry (1995) revealed that there have not been a perfect price index and there have been some deficiencies for each price index.

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[3] Because of the limits of the data resources, the weighting interest rates between 1994 and 1995 were calculated by all term interest rate weighting of Shanghai Financing Center, and we selected seven day CHIBOR between 1996 and 2006. Although the interest rate term does not match in two time intervals, but because various term interest rate differences are not large in the Shanghai Financing Center, there are little influence on model building.(Xie and Luo, 2002)

Generally, the real estate price uses two kinds of indexes: Price index and actual average selling price. There are more than ten real estate price indexes in China, such as China Real Estate Index, National 35 big or media-sized cities real estate price index, Xi'an 40 index and Shanghai real estate price index, etc. Although China Real Estate Index is representative in the multitudinous indices, it is issued officially lately. Therefore we select the National 35 big or media-sized cities real estate price index as the Chinese house price index proxy variable. The data come from *China Statistics Yearbook*, *China Real estate market Yearbook*, Wind and so on. In the end, we average the four months data within each quarter to get quarterly data.

3.5 Selection and Calculation of Stock Market Price Index

We select the close prices of Shanghai Stock Exchange Composite Index (Shanghai Composite Index) to reflect the price level of Shanghai stock market and close prices of Shenzhen Stock Exchange Component Index (Shenzhen Component Index) to reflect the price level of Shenzhen stock. Furthermore, we transform daily data to quarterly data.

4 Granger Causality Test and Cointegration Test

4.1 Unit Root Test

To study the series' stability, we use ADF test and PP test to determine weather the liberalized interest rate (LN*I*), the difference between expected inflation rate and the target inflation rate (*HD*), Output gap (LN*GDPQK*), Shanghai Composite Index (LN*SHI*), Shenzhen Component Index (LN*SZI*), House Price Index (LN*HI*) have unit roots, where "LN" is the symbol of logarithm. Test results showed that the variables are all non-stationary series in the sample time period from 1994Q1 to 2006Q2.[4]

4.2 Granger Causality Test

Table 1 lists the results of Granger test among interest rate(LN*I*) and the difference between expected inflation rate and the target inflation rate (*HD*), Output gap (LN*GDPQK*), Shanghai Composite Index (LN*SHI*), Shenzhen Component Index (LN*SZI*), House Price Index (LN*HI*) . Among the results, the best test lag order 1 based on AIC and SC criteria. Test results are as follows:

[4] Test results were abbreviated because of limitation of paper space. You can get them through email to me if you need them.

Table 1 Granger Causality Test Results

Null hypothesis	Sample capacity	*F*-statistic	*P*-value
HD dose not the Granger cause of LN*I*	49	10.139	0.003
LN*I* dose not the Granger cause of *HD*		11.026	0.002
LN*GDPQK* dose not the Granger cause of LN*I*	49	0.001	0.973
LN*I* dose not the Granger cause of LN*GDPQK*		0.731	0.397
LN*SHI* dose not the Granger cause of LN*I*	49	2.826	0.099
LN*I* dose not the Granger cause of LN*SHI*		0.412	0.524
LN*SZI* dose not the Granger cause of LN*I*	49	5.598	0.022
LN*I* dose not the Granger cause of LN*SZI*		0.003	0.953
LN*HI* dose not the Granger cause of LN*I*	49	7.190	0.010
LN*I* dose not the Granger cause of LN*HI*		3.198	0.080

We can see that the difference between expected inflation rate and target inflation rate, the Shanghai and Shenzhen stock index, House Price Index are all the Granger causes of Chinese liberalized interest rates. The probability of guidance of House Price Index to liberalized interest rate is larger than that of Shanghai and Shenzhen Stock Price Index, and the probability of guidance of Output gap to liberalized interest rate is also small. Therefore we can come to the conclusion that the guidance effect of the asset prices to the interest rates is significant.

4.3 Cointegration Test

Since the foundment of the Cointegration Theory in the early 1980s by Granger, it has developed rapidly and become a normative approach of processing non-stationary time series data. The technology of cointegration relationship test and modeling is improving. In this paper, we employ the Johansen Maximum Likelihood Estimation method which is widely used in the international academia.

Cointegration test is very sensitive to the lags and the improper value of lags may result in "pseudo cointegration", so it is necessary to determine the reasonable value of lags p. We use the AIC and SC criteria to choose the value of p, that means we select the value of p when both AIC and SC are minimum at the same time. After determining the value of p, we examine whether there are constant term and (or) time trend in the cointegration relationship. Then we do cointegration test on other data. Ultimately we got the correct cointegration relationship.

