IMPLICATION OF TAYLOR RULE ON CHINA'S MONETARY POLICY AND INTEREST RATE LIBERALISATION

BY
YIP YAN TING
Student No. 12209082

A PROJECT SUBMITTED IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE DEGREE OF

BACHELOR OF SOCIAL SCIENCES (HONOURS) DEGREE IN CHINA STUDIES

ECONOMICS CONCENTRATION
HONG KONG BAPTIST UNIVERSITY

APRIL 2016
We hereby recommend that the Project by Ms. Yip Yan Ting entitled “Implication of Taylor rule on China's Monetary Policy and Interest Rate Liberalisation” be accepted in partial fulfillment of the requirements for the Bachelor of Social Sciences (Honours) Degree in China Studies in Economics.

Dr. Luk Sheung Kan
Project Supervisor

Second Examiner
Acknowledgements

I would like to thank my supervisor Dr. Luk Sheung Kan for guiding me through the entire study. Thanks are also due to the data base provided by the HKBU library.

____________________________
Student’s signature

China Studies Degree Course
(Economics Concentration)

Hong Kong Baptist University

Date : ______________________
CONTENTS

Abstract --------------------------------------------------------------- 4

1. Introduction ---------------------------------------------------------- 6

2. Background: China's Monetary Policy --------------------------------- 12

3. Literature Review ---------------------------------------------------- 15

4. Methodology ---------------------------------------------------------- 21

5. Data Sources --------------------------------------------------------- 32

6. Empirical Results ---------------------------------------------------- 33

7. Discussion of Results and Limitation of Study------------------------ 46

8. Conclusion------------------------------------------------------------- 51

References--------------------------------------------------------------- 53

Appendix---------------------------------------------------------------- 56
ABSTRACT

On the basis of a simplified Taylor rule, four sets of regression model: interbank lending rate, bank deposit and lending rates and the monetary policy stance, is formulated for China. Output gap and the RRR affected the interbank rates most significantly. Interbank lending rates also play as an interest rate mechanism to transmit monetary policy in China. It can be a measure of China's monetary policy with significant positive correlation to the RRR. The benchmark bank rates are influenced by the inflation rate and the RRR, but not the output gap. The removal of upper and lower limit of bank interest rates increase the benchmark rates. The estimated coefficients of inflation rate to interest rate is estimated as smaller than 1, which is smaller than Taylor's (1993) suggestion, leading to reinforced inflation or deflation in the economy. In fact, the People’s Bank of China (PBC) conducts a combination of price- and quantity-based monetary tools, their effect of all monetary tools on inflation may be consistent with the Taylor principle.
1. Introduction

China interest rate policy is characterized by its dual-track system. In money and bond markets, interest rates, such as repo rate and interbank lending rates, are market-oriented (Porter and Xu, 2009). The national interbank market has been established since 1996, acting as an unified platform for the interbank lending activity.

The interbank lending rates, also called China Interbank Offered Rates (CHIBOR) are the average transaction price in this interbank market. Currently, they consist of seven types of maturity, namely overnight, 7-day, 20-day, 30-day, 60-day, 90-day, and 120-day. In addition, the PBC established the Shanghai Interbank Offer Rate (SHIBOR) System in 2007 in order to form a benchmark yield curve. The SHIBOR is an arithmetic average of Renminbi (RMB) offered rates reported by the bank members in the system. With extension to one year, the rate maturity is longer than the CHIBOR (Porter and Xu, 2009).

On the other hand, policy interest rates are regulated by the People’s Bank of China (PBC). As the central bank, the People’s Bank of China (PBC) sets benchmarks for the bank deposit and lending rates at various maturities. With upper and lower limit imposed on each rate, commercial banks are restricted to set deposit and lending rates within a range of "lower limit times benchmark rate" and "upper limit times benchmark rate". For example, if the benchmark deposit rate is 5 percent with lower
limit of 0.9 times, and upper limit of 1.2 times, the floating range of deposit rate is at 4.5 to 6 percent. Moreover, interest rates for central bank operations, such as deposit rates on required and excess reserves, and rediscounting rates are determined by the PBC. The above regulated interest rates serve as monetary policy tools of the PBC. Rates adjustments reflect changes in the tightness of monetary policy. Detailed description of monetary policy tools of the PBC is in Section 2.1.

Figure 1 and 2 display changes in the benchmark of one-year bank deposit and lending rates, and reserve requirement ratio (RRR) respectively. It is observed that since 2007, the PBC adjusted these three rates with increasing frequency. Frequency of adjustment in the benchmark deposit and lending rates are less than that of the RRR. However, the benchmark deposit and lending rates are more important for signaling the strength of monetary policy changes (He and Pauwels, 2008). The benchmark deposit rate changes simultaneously with that of lending rate. These two rates have a similar trend with the RRR.
As a transition economy changing from a planned to market economy, China undergoes a series of economic reform in a gradualist approach. Its interest rate liberalization starts in 1996. In 2004, the PBC removed both the lower limit of deposit
rates and the upper limit of lending rates. In 2013, the lower limit of lending rates were phased out which indicates that lending rates are liberalized. In 2014, China records a low level of quarter-to-quarter inflation rate at about 0.5 percent (See Figure 3) and a downward trend in market interest rates. These provide a condition which reduces the ease of substantial rise in deposit and lending pricing during liberalization (PBC, 2015), and therefore drives the PBC to remove the upper limit of bank deposit rates in Oct 2015, indicating the basic liberalization of bank interest rates.

Theoretically, the bank interest rates are now "fully liberalized" or no longer subject to floating restrictions. However, it does not mean that the bank interest rates are no longer managed by the PBC. The interest rate regulation will rely more on market-oriented monetary policy tools and transmission mechanism (PBC, 2015).

Figure 3.
The process of interest rate liberalization helps develop the benchmark interest rate system in financial markets, which serves for two functions. First, to provide pricing benchmark for banks and facilitate the establishment of pricing and fund transfer systems within banks. Second, to provide operational and monitoring objectives of the indirect rates regulation for the central bank (Yi, 2009). Hence, interest rate liberalization makes a significant contribution to the financial reform in China.

As one of the major monetary policy tools used by the PBC, reform of deposit and lending rates undoubtedly imposes changes in monetary policy, such as the policy instruments and transmission mechanism of China. A brief discussion about monetary targets and transmission mechanism is in the Section 2.2 and 2.3.

The previous empirical studies (Xie and Luo, 2002; Tan, 2006) which apply Taylor rule in China only cover the period in which the Renminbi (RMB) bank interest rates are not yet liberalized. Therefore, this honours project will cover the period from 2002 to 2014, in which the PBC carries out liberalization on the bank interest rates1.

This paper analyzes China's interest rate policy in the framework of the Taylor rule

---

1 In 2004, the PBC removed the lower limit of bank deposit rates and the upper limit of bank lending rates. In 2013, the lower limit of lending rates is also removed.
and achieves two objectives. First, to distinguish the effect of inflation, output gap and reserve requirement ratio (RRR) on interest rate determination by a linear regression model. By ordinary least square (OLS), it is estimated that the interbank lending rate is more responsive to the output gap and the RRR. The benchmark bank deposit and lending rates are mainly determined by the inflation rate and the RRR. Second, to examine the impact of interest rate liberalization in China. It is found that removal of upper and lower limit of bank interest rates increase the rates. And, when the PBC is undergoing interest rate liberalization, the interbank market is a mechanism to transmit monetary policy.

The rest of this paper is divided into following sections. Section 2 describes the background of China’s monetary policy. Section 3 reviews relevant literature on the Taylor rule. Section 4 and 5 describe the methodology and sources of data used in this paper. Section 6 presents the empirical results. Section 7 discusses the results and limitation of study. And, the last section provides a conclusion.
2. Background: China’s Monetary Policy

2.1 Policy Instruments

Monetary policy of the People’s Bank of China (PBC) aims to “maintain the stability of the value of the currency and thereby promote economic growth”\(^2\). Distinct from the central bank in developed market economies\(^3\), the PBC adopts multiple monetary tools which are mainly divided into two types: quantity-based and price-based.