After these steps, we got the long-term cointegration relationship between liberalized interest rate (LN*I*) and the difference between expected inflation rate and the target inflation rate (HD), the Shanghai and Shenzhen Stock Price Index (LN*SHI*, LN*SZI*), Output gap (LN*GDPQK*), House Price Index (LN*HI*) (the best value of lag is 1; SE denotes the standard error, it is the same below):

$$\begin{aligned}\mathrm{LN}I = & -0.060\,HD + 4.700\,\mathrm{LN}GDPQK - 2.690\,\mathrm{LN}SHI + 1.010\,\mathrm{LN}SZI + 15.710\,\mathrm{LN}HI \\ & \quad (0.024) \qquad (1.644) \qquad (0.758) \qquad (0.477) \qquad (4.521) \\ & +0.010@\mathrm{TREND}(94{:}2) - 61.410 \\ & \quad (0.016) \qquad (4.314) \qquad \text{—S. E.}\end{aligned} \tag{4}$$

As can be seen that the House Price Index (LN*HI*) exerts the largest impact on liberalized interest rate; Output gap and the Shanghai Composite Index have moderate impact on liberalized interest rates and Shenzhen Component Index have less impact than that of Shanghai Composite Index. Taking into account the correlation between Stock Price indexes, we deleted the Shenzhen Component Index, and test again. Then we selected 1 as the best lag based on SC and AIC Rules, the corresponding Cointegration equation that had the largest characteristic root as follows：

$$\begin{aligned}\mathrm{LN}I = & \,39.170 + 0.320\,HD + 0.690\,\mathrm{LN}GDPQK - 0.720\,\mathrm{LN}SHI - 7.000\,\mathrm{LN}HI \\ & (3.894) \quad (0.094) \qquad (0.958) \qquad (0.229) \qquad (4.212) \\ & +0.030@\mathrm{TREND}\,(94{:}2) \\ & \quad (0.014) \qquad \text{—S. E.}\end{aligned} \tag{5}$$

Cointegration equation shows that, in the long run, the reaction coefficient of the difference between expected inflation rate and target inflation rate to the liberalized interest rate is 0.320; the response coefficient of the output gap to the liberalized interest rate is 0.690, the response coefficient of the Shanghai Composite Index to the liberalized interest rate is −0.720, and the response coefficient of the housing price to the liberalized interest rate is −7.000.

Fig. 3 offers the actual value (Actual), fitted value (Fitted) and residuals (Residual) of the long-term cointegration equation.

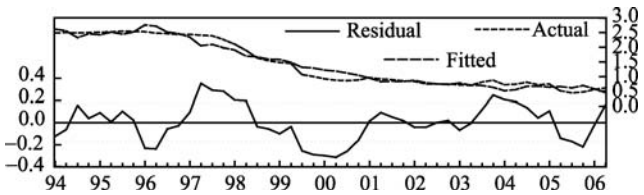

Fig. 3 Actual Value, Fitted Value and Residuals of the Long-term Cointegration Equation

From the above, we can come to the conclusion that the impact of asset prices on the liberalized interest rate is significant, and which will be the foundation of our following exploration of the influence of asset prices to the response function of liberalized interest rate, establishing the extend marketable interest rate rules including asset price, and exploring the transmission mechanism.

5 The Empirical Research of Extended Phillips Curve and IS Curve Employed Asset Prices: Situation in China

5.1 The Empirical Research of Extended Phillips Curve: Situation in China

First of all, we take GDP gap as an important exogenous variable which affect the Phillips curve instead using the Phillips curve to determine the value of GDP gap in this paper. Here we use GDP gap value estimated through linear trend method previously as the sample observation of GDP gap for statistics and modeling and to fit the Phillips curve. At present, this method is a very standardized empirical method, which is accepted by experts from home and abroad. It must be noted that this approach is not an innovation of this paper; the innovation of this paper is that we introduce China's asset prices to the Phillips curve and use the sample data in China to estimate and test.

Rudebusch and Svensson researched the economic growth model of Great Britain and described the characteristics of the British output gap. The model is composed of IS curve which represents the output gap and the Phillips curve which describes the dynamics inflation.

Because a pure forward-looking model is inconsistent with the actual inflation and output data, Clarida, Galí and Gertler (1999) proposed integrated IS curve and Phillips curve, which included the before and after factors.

We give the integrated Phillips curve below, which describes that the current inflation depends not only on the past and expected future inflation, but also on the past demand pressures. The formula is:

$$\pi_t = \mu_0 + \mu_1\pi_{t-i} + \mu_2 E_t[\pi_{t+n}] + \mu_3\tilde{y}_{t-m} + \eta_t \tag{6}$$

where the lag term π_{t-i} reflects the inertia of inflation; while the prepositive term $E_t[\pi_{t+n}]$ is derived from the rational expectations models by Taylor and Calvo (1983).

We adopt quarterly data from the first quarter of 1994 to the second quarter of 2006 to estimate the Phillips curve in China. The aggregate supply curve is represented as follows:

$$\pi_t = \mu_0 + \mu_1\pi_{t-1} + \mu_2\pi_{t+1} + \mu_3\tilde{y}_{t-4} + \eta_t \tag{7}$$

The corresponding GMM result of this model is：

$$\mathrm{LN}CPI_{t} = 0.547\mathrm{LN}CPI_{t-1} + 0.452\mathrm{LN}CPI_{t+1} + 0.021\mathrm{LN}GDPQK_{t-4} + 0.003 \quad (8)$$

$$(0.049) \qquad (0.057) \qquad (0.009) \qquad (0.079) \text{—S. E.}$$

$$R^2 = 0.990, \quad \text{adjusted } R^2 = 0.989, \text{ S. E.} = 0.007, \text{ DW} = 2.352$$

The empirical results show that $\mu_1 > \mu_2$, which indicates the lag impact of inflation rate in China is greater than the potential impact. But this lag impact is still smaller than that in British empirical study carried out by Kontonikas and Montagnoli (2002). The result in Britain indicates the lag impact is even greater, and the coefficient is 0.800.

5.2 The Empirical Research of IS Curve Added with Asset Prices: Situation in China

In this part, we describe the aggregate demand with integrated IS curve. Output gap is the function of pre-outputs, the future expected output, pre-real interest rates, and the added lagged variable *X*, and the model is:

$$\tilde{y}_t = \lambda_0 + \lambda_1 \tilde{y}_{t-i} + \lambda_2 E_t\left[\tilde{y}_{t+n}\right] + \lambda_3 \overline{i}_{t-s} + \Omega' X_{t-k} + v_t \tag{9}$$

where $\overline{i}_t = \left(\dfrac{1}{12}\right)\sum_{i=0}^{11}\left(R_{t-i} - \pi_{t-i}\right)$ is the 12-month lagged average real interest rate. Because the channels through which net assets price and price changes of real estate influence customer's property are so many. The direct influencing factor includes consumption plans which reflect the changes in asset prices and indirect factors which take effect by household and enterprise's balance sheet accounts.

Nevertheless output also may be affected by the changes in asset prices, so we add asset prices into the aggregate demand curve. Thus, the general expression of the total demand curve including real estate and stock prices can be expressed as follows:

$$\tilde{y}_t = \lambda_0 + \lambda_1 \tilde{y}_{t-i} + \lambda_2 E_t[\tilde{y}_{t+n}] + \lambda_3 \overline{i}_{t-s} + \lambda_4 \pi_{t-m}^{HP} + v_{1t} \tag{10}$$

$$\tilde{y}_t = \lambda_0 + \lambda_1 \tilde{y}_{t-i} + \lambda_2 E_t[\tilde{y}_{t+n}] + \lambda_3 \overline{i}_{t-s} + \lambda_4 \pi_{t-m}^{SP} + v_{2t} \tag{11}$$

Aiming at our study issues, we get the China's comprehensive IS curve below which takes into account of asset prices by using quarterly data:

$$\tilde{y}_t = \lambda_0 + \lambda_1 \tilde{y}_{t-1} + \lambda_2 \tilde{y}_{t+1} + \lambda_3 \overline{i}_{t-4} + \lambda_4 \pi_{t-4} + v_t \tag{12}$$

We respectively set up all kinds of China's comprehensive IS curve by adding a variety of asset prices. The empirical result of China's comprehensive IS curve by adding Shanghai Composite Index is as follows:

$$\tilde{y}_t = 0.115\tilde{y}_{t-1} + 0.390\tilde{y}_{t+1} - 0.002\overline{i}_{t-4} + 0.080\pi^{SHI}_{t-4} - 0.566 \tag{13}$$

(0.164) (0.003) (0.049) (0.155) (0.346)—S. E.

R^2 =0.419 , Adjusted R^2 =0.361, S. E. = 0.088, DW= 2.348

The empirical result by adding Shenzhen Component Index is as follows:

$$\tilde{y}_t = 0.172\tilde{y}_{t-1} + 0.443\tilde{y}_{t+1} - 0.002\overline{i}_{t-4} + 0.044\pi^{SZI}_{t-4} - 0.351 \tag{14}$$

(0.150) (0.161) (0.003) (0.040) (0.319)—S. E.

R^2 =0.398 , Adjusted R^2 =0.339, S. E. = 0.090, DW= 2.505

The empirical result by adding house prices is as follows:

$$\tilde{y}_t = 0.162\tilde{y}_{t-1} + 0.468\tilde{y}_{t+1} - 0.001\overline{i}_{t-4} - 0.168\pi^{HI}_{t-4} + 0.790 \tag{15}$$

(0.162) (0.159) (0.003) (0.254) (1.188)—S. E.

R^2 =0.387 , Adjusted R^2 =0.326, S. E. = 0.090, DW= 2.485

We can see that the aggregate demand, compared with aggregate supply, is affected more, during the sample time period in China, when added asset prices such as Shanghai Composite Index, Shenzhen Component Index or House Price Index (λ_2 in equations (13), (14) and (15) are larger than λ_1, from equation (8) we can see that μ_1 is large than μ_2). The results are similar with which was done by Montagnoli and Kontonikas (2002) in Britain.

The results of analyses show that the one-year lagged coefficient of real interest rates is negative and one-year lagged real interest rate is negatively correlated with output (coefficients of one-year lagged interest rate are –0.002, –0.002 and –0.001 in equations 13, 14 and 15). Stock prices have a positive correlation with aggregate demand and coefficients of stock prices are all smaller. Shanghai Composite Index plays a more important role comparing with Shenzhen Component Index (The coefficients of Shanghai and Shenzhen Stock Price Index are 0.080 and 0.044 respectively in equations 14 and 15). Every 10% raise in Shanghai Composite Index will lead to 0.8% expansion in aggregate demand while 10% raise in Shenzhen Component Index will lead to 0.4% expansion in aggregate demand. The stock market is not the barometer for the economic performance during the sample time period in China.