Quantity-based tools include reserve requirement ratio (RRR) and window guidance. Reserve requirement ratio (RRR) is the legal binding percentage of total reserve that banks must keep and deposit in the PBC. For example, when the RRR is 20 percent, a commercial bank with total reserves of 100 billion has to keep 20 billion as its required reserves and deposit it in the central bank. The remaining reserves is considered as excess reserves which can be lent out. The RRR is used to manage liquidity in banking sector.

Under window guidance, the PBC directly advises financial institutions on the loan quota and structure through regular meetings. The adjustment of quota is not binding,

\(^3\) For example, in the U.S., Federal Reserve uses discount rate as the short-term rate to anchor policy expectations.
not scheduled and not announced to public. This tool channels credit to preferred sectors or regions, and differentiates lending treatment towards various types of enterprises (He and Wang, 2011).

Price-based tools include open market operations (OMOs) and policy interest rates. OMOs are collateralized lending and conducted in two approaches: repo is the sale of central bank bills from the PBC to commercial banks, with a repurchase agreement; and reverse repo that is the PBC purchases back assets at a higher price at an agreed date. OMOs are used as a “fine-tuning” tool to regulate market liquidity and hence, avoid excessive volatility in the market interest rates (He and Pauwels, 2008).

2.2 Policy Targets and Transmission Mechanism

In the monetary policy framework of China, the PBC aims at three types of targets (He and Pauwels, 2008):

First of all, operating targets which include reserve money, and interest rates in money and bond market. These targets are considered as implicit. Second, intermediate targets include M2, banking-system credit, and fund-raising in the money and capital markets. These targets are indicative. Lastly, the PBC establishes monetary policy to achieve its final targets which are concerned with long-run
macroeconomic condition including inflation, growth, and financial stability. These targets are implicit.

The PBC makes adjustment in nominal interest rates to achieve the aforementioned policy targets through four transmission mechanisms as described below. Take decreases (increase) in the nominal interest rate as an example. Through the direct interest rate channel, it leads to an increase (decrease) in consumption and investment. Through the exchange rate channel, it causes exchange rate depreciation (appreciation), and increase (decreases) in the exports demand. Through the asset price channel, it raises (decreases) asset prices, and hence, wealth and aggregate demand. Last but not least, by "collateral effect", both the asset price and value of collateral increases (decreases), which can be used to borrow more (fewer) loans. Therefore, a decrease (increase) in nominal interest rate is considered as an expansionary (contractionary) policy.

2.3 Monetary Policy and Exchange Rate Policy

China conducts monetary policy not only according to its internal macroeconomic conditions, but also its exchange rate policy. These two types of policy are interrelated. China’s open trade policy results in large trade surplus and hence, large
current account surplus. China also controls over the fluctuations in its exchange rates by an effectively closed capital account. Under this situation, the PBC purchases foreign currency revenues from the exporters at prevailing exchange rates, financed by either issuing domestic currency or domestic bonds. That is the “sterilization,” and does not increase the money supply.

3. Literature review

3.1 The Taylor Rule

Based on the case of the United States, Taylor (1993) develops an interest rate reaction function, called the "Taylor rule". It is a monetary policy rule which suggests that the Federal Reserve (as central bank in the U.S.) should adjust the Federal Funds rate (short-term interest rate) in response to deviation of actual inflation rate from the target and of real output from potential output. And, potential output refers to the highest level of GDP that could be produced in an economy at full employment level and sustained in the long-run. The Taylor rule is formulated as:

$$ r_t = \pi_t + i_t^* + 0.5ygap_t + 0.5(\pi_t - \pi_t^*) $$

where $r_t$ is the federal funds rate, $\pi_t$ is the inflation rate over the previous four quarters, $i_t^*$ is the equilibrium real interest rate of 2%, $\pi_t^*$ is the target inflation rate of 2%. $ygap_t$ is the output gap measured in percentage of potential GDP as below.

$$ 100(Y_t - Y^*)/Y^* $$
where \( Y_t \) is the actual real GDP and \( Y^* \) is the potential GDP.

Two assumptions are made in the rule. Firstly, for a country with flexible exchange rate system, its central bank sets short-term nominal interest rates independently of other countries. Second, the inflation gap and output gap are assumed to be equally weighted and have the same positive coefficient of 0.5. When inflation is above its target rate or when the real GDP is above the potential level, theoretically, the Fed should increase the Federal Funds rate (i.e. monetary tightening), whereas decrease (i.e. monetary easing) in the opposite situation. For example, the Federal Funds rate falls by 1.5 percent when the actual inflation rate falls below target rate by 1 percent, holding all other variables being constant. The above discussion about the Taylor rule provides a theoretical foundation for this paper.

Later, Taylor (1999) applied his policy rule to the U.S monetary history and examined its effectiveness in practice. The research made notable findings in two aspects as follow. First aspect is "evolution" of the Taylor rule. By regression, it is found that the magnitude of coefficients on inflation rate and output gap gradually increase over the two sample periods, from 1879 to 1914 and from 1955 to 1997, and eventually approximate to the values suggested in Taylor (1993), where coefficients on inflation
rate and output gap are \( (1+0.5) \) and 0.5 respectively. Reason for these substantial changes in the policy rule is the changes of the U.S. monetary policy. During the gold standard era (1879 to 1914), flow of gold into and out of a country was emphasized. For example, a rise in inflation in the U.S. would cause a trade deficit, that is a gold outflow and fall in the money supply. As a result, the Fed would increase its interest rates in the U.S. upward pressure. For the latter two eras, namely the fixed exchange rate era (1954 to 1970s) and the flexible exchange rate era (1980s to 1997), when the exchange rate in the U.S. was fixed, the Fed set its interest rates which follows the monetary policy in foreign countries; and set its interest rates independently from other economies when the exchange rate in the U.S. was flexible.

The second aspect is concerned with a historical comparison between the actual Federal Funds rates and value of the Federal Funds rates implied by the two policy rules\(^4\). It is found that the large deviations from policy rules occurred in three time intervals, and caused the adverse effects to economic performance. Take the first deviation occurred in the early 1960s as an example. The federal funds rates were set far above the rule value ("too tight" monetary policy) led to a prolonged recession in

---

\(^4\) Rule (1) is given by the Taylor rule (1993) with coefficients of both the inflation rate and output gap equal to 0.5, and Rule (2) with a change in coefficient of output gap to 1.
1960-61 and slow expansion from 1962 to 1965. Therefore, Taylor (1999) suggested that "good policy" is to set interest rates close to the rule.

Different variants of the Taylor rule have been proposed for cases of advanced and developing economies. Given the evidence of two groups of economies, namely the "G3" (the U.S., Japan, Germany) and the "E3" (the U.K., Italy and France). Clarida, Gali and Gertler (1997) estimated a forward-looking reaction function, by which central banks adjust interest rates in response to anticipated inflation and output. It is found that to anchor monetary policy, inflation targeting can be an alternative to fixing exchange rates in some situations. Besides, to avoid capital market shock and decrease in policy credibility, central banks conduct "smoothing", that is the gradual adjustment in interest rates to target rates within several quarters, instead of a one-step change in one quarter.

On the other hand, backward-looking reaction function (Ophanides, 2001) suggests that central banks adjust current interest rates according to previous quarter inflation and output gap due to unavailability of real-time data and time lag. The Taylor rule (1993) relies on real-time data of current inflation and output gap, is thus not operational. However, using lagged value of inflation and output gap would present
similar results to current value due to the inertia of these two variables (Tan, 2006).

The natural-growth targeting rule (Ophanides, 2003), in which output gap is replaced by output growth rate, mimicked the monetary policy of the Fed well.

3.2 Application of Taylor rule in China

A considerable number of studies focus on application of the Taylor rule to China. Most of them support the rule can be applied to China's case. Xie and Luo (2003) examined the period from 1992 to 2001, using Shanghai Interbank Offered Rates (SHIBOR, 1992-1995) and national interbank rates (1996-2001). It is found that the Taylor rule can be well-used to measure China's monetary stance, and lagged policy operation causes the gap between actual value of interest rates and rule value. Kong (2008) stated the Taylor rule is superior to the McCallum rule in terms of measuring the actual monetary stance of China and providing guidelines for the PBC. Wang (2006) estimated an interest smoothing Taylor rule for China which describes changes in interest rates from 1993 to 2003.