The lagged coefficient of variation of the real estate price changing shows that the current total demand would be reduced by 1.68% as the real estate price grows by 10%. This result indicates that the development of Chinese real estate market fails to play the role of the wealth effect, but indeed damages the entities economy, and decreases the consumption. Therefore, it is necessary to push reform of the real estate market in order to push forward reform continuously, and actively expand domestic demands. Thus real estate market in China will play an actual role of the wealth effect. There is still a long path before us to have a healthily developed Chinese real estate market.

We began to study the transmission mechanism of fluctuations of asset prices to monetary policy and attempt to establish an extended interest rate response model that suits Chinese specific conditions after analyzing the influence of fluctuations of asset prices to aggregate demand and inflation.

6 The Empirical Estimation of the Effects of the Asset Price Fluctuations on the Monetary Policy in China

About the empirical and theoretical research work on the monetary policy response mechanisms of interest rates, foreign scholars have accumulated a large number of research findings, and we shall not enumerate. In the following part, we will create China's monetary policy reaction model based on the volatility in asset prices, and make empirical estimation.

6.1 The Monetary Policy Reaction Model of Interest Rate without Considering Asset Prices and the Empirical Estimation in China

Clarida thought that the central bank had operational goals on the short-term nominal interest rates. Kent and Lowe (1997) believed that, in the baseline model, typically the output gap and expected inflation are used to describe a country's economy, and under the inflation targeting system, the forward-looking actions would be adjusted following the central bank's policy operations. In each period, real interest rates would be partially adjusted according to the target value. With the central bank loss function which includes the interest rates changes, Svensson (1997) proved the existence of partial adjustment mechanism. We combine the partial adjustment mechanism with the objective criteria and get the monetary policy reaction model of interest rates without considering asset prices.

$$R_t = \left(1 - \sum_{i=1}^{l} \varphi_i\right)\{\alpha + \beta(E_t[\pi_{t+n}] - \pi^*) + rE_{t-1}[\tilde{y}_t]\} + \sum_{i=1}^{l} \varphi_i R_{t-i} + \mu_t \qquad (16)$$

where $\sum_{i=1}^{l} \varphi_i \in [0,1]$ measures the smoothness of interest rates which is considered from the view of central bank's operations. Williams (1999) believed that, from the public view, the frequent changes in the interest rate directions may be the central bank's faults. Therefore, maintaining the direction of interest rate movements can keep the central bank's credibility objectively. Smoothening interest rates can be seen as the reflection of the inaccessibleness of the accurate economic information and the uncertainty of the transmission mechanism of monetary policy. Taking into account these uncertainties in the actual economic performance, the central bank would tend to slow the adjustment in order to achieve the goal of sound control. We still use π^* to denote the inflation target, and r^* in $\alpha = r^* - \beta\pi^*$ to denote the long-run equilibrium nominal interest rate. In the setting of R_t by the monetary policy-makers, y_t^* is not observed, therefore we use $E_{t-1}[\tilde{y}_t]$ to replace the actual value of the expected level of output gap. Here, the random error term μ_t represents white noise of the impact of monetary policy.

We replace some unknown and future-expecting variables with known values in Eq. (16), and the estimated model is as follows:

$$R_t = \left(1 - \sum_{i=1}^{l} \varphi_i\right)\left\{\alpha + \beta\left(\pi_{t+n} - \pi^*\right) + r\tilde{y}_t\right\} + \sum_{i=1}^{l} \varphi_i R_{t-i} + \omega_t \tag{17}$$

Eq. (17) satisfies:

$$E_t\left[R_t - \left(1 - \sum_{i=1}^{l} \varphi_i\right)\left\{\alpha + \beta\left(\pi_{t+n} - \pi^*\right) + r\tilde{y}_t\right\} + \sum_{i=1}^{l} \varphi_i R_{t-i} / Z_t\right] = 0 \tag{18}$$

where Z_t denotes, when the interest rates are certain, the observable variables in the information of the central bank in time *t*. Furthermore, Z_t and ω_t is orthogonal vector. Due to the lag of the expected inflation and output variables, not refusing the orthogonality means that the central bank takes into account the lagged variables and uses them to predict future inflation and output in the reaction function. Because the information is not available when the policy makers make decisions, and, generally speaking, the empirical evidence does not show that taking the lagged data to replace current data will lead to major defects. In addition, due to the inertia of inflation and output levels, using lagged inflation and output gap instead of the current value does not have vital impact on the results. Of course, we believe that when the central bank makes decisions on interest rate adjustments, he must get much more information on the economic situations than just the information reflected by the inflation and output. Rudebusch and Svensson (1999) have proved this. They believed that using current data to replace the lagged data indicates more information not reflected in the inflation and output. At the same time, they also believed that the inflation and output variables were not relevant with the exogenous impact μ_t of monetary policy. In this way, we can change the form of Eq. (18), the simplified equation is as follows:

$$R_t = \phi_0 + \phi_1\left(\pi_{t+n} - \pi^*\right) + \phi_2\tilde{y}_t + \phi_3 R_{t-i} + \varepsilon_t \tag{19}$$

where $\phi_0 = \left(1 - \sum_{i=1}^{l} \varphi_i\right)\alpha$, $\phi_1 = \left(1 - \sum_{i=1}^{l} \varphi_i\right)\beta$, $\phi_2 = \left(1 - \sum_{i=1}^{l} \varphi_i\right)\gamma$, $\phi_3 = \sum_{i=1}^{l} \varphi_i$.