By a cointegration test, Lu and Zhong (2003) confirmed that both the original and forward-looking Taylor Rule describe the movement of interbank offered rate. Zhang

---

5 The McCallum rule is a monetary policy rule based on money supply, which estimates a target monetary base (M0) in response to inflation and output.
and Zhang (2007) also formulated a forward-looking reaction function which fits the trend of the interbank offered rates, deposit and lending rates, and rate differences between them. Shu and Ng (2010) establish a monetary reaction function which is an original Taylor rule with monetary policy stance indicator on the left-hand side, finding economic growth and inflation significantly influence the monetary stance of the PBC; and, impact from money and credit growth, and unemployment resulted as insignificant.

On the other hand, Tan (2006) suggested that the Taylor rule is not applicable to China due to the lag of market-oriented reform of interest rates and the inefficiency of transmission mechanism of monetary policy. The above empirical studies presented diverse results since each selected different sample period, different proxy variables, and variant of the Taylor rule.

Our review shows that a majority of researches support the original Taylor rule and its variants can be applied to China. It confirms our choice of the Taylor rule as a reaction function to analyse China's monetary policy in this paper. In general, either the regulated or market interest rates is used to examine how it is affected by inflation and output. Given the dual-track interest rate system in China, this paper will estimate
the Taylor rule on both types of interest rates for comparison. And, we try to make up for the neglected area in previous researches.

In contrast to the researches reviewed, this paper will stick to the original Taylor rule, instead of a forward-looking or interest rate smoothing rule. It is because a simpler rule function facilitate the input of monetary policy tools as independent variables, and to isolate the effect of each variable on the interest rates.

4. Methodology

4.1 Empirical Framework

This section describes the empirical framework adopted in this paper.

On the basis of the original Taylor rule (1993), a simplified Taylor rule is derived, which is a linear regression model. The rule is:

\[ r_t = \beta_0 + \beta_1 \pi_t + \beta_2 ygap_t + \varepsilon_t \]

where \( r_t \) is short-term nominal interest rate;

Given that both the equilibrium real interest rate and target inflation rate is set as two separate constants in the original Taylor rule (1993), they are merged into a single constant (\( \beta_0 \)) for simplicity in this paper. In other words, the constant (\( \beta_0 \)) is a mixture of equilibrium real interest rate and the target inflation rate. And,
\( \pi_t \) is the actual inflation rate;

\( ygap_t \) is output gap;

and \( \varepsilon_t \) is a error term.

It is expected that change in short-term nominal interest rate is a respond to the changes in actual inflation rate and output gap. And, a positive correlation between short-term nominal interest rate and each macroeconomic variable: inflation rate and output gap. By ordinary least squares (OLS), we estimate the value of constant \((\beta_0)\), unknown coefficient of actual inflation rate and of output gap (i.e. \(\beta_1\) and \(\beta_2\)) in the aforementioned linear regression model. Lastly, we formulate a monetary policy reaction function of China. The independent and dependent variables in the simplified Taylor rule are described in Section 4.2 and 4.3 respectively.

### 4.2 Independent variables

Actual inflation rate \((\pi_t)\), which is measured as the percentage change in quarter-to-quarter Consumer Price Index (CPI) with 2005 as the base year:

\[
\pi_t = 100 \frac{CPI_t - CPI_{t-1}}{CPI_{t-1}}
\]

To compute the real GDP, nominal GDP (in billion RMB, measured by value-added approach\(^6\)) is deflated by quarter-to-quarter GDP deflator with 2005 as the base year:

---

\(^6\) According to the "Annual GDP Accounting Instructions of China", China employs value-added approach as the official GDP measurement approach. Retrieved from
\[
\text{Real GDP}_{(t)} = \frac{\text{Nominal GDP}_{(t)}}{\text{GDP deflator}_{(t)}}
\]

The data of Consumer Price Index (CPI), GDP deflator and nominal GDP are seasonally adjusted.

In Taylor (1993), output gap \((\text{ygap}_t)\) is measured in percentage of potential GDP, that is:

\[100(\text{Y}_t - \text{Y}^*)/\text{Y}^*\]

where \(Y_t\) is actual real GDP and \(Y^*\) is potential GDP.

Figure 4.

![Actual real GDP (2002-2014)](image)

Potential GDP is not directly observational, and no data on China's potential GDP is officially published by National Bureau of Statistics of China (NBS) or international economic organization (e.g. World Economic Outlook of the International Monetary Fund).
Fund). Given these two facts, economists compute potential GDP in different methods, including average-taking and detrending (which includes linear trend, first difference and Hodrick-Prescott filter). As shown in Figure 4, China's actual real GDP has a steady upward trend from 2002 to 2014. Therefore, we employ the linear time trend as the output detrending approach by following equation:

\[ Y_t = b_0 + b_1 t + ygap_t \]

where \( b_0 \) is a constant; \( ygap_t \) is the regression residual and we consider it as output gap; \( t \) is time trend in quarters from 2002Q1 to 2014Q4. There is a total of 52 quarters, that is \( t = \{1, 2, 3, \ldots, 52\} \).

By OLS, we estimate the value of constant and coefficient of time trend (i.e. \( b_0 \) and \( b_1 \)) and the major regression result is reported as below (see Appendix I for more detailed results).

\[
\begin{align*}
    b_0 &= 2587.338^{**} \\ (41.119) \\
    b_1 &= 157.964^{**} \\ (76.456) \\
    R^2 &= 0.9915
\end{align*}
\]

Note: ** denote significant at the 5% level. The t-statistics are stated in the parentheses.

The output gap (\( ygap_t \)) is then computed in the following rearranged equation:

\[ ygap_t = Y_t - 2587.338 - 157.964t \]

Figure 5 displays the trend of output gap in China. In 2002, China had a large positive output gap of 592.7 billion, that is actual real GDP above the potential level. Since then, the gap has gradually dropped to near the potential level in 2004Q1, and
negative output gap, that is actual real GDP falls below the potential level, existed from 2004Q2 to the end of 2006. From 2008Q2 to 2009Q1, actual real GDP continued to decrease and is lower than the potential output during the 2008 global financial crisis, and had a gradual recovery afterwards. Since 2011, the output gap has returned to a positive. Overall, China's output gap exhibits a "W-shaped" trend in our sample period from 2002 to 2014.

4.3 Dependent variables

Short-term nominal interest rate ($r_t$) is the only dependent variable in the simplified Taylor rule. Unlike the U.S., China has a dual-track interest rate system, which consists of market-determined interest rates and interest rates under regulation by the People's Bank of China (PBC). Thus, we adopts variation in the proxy of short-term
nominal interest rate, and conduct four sets of regression as described below.

4.3.1 First regression (Interbank lending rates)

The first set of regression focuses on the market-determined interest rates in China's interbank market. The interbank lending rates are weighted average interest rates. Because of the restrictions imposed on interbank lending at longer maturities, interbank transactions are concentrated at shorter maturity of 30-day or shorter. In 2013, lending at overnight or at 7-day maturity accounts for more than 90 percent of the transactions in the interbank lending market (He, Wang and Yu, 2014). Under this condition, the overnight, 7-day and 30-day interbank lending rates are employed as the proxy of short-term nominal interest rate. Moreover, the interbank lending rates are also assumed as the most-liberalized interest rates in China (Xie and Luo, 2003) among the four proxy variables in this paper. However, the drawback of using interbank lending rate is that it is driven by bank liquidity. When the banks have decrease in or shortage of funds, they will borrow funds from other banks through the interbank market, in order to maintain liquidity for people's withdrawal of money from banks. In addition, interbank lending can be a channel for the banks to borrow funds to meet the reserve requirement.
The first equation in this set of regression is:

\[ INTER_t = \beta_0 + \beta_1 \pi_t + \beta_2 ygap_t + \epsilon_t \]  

(1a)

where \( INTER_t \) is quarterly interbank lending rate\(^7\) at overnight, 7-day or 30-day maturity.

One additional independent variable: reserve requirement ratio (RRR) is placed in Eq. (1b):

\[ INTER_t = \beta_0 + \beta_1 \pi_t + \beta_2 ygap_t + \beta_3 RRR_t + \epsilon_t \]  

(1b)

where \( RRR_t \) is reserve requirement ratio (RRR) set by the PBC, binding to commercial banks and other financial institutions.

It is expected that reserve requirement ratio (RRR) and interbank lending rate is positively correlated. When the PBC increases RRR, reduced liquidity in banks will pose upward pressure to the interbank lending rate.

4.3.2 Second regression (Benchmark of bank lending rate)

The second set of regression focuses on the PBC's adjustments of regulated interest rate. The benchmark of one-year\(^8\) bank lending rate is employed as the proxy of short-term nominal interest rate \( r_t \).

---

\(^7\) The interbank lending rate is on a monthly basis. Hence, a 3-month average is taken to obtain a quarterly interbank lending rate, that is \( INTER_t = (INTER_{M1} + INTER_{M2} + INTER_{M3})/3 \).

\(^8\) refers to the maturity of "six-month to one-year (inclusive of one-year)". For simplicity, we name the bank lending rate at this maturity as "one-year".
\[ LEND_t = \beta_0 + \beta_1 \pi_t + \beta_2 ygap_t + \epsilon_t \]  \hspace{1cm} (2a)

where \( LEND_t \) is benchmark of one-year bank lending rates.

Similarly, to capture the influence of reserve requirement ratio (RRR) on PBC’s determination of benchmark lending rates, the RRR is placed into Eq. (2b) as an independent variable, forming the equation:

\[ LEND_t = \beta_0 + \beta_1 \pi_t + \beta_2 ygap_t + \beta_3 RRR_t + \epsilon_t \]  \hspace{1cm} (2b)

To estimate the possible effects of 2008 global financial crisis on benchmark lending rate, a dummy variable of financial crisis is added into Eq. (2b), forming Eq. (2c). The financial crisis covers three quarters from 2008Q3 to 2009Q1, which is indicated by "1"; otherwise, indicated by "0".

\[ LEND_t = \beta_0 + \beta_1 \pi_t + \beta_2 ygap_t + \beta_3 RRR_t + \beta_4 D_{FINCRI} + \epsilon_t \]  \hspace{1cm} (2c)

where \( D_{FINCRI} = \begin{cases} 0 \text{ (not in time of financial crisis)} \\ 1 \text{ (in time of financial crisis)} \end{cases} \)

To examine the effects of interest rate liberalization on benchmark bank lending rates, two dummy variables are added into our simplified Taylor rule one by one. First, it is a dummy variable of removal of upper limit of lending rates. Quarters before removal, from 2002Q1 to 2004Q3, that is when the upper limit is imposed, are indicated by "0". And, quarters having and after the removal, from 2004Q4 to 2014Q4, are indicated by "1". The equation is:
\[ LEND_t = \beta_0 + \beta_1 \pi_t + \beta_2 ygap_t + \beta_5 D_{REUPP} + \epsilon_t \quad (2d) \]

where \( D_{REUPP} = \begin{cases} 0 \ (\text{without upper limit removal)} \\ 1 \ (\text{with upper limit removal)} \end{cases} \)

Second, a dummy variable of lower limit removal of lending rate is added. Quarters before the removal from 2002Q1 to 2013Q2, that is when the lower limit is imposed on bank lending rates by the PBC, are indicated by "0". And, quarters having and after the removal, from 2013Q3 to 2014Q4, are indicated by "1". The equation is:

\[ LEND_t = \beta_0 + \beta_1 \pi_t + \beta_2 ygap_t + \beta_5 D_{REUPP} + \beta_6 D_{RELOW} + \epsilon_t \quad (2e) \]

where \( D_{RELOW} = \begin{cases} 0 \ (\text{without lower limit removal)} \\ 1 \ (\text{with lower limit removal)} \end{cases} \)

4.3.3 Third regression (Benchmark of bank deposit rate)

The third set of regression focuses on adjustments of another regulated interest rate by the PBC. The benchmark of one-year bank deposit rate is employed as the proxy of short-term nominal interest rate \( (r_t) \).

\[ DEPO_t = \beta_0 + \beta_1 \pi_t + \beta_2 ygap_t + \epsilon_t \quad (3a) \]

where \( DEPO_t \) is benchmark of one-year bank deposit rate.

Following the practice of second regression (benchmark of bank lending rate), the RRR, a dummy variable of 2008 global financial crisis, and a dummy variable of
lower limit removal of deposit rate is separately added into the right-hand side of the above Eq. (3a).\textsuperscript{9} Quarters when the lower limit is removed, from 2004Q4 to 2014Q4, are indicated by "1"; otherwise by "0". The three equations are:

\begin{align*}
DEPO_t &= \beta_0 + \beta_1 \pi_t + \beta_2 ygap_t + \beta_3 RRR_t + \epsilon_t \quad (3b) \\
DEPO_t &= \beta_0 + \beta_1 \pi_t + \beta_2 ygap_t + \beta_3 RRR_t + \beta_4 D_{FINCRI} + \epsilon_t \quad (3c) \\
DEPO_t &= \beta_0 + \beta_1 \pi_t + \beta_2 ygap_t + \beta_7 D_{RELOW} + \epsilon_t \quad (3d)
\end{align*}

\textbf{4.3.4 Fourth regression (Monetary stance indicator)}

The fourth regression focuses on the monetary policy tools and policy stance of China. The short-term nominal interest rate (\(r_t\)) is replaced by a monetary stance indicator by narrative approach (Sun, 2015). The independent variable: reserve requirement ratio (RRR) is excluded in this regression because the RRR is taken into consideration when compiling the narrative indicator\textsuperscript{10}. Alternatively, one may estimate by using multinomial regression but this is beyond the scope of this dissertation. However, it is worth a trial and see if it provides any significant empirical result. The narrative indicator takes five discrete values between -2 and 2, which indicate the degree of monetary policy tightness in China.

\textsuperscript{9} The PBC abolished the upper limit of deposit rates in Oct 2015, which is beyond our sample period, therefore the dummy variable of upper limit removal is excluded in the third regression.

\textsuperscript{10} In Sun (2015), the monetary stance indicator is compiled by studying the PBC’s historical records.
Table 1. **Narrative monetary stance indicator and Criteria**

<table>
<thead>
<tr>
<th>Score</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>(Very Tight) - Strong tightening; Strong emphasis on inflation reduction</td>
</tr>
<tr>
<td>1</td>
<td>(Tight) - Tightening; Mild emphasis on inflation control, liquidity</td>
</tr>
<tr>
<td></td>
<td>management and macroeconomic management</td>
</tr>
<tr>
<td>0</td>
<td>(Neutral) - Normal</td>
</tr>
<tr>
<td>-1</td>
<td>(Easy) - Easing; Mild emphasis on real growth</td>
</tr>
<tr>
<td>-2</td>
<td>(Very Easy) - Strong easing; Strong emphasis on real growth</td>
</tr>
</tbody>
</table>


Figure 6 shows the trend in quarterly monetary stance indicator in sample period from 2002Q1 to 2014Q4. The PBC gradually conducts monetary tightening until 2004Q2, and sustains a stable stance at the "1-level" for three years afterwards. There is a very easing monetary stance from 2008Q2 to 2010Q2 when is the time of financial crisis and post-crisis period.

Figure 6.
The reaction function adopting monetary stance indicator (by narrative approach) as the dependent variable is as follow:

\[ MSI_t = \beta_0 + \beta_1 \pi_t + \beta_2 \gamma gap_t + \epsilon_t \] (4)

where \( MSI_t \) is the monetary stance indicator of certain quarter. That is

\[
MSI_t = \begin{cases} 
2 \text{ (Very tight)} \\
1 \text{ (Tight)} \\
0 \text{ (Neutral)} \\
-1 \text{ (Easy)} \\
-2 \text{ (Very easy)} 
\end{cases}
\]

It is expected that when actual inflation rate or output gap increases, the PBC will establish more tightening monetary policy to avoid overheating in the Chinese economy. In other words, the narrative indicator will tends to be positive or greater in value.