Based on the principles above, we do empirical analyses on Chinese situations through the above-mentioned functions. Among them, we adopt the average inflation rate in the coming year as the future expected inflation rate π_{t+n} ; use a constant value of 4.0% for π^* ; In addition, we adopt a two-quarter lagged liberalized interest rate for R_{t-i} . In this way, after using GMM estimation methods on the above-mentioned function, we get the estimated equation on the constant and the second-order lagged short-term interest rates, inflation and output gap as follows:

$$R_t = 0.126\left(\pi_{t+n} - \pi^*\right) - 0.785\tilde{y}_t + 0.876R_{t-2} + 0.457 \qquad (20)$$

(0.043) (0.687) (0.045) (0.218)—S. E.

R^2 = 0.979, adjusted R^2 = 0.978, SE = 0.645, J statistic = 5.310E-31

Based on Eq. (20) : ϕ_0 = 0.457, ϕ_1 = 0.126, ϕ_2 = –0.785, ϕ_3 = 0.876

$$\alpha = \phi_0 \Big/ \left(1 - \sum_{i=1}^{l} \varphi_i\right) = 0.457/(1–0.876) = 3.685;$$

$$\beta = \phi_1 \Big/ \left(1 - \sum_{i=1}^{l} \varphi_i\right) = 0.126/(1–0.876) = 1.016;$$

$$\gamma = \phi_2 \Big/ \left(1 - \sum_{i=1}^{l} \varphi_i\right) = –0.785/(1–0.876) = -6.331.$$

GMM results from the above analyses show that the estimated coefficient of inflation β is greater than 1 (1.016) and the baseline rules meet the dynamic stability standards. If β is less than the stability limit 1, the slope of aggregate demand curve is positive while the slope of output impacted by the inflation is negative. Negative output gap coefficient means that, when inflation expectations remain unchanged, each one percentage point raise of output gap, will lead to 0.785% interest rates cut by China's central bank. The number of interest rate smoothing parameter closes to 1 (0.876) and this indicates the short-term interest rates will remain a relatively high level. Finally, J statistics show that over-identification of the baseline model restrictions are not denied.

6.2 Monetary Policy Interest Rate Response Model Adding Asset Prices and Its Empirical Estimation in China

Asset prices contain the important information of the future aggregate demand and inflationary pressures. Asset price fluctuations have some endogeneity for the monetary policy transmission. Fluctuations in asset prices have significant impacts on interest rates. Cecchetti (2000) found, based on the simulation, Taylor Rule would be more suitable if it includes the asset price inflation. Therefore, we learn from these views, such as Cecchetti's, by adding asset prices factor into China's central bank monetary policy rules, expand the Taylor Rule and establish the monetary policy interest rate reaction model including the asset prices, so the model is as follows:

$$R_t = \left(1 - \sum_{i=1}^{l} \varphi_i\right)\left\{\alpha + \beta\left(E_t\left[\pi_{t+n}\right] - \pi^*\right) + rE_{t-1}\left[\tilde{y}_t\right] + \Theta' X_t\right\} + \sum_{i=1}^{l} \varphi_i R_{t-i} + \varepsilon_t \quad (21)$$

where $X_t = [x_{1t}, \cdots, x_{jt}]'$ denotes the newly added explanatory variables, and $\Theta = [\theta_1, \cdots, \theta_j]'$ denotes the new coefficient vector of explanatory variables. In our empirical analysis, X_t includes synchronous real estate prices or the stock prices variable. We use the same period data, rather than the expected data is because forecasting volatility in asset prices is not an easy task. In addition, the weak efficient market means that the current asset prices can basically reflect the history data. Therefore, there is no need to include lagged data. After deforming the above-mentioned functions, we get the following equation:

$$R_t = \phi_0 + \phi_1\left(\pi_{t+n} - \pi^*\right) + \phi_2 \tilde{y}_t + \phi_3 R_{t-i} + \phi_3 X_t + \upsilon_t \quad (22)$$

where

$$\phi_0 = \left(1 - \sum_{i=1}^{l} \varphi_i\right)\alpha, \quad \phi_1 = \left(1 - \sum_{i=1}^{l} \varphi_i\right)\beta, \quad \phi_2 = \left(1 - \sum_{i=1}^{l} \varphi_i\right)\gamma,$$

$$\phi_3 = \sum_{i=1}^{l} \varphi_i; \quad \phi_4 = \left(1 - \sum_{i=1}^{l} \varphi_i\right)\Theta'$$

The function above used GMM estimation methods, and prediction tools include constant, second-order lag nominal short-term interest rates, inflation, output gap, and asset price (Shanghai Composite Index, Shenzhen Component Index, and House Price Index). Under this framework, we respectively establish the interest rates reaction mechanism model of China's monetary policy by adding asset prices.

The extended interest rate reaction mechanism model including Shanghai Composite Index is as follows:

$$R_t = 0.019\left(\pi_{t+n} - \pi^*\right) - 0.222\tilde{y}_t + 0.913R_{t-i} + 0.025\pi_t^{SHI} - 0.109 \quad (23)$$

(0.007) (0.149) (0.053) (0.138) (1.034)—S. E.