5. Data Sources

The data used in this paper is quarterly measured and covers the period from 2002Q1 to 2014Q4. The data of dependent variables is mainly from two sources. Firstly, benchmark of bank deposit and lending rates, and interbank lending rates are adopted from the historical data of the People's Bank of China (PBC). Secondly, the value of narrative monetary stance indicator is adopted from Sun (2015) research paper, which is summarized in the appendix of his paper.
National Bureau of Statistics of China (NBS) only published monthly and annual national current CPI compared with same month of preceding year with 1978 as the base year, and the data of quarterly real GDP of certain period is unavailable from National Bureau of Statistics of China (NBS). Therefore, for the independent variables, including the quarter-to-quarter CPI, GDP deflator, nominal GDP and reserve requirement ratio (RRR), we use the data from the vintage dataset by Higgins and Zha (2015). This dataset is a reliable source since its calculation is based on a variety of data sources, including the NBS, International Monetary Fund (IMF) and other official institutions.

6. Empirical results

6.1 First regression (Interbank lending rates)

The major results of the first set of regressions are reported in Table 2 as follows.

<table>
<thead>
<tr>
<th>Dependent variable: Interbank lending rates</th>
<th>Equation (1a) (Simplified Taylor rule)</th>
<th>Equation (1b) (Simplified Taylor rule + RRR)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Constant</td>
<td>2.032** (17.874)</td>
<td>1.265** (6.906)</td>
</tr>
<tr>
<td>Inflation rate</td>
<td>0.28** (2.327)</td>
<td>0.201 (1.995)</td>
</tr>
<tr>
<td>Output gap</td>
<td>0.00165** (0.237)</td>
<td>0.00157** (0.237)</td>
</tr>
</tbody>
</table>
In the case of simplified Taylor rule, regardless of which maturity the interbank lending rate of, coefficients of both the inflation rate and output gap are positive and statistically significant. The results conform to the positive correlation of short-term nominal interest rate with inflation and with output gap as suggested by Taylor (1993, 1999).

Firstly, when overnight rate is used as dependent variable, inflation rate has a coefficient of 0.28, meaning 1 percent increase in inflation rate causes 0.28 percent increase in overnight interbank lending rate. The output gap with a coefficient of 0.00165 means that 100 billion increase in output gap raises overnight interbank lending rate by 0.165 percent.

Secondly, in respective cases of 7-day and 30-day maturity, the inflation rate is estimated with a coefficient of 0.536 and 0.68; and output gap with a coefficient of...
0.00176 and 0.00213. 1 percent rise in inflation rate raises 7-day interbank lending rate by 0.536 percent and 30-day rate by 0.68 percent. As shown in the result, the coefficients of inflation rate and output gap in the cases of 7-day and 30-day maturity are larger than that of overnight maturity, and coefficient's magnitude rises at longer maturity. It implies that the positive impact of inflation rate and output gap (as independent variables) on interbank lending rate will be stronger at longer maturity.

When reserve requirement ratio (RRR) is input into our simplified Taylor rule as an independent variable, coefficients of inflation rate and output gap remain positive and statistically significant\(^\text{11}\). However, their magnitude drop once the RRR is added. Similar to the regression of simplified Taylor rule, the result exhibits a pattern of "larger coefficient at longer maturity".

Reserve requirement ratio (RRR) is positively correlated to the interbank lending rate at all three maturity. If the PBC raises RRR by 1 percent, the interbank lending rate will increase by 0.061 percent at overnight tenor, by 0.108 percent at 7-day maturity and by 0.13 percent at 30-day maturity. The result is consistent with our expectation stated in previous section. The increase in interbank lending rate can be explained by

\(^{11}\) except for the case adopting overnight rate, in which the coefficient of inflation rate is statistically insignificant.
the fact that increase in the RRR reduces amount of excess reserves and hence, the liquidity in banking sector. Influence of the RRR on interbank market is indirect.

Regression result from the simplified Taylor rule shows that the constant ranges from 2.032 to 2.758. If the independent variable: RRR is placed into the rule, the constant falls to a range between 1.046 and 1.265. These two ranges represent the sum of target inflation rate and equilibrium real interest rate in China's interbank market approximates to 1 percent or 2 percent. Taylor (1993) suggests, the equilibrium real interest rate is set to equal 2 percent in the U.S.. Comparing with this assumption, our estimated rate obtained from China's case is lower.

A possible explanation is that China, as a transition economy, is at a stage of economic development different from the U.S. which is a developed economy. China may target at inflation level lower than that in the U.S. and the real interest rate is at different equilibrium. Besides, is the difference in sample period selected between Taylor (1993) and our paper.

To evaluate of the effect of independent variables on interbank lending rate, we compare the change in interbank lending rate resulted from the one standard deviation
increase in independent variables. It is found that the strength of output gap is larger than that of the inflation rate with all three types of maturity in both Eq. (1a) and Eq. (1b) (For the detail descriptive statistics of inflation rate, output gap, RRR and interest rates, please see Appendix II; For the results of coefficient of independent variables times one standard deviation increase, please see Appendix III).

Take the case of overnight rate in Eq. (1b) as an example. Inflation rate rises by one standard deviation of 0.70364 percent, resulting in about 0.141 percent rise in overnight interbank lending rate; while output gap rises by one standard deviation of 221.401 billion, resulting in about 0.348 percent rise in overnight interbank lending rate. One standard deviation of 5.566 percent rise in the RRR increases the overnight interbank lending rate by 0.34 percent. The result indicates that among the two macroeconomic variables, interbank lending rates have stronger response to the output gap than to inflation rate.

Lastly, the strength of RRR is similar to that of output gap. One standard deviation increase in the RRR causes increase in overnight rate similar to by one standard deviation increase in output gap. The RRR contributes to larger rise in rates at 7-day and 30-day maturity.
### 6.2 Second regression (Benchmark of bank lending rate)

The major results of the second set of regression are reported in Table 3 as follows.

<table>
<thead>
<tr>
<th>Dependent variable:</th>
<th>Equation (2a)</th>
<th>Equation (2b)</th>
<th>Equation (2c)</th>
<th>Equation (2d)</th>
<th>Equation (2e)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Benchmark of one-year bank lending rate</td>
<td>(Simplified Taylor rule)</td>
<td>(Simplified Taylor rule + RRR)</td>
<td>(Simplified Taylor rule + RRR + D_FIN)</td>
<td>(Simplified Taylor rule + D_REUPP)</td>
<td>(Simplified Taylor rule + D_REUPP + D_RELOW)</td>
</tr>
<tr>
<td>Constant</td>
<td>5.693** (51.176)</td>
<td>5.103** (26.103)</td>
<td>5.065** (26.692)</td>
<td>5.104** (26.382)</td>
<td>5.047** (24.542)</td>
</tr>
<tr>
<td>Inflation rate</td>
<td>0.307** (2.608)</td>
<td>0.246** (2.291)</td>
<td>0.383** (3.129)</td>
<td>0.288** (2.719)</td>
<td>0.282** (2.649)</td>
</tr>
<tr>
<td>Output gap</td>
<td>-0.00038 (-1.019)</td>
<td>-0.00044 (-1.294)</td>
<td>-0.0001 (-0.308)</td>
<td>0.00040 (0.995)</td>
<td>0.00065 (1.295)</td>
</tr>
<tr>
<td>RRR</td>
<td>/</td>
<td>0.047** (3.513)</td>
<td>0.04** (2.974)</td>
<td>/</td>
<td>/</td>
</tr>
<tr>
<td>Dummy: Financial crisis</td>
<td>/</td>
<td>/</td>
<td>0.795** (2.106)</td>
<td>/</td>
<td>/</td>
</tr>
<tr>
<td>Dummy: Upper limit removal</td>
<td>/</td>
<td>/</td>
<td>/</td>
<td>0.762** (3.555)</td>
<td>0.875** (3.445)</td>
</tr>
<tr>
<td>Dummy: Lower limit removal</td>
<td>/</td>
<td>/</td>
<td>/</td>
<td>/</td>
<td>-0.245 (-0.835)</td>
</tr>
<tr>
<td>Observations</td>
<td>52</td>
<td>52</td>
<td>52</td>
<td>52</td>
<td>52</td>
</tr>
<tr>
<td>Std. Error</td>
<td>0.583</td>
<td>0.525</td>
<td>0.508</td>
<td>0.524</td>
<td>0.526</td>
</tr>
<tr>
<td>$R^2$</td>
<td>0.154</td>
<td>0.327</td>
<td>0.385</td>
<td>0.330</td>
<td>0.340</td>
</tr>
<tr>
<td>Adjusted $R^2$</td>
<td>0.12</td>
<td>0.285</td>
<td>0.333</td>
<td>0.289</td>
<td>0.284</td>
</tr>
</tbody>
</table>

Note: ** denote significant at the 5% level.
The t-statistics are stated in the parentheses.
Overall, the estimated coefficients of inflation rate are positive and statistically significant. However, coefficients of output gap are insignificant in all five equations, meaning output gap may not influence benchmark lending rate.

In the case of simplified Taylor rule, inflation rate records a coefficient of 0.307. In response to 1 percent rise in the inflation rate, the People's Bank of China (PBC) will raise the benchmark of one-year bank lending rate by 0.307 percent. If the RRR is added to the simplified Taylor rule, the coefficient falls to 0.246. The above estimated coefficients approximates to the result of overnight interbank lending rate in first regression. It implies that both the overnight interbank market and the PBC react to inflation in a similar magnitude.

The dummy variable of 2008 global financial crisis positive coefficient of 0.795, meaning that the benchmark of one-year lending rate is 0.795 percent higher in the time during the financial crisis (i.e. 2008Q2 to 2009Q) than in the time without occurrence of financial crisis. This result is opposite to expectation that the central bank should lower interest rate to stimulate growth during financial crisis. For example, the U.S. Federal Reserve has lowered the Fed Funds Rate and discount rate six times in 2008.
To account for this result, a possible reason is that the PBC waits and sees how the domestic economy respond to the global financial crisis. The central bank is also cautious about its adjustment of the benchmark lending rates, to avoid fluctuation in China's financial market when there is increasing uncertainty from external economic environment.

Another reason is that in 2008, when the global financial crisis occurred, China recorded a dramatic rising in property price. To depress the overheated property market, the PBC tends to maintain high lending rate. In China, asset price also has impact on retail lending rates. (Li and Wang, 2010).

Regarding the regression models which take the lending rate liberalization into account, the dummy variable of removal of upper limit has a positive and significant coefficient of 0.762. It means that after the PBC removed the upper limit of bank lending rate in Oct 2004, the benchmark of one-year lending rate is 0.762 percent higher than the rate before removal. However, the dummy variable of removal of lower limit records a statistically insignificant coefficient and we fail to observe the possible influence of removal of lower limit whether is positively or negatively correlated to the benchmark lending rate. One possible reason is that only six quarters
with the removal of both the upper and lower limit are examined. The time is relatively short when comparing with the time after upper limit removal. Therefore, further empirical study is needed to estimate the impact of lower limit removal on lending rate.

The positively significant constant, ranging from 5.047 to 5.693, represents that the sum of target inflation rate and equilibrium real benchmark rate of one-year lending is close to 5 percent.

### 6.3 Third regression (Benchmark of bank deposit rate)

The major results of the third set of regressions are reported in Table 4 as follows.

<table>
<thead>
<tr>
<th>Dependent variable: Benchmark of one-year bank deposit rate</th>
<th>Equation (3a) (Simplified Taylor rule)</th>
<th>Equation (3b) (Simplified Taylor rule +RRR)</th>
<th>Equation (3c) (Simplified Taylor rule +RRR +D_FIN)</th>
<th>Equation (3d) (Simplified Taylor rule +D_RELOW)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Constant</td>
<td>2.483** (21.212)</td>
<td>1.537** (9.199)</td>
<td>1.503** (9.302)</td>
<td>1.649** (9.136)</td>
</tr>
<tr>
<td>Inflation rate</td>
<td>0.296** (2.391)</td>
<td>0.198** (2.162)</td>
<td>0.320** (3.070)</td>
<td>0.269** (2.726)</td>
</tr>
<tr>
<td>Output gap (Linear trend)</td>
<td>-0.00019 (-0.473)</td>
<td>-0.00028 (-0.955)</td>
<td>0.000013 (0.043)</td>
<td>0.00092** (2.455)</td>
</tr>
<tr>
<td>RRR</td>
<td>/</td>
<td>0.075**</td>
<td>0.069**</td>
<td>/</td>
</tr>
</tbody>
</table>
Similar to the results of second regression (benchmark of one-year bank lending rate), the inflation rate is positively correlated to the benchmark deposit rate. The coefficient of output gap is insignificant, except for the case in which dummy variable of lower limit removal is added into regression: with a positively significant coefficient of 0.00092, when output gap increases by one standard deviation of 221.401 billion, the benchmark deposit rate will rise by 0.2 percent. The increase in benchmark rate caused by one standard deviation increase in output gap is 0.011 percent slightly larger than that by one standard deviation increase in inflation rate. Consistent with the interbank lending rate, the benchmark deposit rates is more responsive to the output gap than to inflation rate.

The coefficient of RRR is estimated at 0.075 and 0.069, which are higher than that in
the second regression (benchmark of one-year bank lending rate). For the two dummy
variables, the global financial crisis has a positive coefficient of 0.705, which is
slightly smaller than second regression by 0.09. And, the lower limit removal with a
positive coefficient of 1.08, meaning that the benchmark of one-year deposit rate is
1.08 percent higher if there is no lower limit imposed. This increase in the benchmark
deposit rate is highly significant which accounts for 1.5 standard deviation of the rate.

Lastly, the constant, that is the sum of equilibrium real benchmark rate of one-year
deposit and inflation target, ranges from 1.503 to 2.483.

Overall, the constant, independent variables and dummy variables in this third
regression (benchmark of one-year bank deposit rate) have the same direction of
correlation with benchmark rates as in the second regression (benchmark of one-year
bank lending rate). There are only small differences in terms of the size of each
coefficient between these two sets of regression.
6.4 Fourth regression (Monetary stance)

The major results of the third regressions are reported in Table 5 as follows.

<table>
<thead>
<tr>
<th>Table 5: Fourth regression</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Dependent variable:</strong></td>
</tr>
<tr>
<td>Monetary stance indicator</td>
</tr>
<tr>
<td>Constant</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td>Inflation rate</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td>Output gap</td>
</tr>
<tr>
<td>(Linear trend)</td>
</tr>
<tr>
<td>Observations</td>
</tr>
<tr>
<td>Std. Error</td>
</tr>
<tr>
<td>$R^2$</td>
</tr>
<tr>
<td>Adjusted $R^2$</td>
</tr>
</tbody>
</table>

Note: ** denote significant at the 5% level.
The t-statistics are stated in the parentheses.

The inflation rate has a positive coefficient of 1.012. It implies that 1 percent rise in the inflation rate will lead to an increase in the value of monetary stance indicator, that is the PBC increases tightness of monetary policy implemented, vice versa. This result matches our previous expectation. The coefficient of output gap is statistically insignificant which means the output gap may not affect policy stance in China. And, it is consistent with He and Pauwels (2008) suggested that the output gap is not a determinant of policy stance changes by the PBC. Unlike results from the first and second set of regression, the constant has a negative value of -0.619. It implies that
monetary stance will close to "easing" if no inflation and output gap (i.e. deviation of real GDP from potential GDP).

Robustness test

In this paper, a robustness test is conducted.

The output growth rate is employed to replace output gap as a independent variable in our regression model. It is measured in percentage of real GDP in previous quarter as below.

\[
100(Y_t - Y_{t-1})/Y_{t-1}
\]

where \( Y_t \) is the real GDP in current quarter and \( Y_{t-1} \) is the real GDP in previous quarter.

The result of robustness check is summarized as shown in the Appendix IV and is briefly described as below. For the first regression, the constant, inflation rate and RRR remain to be positively significant with a similar size of coefficient. The only change is the real GDP growth rate is negatively significant. For the second regression, the estimated coefficients of real GDP growth rate are not in a consistent direction of correlation with bank lending rate and some are insignificant. In terms of correlation and significance, coefficients of the three dummy variables (financial crisis, and removal of upper and lower limit) in line with the result using output gap. For the
third and fourth regression, the result is similar with using the output gap.

In short, regarding the constant, inflation rate, RRR and the dummy variables, the result from robustness test is consistent with our previous estimation, with slightly changes in the magnitude. The real GDP growth rate records significantly negative coefficient in some cases, which cannot be explained in this paper and future investigation is needed.

7. Discussion of results and Limitations of study

In this section, we describe the major findings arise from aforementioned empirical results, meanwhile, compare and contrast our findings with those from previous researches.