R^2 = 0.974, adjusted R^2 = 0.975, SE = 0.131, J statistic = 4.120E–27

The extended interest rate reaction mechanism model adding Shenzhen Component Index is as follows:

$$R_t = 0.019\left(\pi_{t+n} - \pi^*\right) - 0.211\tilde{y}_t + 0.909R_{t-i} + 0.014\pi_t^{SZI} - 0.033 \quad (24)$$

(0.007) (0.146) (0.039) (0.081) (0.664)—S.E.

R^2 = 0.974, adjusted R^2 = 0.972, SE = 0.131, J statistic = 3.130E–31

The extended interest rate reaction mechanism model including House Price is as follows:

$$R_t = 0.015(\pi_{t+n} - \pi^*) - 0.106\tilde{y}_t + 0.783R_{t-i} + 2.203\pi_t^{HI} - 10.036 \qquad (25)$$

(0.004) (0.117)(0.039)(0.478) (2.195)—S.E.

$R^2 = 0.981$, adjusted $R^2 = 0.979$, SE = 0.114, J statistic = 3.340E–23

From the analysis above we can see that Shanghai stock market exerts a larger impact than Shenzhen stock market. Therefore, we research the China's interest rate reaction mechanism model adding House Price Index and the Shanghai Composite Index at the same time, and the empirical results are as follows:

$$R_t = 0.015(\pi_{t+n} - \pi^*) - 0.117\tilde{y}_t + 0.787R_{t-i} + 0.018\pi_t^{SHI} + 2.200\pi_t^{HI} - 10.157 \qquad (26)$$

(0.005) (0.129)(0.051) (0.128) (0.476) (2.377)—S. E.

$R^2 = 0.981$, adjusted $R^2 = 0.979$, SE = 0.115, J statistic = 4.610E–29

Through the interest rate response model adding stock indexes and the house price, we can see that: First of all, in the response model adding the real estate price data, the corresponding coefficient of real estate prices is, noticeably, positive. When the real estate prices raise, the monetary policy tends to be tight, and if real estate prices raise by 1%, the corresponding interest rate of monetary policy will raise by 2.200%. Monetary policy exerts a stronger response to expected inflation than the inflation in the baseline standard, and its standard error is even smaller. Secondly, after adding the stock price into the base model, and when Shanghai Composite Index and Shenzhen Component Index are added, the impact factors are positive and statistically significant, but its coefficient (0.025, 0.014) is much smaller than the real estate prices' impact coefficient (2.200). When asset prices (stock indexes and house prices) are incorporated into the model, the impact of house price is much larger than that of stock index (2.200 > 0.018). Therefore, the model including real estate prices helps the monetary policy interest rate reaction model to be more practical. Fig. 4 provides the actual value (Actual), fitted value (Fitted) and the residual value (Residual) of the interest rate response model including house prices and stock indexes.

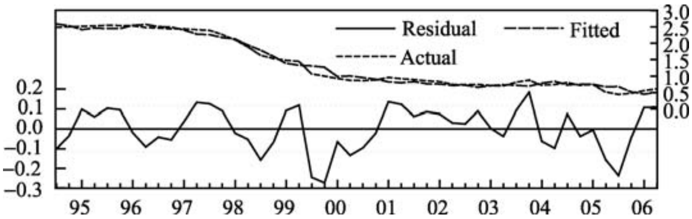

Fig. 4 The Actual Value and the Fitted Value of the Interest Rate Response Model Including the Asset Prices

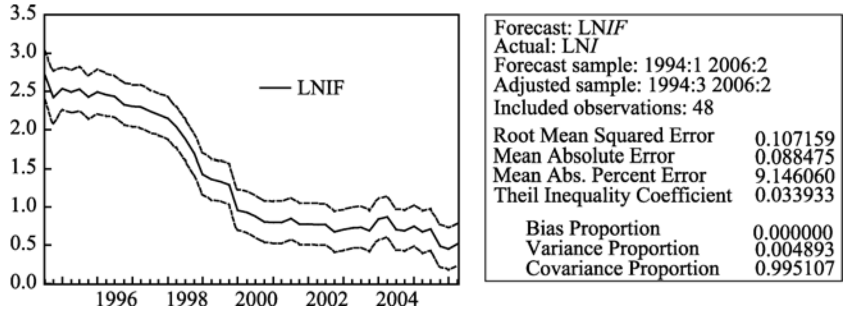

Fig. 5 The Predictive Values (predicted value) and Forecasting Performance Indexes of the Model

For now, we have analyzed the impact of asset price fluctuations on China's monetary policy under different circumstances. For visual comparison, we provide a comparative chart calculated by monetary policy response model of interest rates adding asset prices (stock price and house price) (Fig. 6, where LN*I* denotes the real interest rates values, LN*I1* denotes the fitted values of the benchmark model, and LN*I2* denotes the fitted values of the models adding asset price:

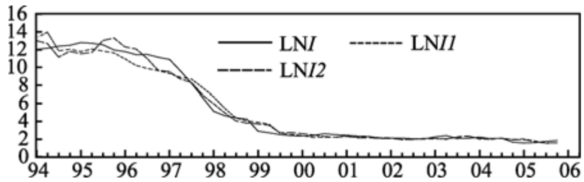

Fig. 6 The Actual Values and Fitted Values of the Base Model and Extended Model

Table 2 The Describing Statistics of Real Values and Fitted Values in the Baseline Model and Extended Model

Describes	The real values of interest rate	The fitted values of baseline model	The fitted values of extended model including asset prices
Mean	5.416	5.349	5.376
Median	2.503	2.466	2.657
Max.	12.800	13.967	13.308
Min	1.553	1.548	1.535
Standard deviation	4.349	4.169	4.265

From the comparison above, we can see that simulation performance of targeting interest rate of the extended model adding asset prices is better than that of the benchmark model. The former is closer to the real interest rate of the central bank. Therefore, asset prices (stock price, house price, etc.) should become the important endogenous variables which would be monitored by the central bank.