First of all, for the market-determined interbank interest rate, the findings are as below. The lending rates in national interbank market can be influenced by not only price level and output changes, but also by the reserve requirement ratio (RRR), which is one of the quantity-based monetary tools of the PBC. Nevertheless, the 7-day repo rate, as another key interbank interest rate in China, is not affected by the RRR adjustment and OMOs as suggested in Porter and Xu (2009).
Interbank lending rates also play an important role in the monetary policy transmission mechanism in China as a interest rate channel. This finding is built on our result that the RRR influences interbank lending rate, and the fact that interbank market is a wholesale market for funds, which is interrelated to the retail market of bank deposit and lending. Take rise in the RRR (by the PBC) as an example. It will cause rise in interbank lending rates, that is increasing the cost of funds in the wholesale interbank market and hence, increase retail lending rate. As a result, reduce borrowing of funds from commercial banks and lower inflation. However, interbank interest rate pose only short-term effects on stabilizing inflation and promoting output (Yang & Teng, 2011). The role of interbank rate in monetary policy transmission is strengthened by the liberalization of bank deposit and lending rates (Porter and Xu, 2009).

To some extent, the interbank lending rate can be used as a measure of China's monetary policy because of its quite significant positive correlation with the RRR. Our findings is in line with the result of cointegration test by Lu and Zhong (2003). Some economists (Xie & Luo, 2002; Zheng, Wang & Guo, 2012) also adopt the interbank lending rates as policy interest rate. Given the segmentation of financial

---

12 In this paper, by calculation, the correlation coefficient between RRR and interbank lending rate at three maturity is 0.528 for overnight; 0.684 for 7-day; and 0.658 for 30-day.
markets in China, Liu and Zhang (2007) argue that the short-term interbank interest rates are not necessarily a accurate measure of policy stance. Therefore, a number of researches (He & Pauwels, 2008; Xiong, 2012; Sun, 2013, 2015) observe a set of monetary tools including the RRR, adjustment in the policy deposit and lending interest rates, and changes in outstanding central bank bills by OMOs, to measure policy stance of the PBC. The measure is also constrained by unobservable monetary policy tools, such as “window guidance”.

Second, regarding the regulated bank interest rates, we obtain the following findings. Both the benchmark deposit and lending rates have positive correlation with inflation but they do not necessarily reflect a inflation targeting of the PBC, which is in opposition to Girardin, Lunven and Ma suggested (2012, 2014).

The response of interest rate to inflation and output gap is not necessarily related to the degree of liberalization of that interest rate. The benchmark of bank lending rate has insignificant coefficient on output gap even though both the ceiling and floor on this rate are removed. On the other hand, the benchmark of bank deposit rate, with ceiling, has positively significant coefficient on output gap. Therefore, we argue that a more liberalized policy interest rate does not mean it is more responsive to
macroeconomic variables.

Third, it is the comparison between estimated coefficient and the Taylor principle\(^\text{13}\). It is worth noting that in the first three sets of regression (focus on interbank lending rate, benchmark of bank lending and deposit rates), the estimated coefficients of inflation rate to interest rate is smaller than 1, that is \(\beta_1 < 1\), is lower than the level suggested by Taylor (1993). It indicates that the interest rate adjustment by central bank is smaller than the changes in actual inflation rate. If interest rate rises by a smaller size than inflation rate when inflation rate increases, the real interest rate will fall, leading to the increase in aggregate demand and hence, higher inflation. Conversely, if interest rate drops by a smaller size than inflation rate when inflation rate decreases, the real interest rate will rise, leading to the decrease in aggregate demand and hence, stronger deflation (Li & Wang, 2010). In short, the response of interest rate to inflation rate is accommodative which will reinforce inflation or deflation in the economy.

The above theoretical interpretation may not appropriately describe the situation in China because of the fact that the People’s Bank of China (PBC) conducts monetary policy with a combination of price- and quantity-based tools. Apart from the RRR and

\(^{13}\) The Taylor principle suggests that for the Taylor rule, coefficient of inflation rate should be greater than 1 (\(\beta_1 > 1\)). And, coefficient of output gap should be positive (\(\beta_2 > 0\)).
bank deposit and lending rate (with floor and ceiling) examined in this paper, there
are open market operations (OMOs), central bank lending, rediscounting, window
guidance and etc. If we combine the effect of all these monetary tools on inflation, a
sum of their coefficient on inflation rate would be greater than 1, which conform to
the Taylor principle.

There are some limitations with this paper, they are:

Firstly, the limitation of integrating the real equilibrium interest rate and target
inflation rate into a constant is that we fail to differentiate each rate from the sum and
estimated size to each rate. And, these two rates change frequently in response to the
state of economy (Li & Wang, 2010).

Secondly, this paper is constrained by the availability of data. We fail to observe changes in
the size of coefficients of inflation rate, output gap and the RRR, before and after
interest rate full liberalization. After the upper limit of deposit rate is removed by the
PBC in Oct 2015, more updated data would enable us to divide the sample period into two
sub-sample periods and conduct separate regression. Hence, to examine the influence of full
liberalization of bank deposit and lending rates.
Last, it is the exchange rate assumption. In the Taylor rule, it is assumed that a flexible exchange rate system is adopted in the economy and the short-term nominal interest rate is set independently. Currently, China adopts a managed floating exchange rate system. However, the exchange rate is pegged with the U.S. dollar de facto, meaning that currency in China affected by the U.S. exchange rate. As a result, it is impossible for the PBC to conduct independent monetary policy, and the U.S. monetary policy has to be taken into account. Therefore, we may input exchange rate as an independent variable into the regression model in future research.

8. Conclusion

Interbank lending rates are positively correlated with inflation, output gap and the RRR. The strength of output gap and the RRR is the largest to affected the interbank rates. It is found that interbank lending rates also play as an interest rate mechanism in the monetary policy transmission in China. However, the effects on stabilizing inflation and promoting output is short-termed.

Having a significant positive correlation with the RRR, interbank lending rate can be a measure of China's monetary policy.

The benchmark bank rates are influenced by the inflation rate and the RRR, but not
the output gap. The benchmark deposit and lending rates have positive correlation with inflation but it needs not reflect a inflation targeting of the PBC. The removal of upper and lower limit of bank interest rates tends to increase the benchmark rates. But we fail to observe if there is any changes in the size of coefficient of inflation rate, output gap and the RRR after interest liberalization.

Lastly, in the regression focusing on interbank lending rate, benchmark of bank lending and deposit rates, the coefficients of inflation rate to interest rate is estimated as smaller than 1, which is smaller than Taylor's (1993) suggestion. The insufficient response of interest rate to inflation rate is accommodative, leading to reinforced inflation or deflation in the economy. In fact, the People’s Bank of China (PBC) conducts a combination of price- and quantity-based monetary tools. Combining effect of all monetary tools on inflation, the coefficient on inflation rate would be greater than 1, which is consistent with the Taylor principle.
References


Li, Q., & Wang, Z. (2010). "The Taylor rules and macroeconomic fluctuation in


People's Bank of China (PBC), (2015). “Monetary Policy Department's Response to the Press About the Decrease in Interest Rate, Reserve Requirement Ratio and the Removal of Deposit Rate Upper Limit”.


Data Sources


Appendix

I. Regression result of output detrending by linear trend approach

<table>
<thead>
<tr>
<th>Output detrending (linear trend)</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Constant</td>
<td>2587.339** (41.12)</td>
</tr>
<tr>
<td>Time trend (T)</td>
<td>157.964** (76.456)</td>
</tr>
<tr>
<td>Observations</td>
<td>52</td>
</tr>
<tr>
<td>Std. Error</td>
<td>223.604</td>
</tr>
<tr>
<td>$R^2$</td>
<td>0.992</td>
</tr>
<tr>
<td>Adjusted $R^2$</td>
<td>0.991</td>
</tr>
</tbody>
</table>

Note: ** denote significant at the 5% level.
The t-statistics are stated in the parentheses.