7 Conclusion and Recommendation

Based on China's macroeconomic quarterly data from 1994 to 2006, through the Granger causality test, cointegration test, as well as the extension of the benchmark Taylor Rule, we studied the IS curve adding asset prices (stock prices and housing price) in China, and established China's monetary policy reaction model of the interest rate by adding asset prices, further analyzed the impact of asset price fluctuations on the monetary policy.

From the Granger causality test results, we can see that the difference between the expected inflation rate and the target inflation rate, the Shanghai and Shenzhen stock index, house price index are all the Granger causes of Chinese liberalized interest rates, besides, the guiding probability of House Price Index is greater than the Shanghai and Shenzhen stock index on the liberalized interest rates. Based on the results of the cointegration test, the response coefficient of the difference between the expected inflation rate and the target inflation rate of liberalized interest rate is 0.320; the response coefficient of output gap for the liberalized interest rate is 0.690; the response coefficient of Shanghai stock index for the liberalized interest rate is –0.720; the response coefficient of house price for the liberalized interest rate is about –7.000. From the results of the long-term cointegration equation, the impact of asset prices on the interest rates is greater.

In addition, based on the estimation of the extended Phillips curve, we found the post-back impact of domestic inflation rate is greater than the potential effect. From the estimation of the Chinese IS curve adding the asset price, we can see that the aggregate demand adding the asset price factors (Shanghai Composite Index, Shenzhen Component Index and house price) in the sample time period, is influenced much more by the forward-looking factors than the aggregated supply. There is a positive correlation between stock price and the aggregated demand, and the role of Shanghai stock market in terms of comparison is greater than the impact of Shenzhen stock market. For Shanghai and Shenzhen stock markets, when the stock indexes raise 10.000%, the current expansion of aggregated demands are all less than 1.000%. This indicates that China's stock market has not yet played the "barometer" role in the economy. On the other hand, with 10.000% growth in real estate prices, the current aggregated demand will reduce 1.700%. This illustrates that the development of China's real estate market not only failed to play the role of wealth effects, but also had a greater damage on the real economy, and decreased the consumption. Therefore, under the status quo, we should constantly push forward reform, co-ordinate the relationship between investment and consumption, and streamline the pricing mechanism of the real estate market to resolve the real estate market bubble risks and enhance the stable and healthy development of the real estate market.

From the empirical models of the monetary policy response of interest rates, we can see that keeping inflation expectations unchanged, every 1% increase in output gap will lead to a 0.785% decrease of the central bank's interest rates. In addition, the results of the analysis also show that: firstly, the impact of real estate prices on the monetary policy is very remarkable. When the real estate prices rise, the corresponding monetary policy tends to be tight: every 1% increase in the real estate price will lead to a 2.200% increase in corresponding interest rate of monetary policy. Secondly, when the asset prices (stock prices and house prices) are incorporated into the model, the impact on monetary policy by the house price is larger than the impact of the stock prices, and the general trend of real interest rates can be better described by the implied target rate than the real interest rate. Therefore, the monetary policy function including asset prices as endogenous variables will make the objectives of monetary policy of the central bank more controllable.

In conclusion, due to the significant impact of the fluctuations in asset prices on monetary policy, we suggest that when the central bank makes its own monetary policies, asset prices fluctuations should be considered as endogenous factors, and added into the central bank's forward-looking interest rate rules, in order to promote the healthy development of China's real estate market, the stock market and derivatives market, the energy and commodity markets ,and to maintain rapid, smooth, continuous and coordinated development of economy.

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References

Bernanke B S, Woodford M (1997). Inflation forecasts and monetary policy. Journal of Money, Credit and Banking, 29 (4): 653–684

Borio C, Lowe P (2002). Asset prices, financial and monetary stability: Exploring the nexus. BIS working papers, No. 114

Bullard J, Schaling E (2002). Why the Fed should ignore the stock market. Federal Reserve Bank of St. Louis Review, 84: 35–41

Calvo G A (1983). Staggered prices in a utility maximizing framework. Journal of Monetary Economics, (12): 383–398

Cecchetti S G, Genberg H, Lipsky J, Wadhwani S (2000). Asset prices and central bank policy.

Geneva Reports on the World Economy, (2)
Clarida R, Galì J, Gertler M (1999). The science of monetary policy: A new Keynesian perspective. Journal of Economic Literature, 37: 1661–1707
Clarida R, Gali J, Gertler M (2000). Monetary policy rules and macroeconomic stability: Evidence and some theory. Quarterly Journal of Economics, 115(1): 147–180
Clarida R, Galí J, Gertler M (2002). A simple framework for international monetary policy analysis. Journal of Monetary Economics, 49: 879–904
Fanelli L (2007). Testing the new Keynesian Phillips curve through Vector Autoregressive models: Results from the Euro area. Oxford Bulletin of Economics and Statistics, 70(1): 53–66
Friedman M (1960). A Program for Monetary Stability. New York: Fordham University Press
Glenn R, Svensson L (1999). Policy rules for inflation targeting. In: Monetary Policy Rules, edited by J. B. Taylor. Chicago: University of Chicago Press
Hayek F A (1978). An Enquiry into the Nature and Effects of the Paper Credit of Great Britain. Fairfield: Augustus M. Kelley Publishers (reprint)
Henry O P (1995). Data sources for measuring house price changes. Journal of Housing Research, 6(3): 377–387
Kent C, Lowe P (1997). Asset price bubbles and monetary policy. Research Discussion Paper, No. 9709. Reserve Bank of Australia
Kontonikas A, Montagnoli A (2002). Has monetary policy reacted to asset price movements: Evidence from the UK. Economics and Finance Discussion, 2–11, Economics and Finance Section, Brunel Business School, Brunel Universtiy Kuttner
Kozicki S (1999). Multivariate detrending under Common Trend Restrictions: Implications for Business Cycle Research. Journal of Economic Dynamics and Control, 23(7): 997–1028
Levin A, Wieland V, Williams J C (1998). Robustness of simple monetary policy rules under model uncertainty. NBER working papers, No. 6570
McCallum B T (1988). Robustness properties of a rule for monetary. Camegie-Rochester conference series on public policy, 29: 173–204
Mehra Y P (1999). A forward-looking monetary policy reaction function. Economic Quarterly (Federal Reserve Bank of Richmond), April 1
Simons H C (1948). Economic Policy for a Free Society. Chicago：University of Chicago Press
Svensson L (1997). Inflation forecast targeting: Implementing and monitoring inflation targets. European Economic Review, 41: 1111–1146
Taylor J B (1985). What Would Nominal GNP Targeting Do to the Business Cycle? Camegie-Rochester Conference Series on Public Policy, (22): 61–84
Taylor J B (1993). Discretion versus policy rules in practice. Corniege-Rochester Conference Series on Public Policy, 39: 195–214
Taylor J B (1998). An historical analysis of monetary policy rules. NBER working papers, No. 6768
Thomton H (1802). An enquiry into the nature and effects of the paper credit of Great Britain. In: Stabilizing the Dollar, edited by I. Fisher (1920). New York: Macmilian
Williams J C (1999). Simple rules for monetary policy. Finance and Economics Discussion Series, (12)
刘斌，张怀清 (Liu Bin, Zhang Huaiqing) (2001). 我国产出缺口的估计 (China's output gap estimates). 金融研究, (10)
宋国青 (Song Guoqing) (1998). 宏观经济的波动与人民币汇率 (Macroeconomy fluctuation and exchange rate of Renminbi). 联办研究报告, No. 98005

王少平，涂正革，李子奈 (Wang Shaopin, Tu Zhengge，Li Zinai) (2001). 预期增长的菲利普斯曲线及其对中国适用性检验 (Anticipated augmentation Phillips curve test in China). 中国社会科学, (4)

王胜，邹恒甫 (Wang Sheng, Zou Hengfu) (2006). 开放经济中的泰勒规则——对中国货币政策的检验 (Taylor rule of open economy—monetary policy test in China). 统计研究，23(3): 42–47

谢平，罗雄 (Xie Ping, Luo Xiong) (2002). 泰勒规则及其在中国货币政策中的检验 (Taylor rule and test in Chinese monetary policy). 经济研究, (3): 3–12

杨继红，王涣尘 (Yang Jihong, Wang Huanchen) (2006). 我国货币政策是否响应股市泡沫的实证分析 (The empirical analysis whether our country monetary policy does respond the stock market foam). 财贸经济, (3): 38–41

曾立飞，徐剑刚，唐国兴 (Zeng Lifei, Xu Jiangang, Tang Guoxin) (2006). 开放经济下中国新凯恩斯混合菲利普斯曲线 (Chinese new Keynes mix the Phillips curve under the open economy). 数量经济技术经济研究, 23(3): 76–84

赵进文，高辉 (Zhao Jinwen, Gao Hui) (2004). 中国利率市场化条件下货币政策规则的构建 (Designing monetary policy rule construction under Chinese interest rate marketable condition). 经济学(季刊), (3)

赵进文，黄彦 (Zhao Jinwen, Huang Yan) (2006). 中国货币政策与通货膨胀关系的模型实证研究 (The empirical research of Chinese monetary policy and inflation relations). 中国社会科学, (2): 45–54

赵进文，闵捷 (Zhao Jinwen, Min Jie) (2005). 央行货币政策操作效果非对称性实证研究 (Empirical study on the asymmetry of the effect of monetary policy operation of China's center bank). 经济研究: (2): 26–34

赵进文，闵捷 (Zhao Jinwen, Min Jie) (2005). 央行货币政策操作政策拐点与开关函数的测定(Measurement for the breakpoints and transition functions for monetary policy operation of China's center bank). 经济研究: (12): 90–101