II. Descriptive Statistics of inflation rate, output gap, reserve requirement ratio (RRR) and interest rates

<table>
<thead>
<tr>
<th></th>
<th>Mean</th>
<th>Median</th>
<th>Std. deviation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Inflation rate</td>
<td>0.6497</td>
<td>0.52686</td>
<td>0.70364</td>
</tr>
<tr>
<td>Output gap (Linear trend)</td>
<td>1.30E-10</td>
<td>-36.66792</td>
<td>221.401</td>
</tr>
<tr>
<td>RRR</td>
<td>13.36699</td>
<td>15</td>
<td>5.56611</td>
</tr>
<tr>
<td>Interbank lending rate</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Overnight</td>
<td>2.21383</td>
<td>2.12593</td>
<td>0.69982</td>
</tr>
<tr>
<td>7-Day</td>
<td>2.74214</td>
<td>2.43445</td>
<td>0.95006</td>
</tr>
<tr>
<td>30-Day</td>
<td>3.19971</td>
<td>2.90185</td>
<td>1.19568</td>
</tr>
<tr>
<td>Benchmark</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>one-year lending rate</td>
<td>5.89213</td>
<td>5.7575</td>
<td>0.62146</td>
</tr>
<tr>
<td>Benchmark</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>one-year deposit rate</td>
<td>2.67481</td>
<td>2.4425</td>
<td>0.63986</td>
</tr>
</tbody>
</table>

56
### III: Regression result of Independent variable coefficient times 1 std. deviation

<table>
<thead>
<tr>
<th>Independent variable (coefficient times 1 std. deviation)</th>
<th>Equation 1a (Simplified Taylor rule)</th>
<th>Equation 1b (Simplified Taylor rule + RRR)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Overnight</td>
<td>7-Day</td>
</tr>
<tr>
<td>Inflation rate</td>
<td>0.197</td>
<td>0.377</td>
</tr>
<tr>
<td>Output gap (Linear trend)</td>
<td>0.365</td>
<td>0.390</td>
</tr>
<tr>
<td>RRR</td>
<td>/</td>
<td>/</td>
</tr>
</tbody>
</table>

### IV: Regression result of adopting output growth rate in regression model

<table>
<thead>
<tr>
<th>Dependent variable: Interbank lending rates</th>
<th>First regression</th>
</tr>
</thead>
<tbody>
<tr>
<td>Equation 1a (Simplified Taylor rule)</td>
<td>Equation 1b (Simplified Taylor rule + RRR)</td>
</tr>
<tr>
<td>Dependent variable: Interbank lending rates</td>
<td>Overnight</td>
</tr>
<tr>
<td>Constant</td>
<td>3.716**</td>
</tr>
<tr>
<td>Inflation rate</td>
<td>0.316**</td>
</tr>
<tr>
<td></td>
<td>(2.737)</td>
</tr>
<tr>
<td>Real GDP growth rate</td>
<td>-0.716**</td>
</tr>
<tr>
<td></td>
<td>(-5.054)</td>
</tr>
<tr>
<td>RRR</td>
<td>/</td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td>Observations</td>
<td>52</td>
</tr>
<tr>
<td>Std. Error</td>
<td>0.567</td>
</tr>
<tr>
<td>$R^2$</td>
<td>0.368</td>
</tr>
<tr>
<td>Adjusted $R^2$</td>
<td>0.342</td>
</tr>
</tbody>
</table>

Note: ** denote significant at the 5% level.
The t-statistics are stated in the parentheses.

<table>
<thead>
<tr>
<th>Dependent variable:</th>
<th>Equation (4) (Simplified Taylor rule)</th>
<th>Equation (5) (Simplified Taylor rule +RRR)</th>
<th>Equation (6) (Simplified Taylor rule +RRR +D_FIN)</th>
<th>Equation (7) (Simplified Taylor rule +D_REUPP)</th>
<th>Equation (8) (Simplified Taylor rule +D_REUPP +D_RELOW)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Constant</td>
<td>6.352** (18.788)</td>
<td>5.171** (9.263)</td>
<td>4.941** (9.176)</td>
<td>5.841** (17.503)</td>
<td>5.959** (16.724)</td>
</tr>
<tr>
<td>Inflation rate</td>
<td>0.375** (3.269)</td>
<td>0.275** (2.380)</td>
<td>0.389** (3.272)</td>
<td>0.324** (3.121)</td>
<td>0.320** (3.077)</td>
</tr>
<tr>
<td>Real GDP growth rate</td>
<td>-0.295** (-2.095)</td>
<td>-0.023 (-0.138)</td>
<td>0.039 (0.239)</td>
<td>-0.275** (-2.176)</td>
<td>-0.323** (-2.372)</td>
</tr>
<tr>
<td>RRR</td>
<td>0.045** (2.583)</td>
<td>0.042** (2.516)</td>
<td>/</td>
<td>/</td>
<td>/</td>
</tr>
<tr>
<td>Dummy: Financial crisis</td>
<td>/</td>
<td>0.857** (2.483)</td>
<td>/</td>
<td>/</td>
<td>/</td>
</tr>
<tr>
<td>Dummy: Upper limit removal</td>
<td>/</td>
<td>/</td>
<td>/</td>
<td>0.629** (3.63)</td>
<td>0.662** (3.743)</td>
</tr>
<tr>
<td>Dummy: Lower limit removal</td>
<td>/</td>
<td>/</td>
<td>/</td>
<td>/</td>
<td>-0.231 (-0.952)</td>
</tr>
<tr>
<td>Observations</td>
<td>52</td>
<td>52</td>
<td>52</td>
<td>52</td>
<td>52</td>
</tr>
<tr>
<td>Std. Error</td>
<td>0.565</td>
<td>0.534</td>
<td>0.508</td>
<td>0.505</td>
<td>0.506</td>
</tr>
<tr>
<td>$R^2$</td>
<td>0.207</td>
<td>0.304</td>
<td>0.385</td>
<td>0.378</td>
<td>0.390</td>
</tr>
<tr>
<td>Adjusted $R^2$</td>
<td>0.175</td>
<td>0.260</td>
<td>0.332</td>
<td>0.339</td>
<td>0.338</td>
</tr>
</tbody>
</table>

Note: ** denote significant at the 5% level.
The t-statistics are stated in the parentheses.
### Third regression

<table>
<thead>
<tr>
<th>Dependent variable: Benchmark of one-year RMB deposit rate</th>
<th>Equation (4) (Simplified Taylor rule)</th>
<th>Equation (5) (Simplified Taylor rule +RRR)</th>
<th>Equation (6) (Simplified Taylor rule +RRR +D_FIN)</th>
<th>Equation (7) (Simplified Taylor rule +D_RELOW)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Constant</td>
<td>3.644** (11.263)</td>
<td>1.824** (3.869)</td>
<td>1.640** (3.583)</td>
<td>3.009** (10.460)</td>
</tr>
<tr>
<td>Inflation rate</td>
<td>0.391** (3.559)</td>
<td>0.236** (2.422)</td>
<td>0.327** (3.237)</td>
<td>0.327** (3.656)</td>
</tr>
<tr>
<td>Real GDP growth rate</td>
<td>-0.513 (-3.805)</td>
<td>-0.094 (-0.657)</td>
<td>-0.044 (-0.320)</td>
<td>-0.488 (-4.482)</td>
</tr>
<tr>
<td>RRR</td>
<td>/</td>
<td>0.069** (4.715)</td>
<td>0.066** (4.730)</td>
<td>/</td>
</tr>
<tr>
<td>Dummy: Financial crisis</td>
<td>/</td>
<td>/</td>
<td>0.684** (2.332)</td>
<td>/</td>
</tr>
<tr>
<td>Dummy: Lower limit removal</td>
<td>/</td>
<td>/</td>
<td>/</td>
<td>0.782** (5.235)</td>
</tr>
<tr>
<td>Observations</td>
<td>52</td>
<td>52</td>
<td>52</td>
<td>52</td>
</tr>
<tr>
<td>Std. Error</td>
<td>0.540</td>
<td>0.451</td>
<td>0.432</td>
<td>0.436</td>
</tr>
<tr>
<td>$R^2$</td>
<td>0.315</td>
<td>0.532</td>
<td>0.580</td>
<td>0.564</td>
</tr>
<tr>
<td>Adjusted $R^2$</td>
<td>0.287</td>
<td>0.503</td>
<td>0.545</td>
<td>0.537</td>
</tr>
</tbody>
</table>

Note: ** denote significant at the 5% level.
The t-statistics are stated in the parentheses.

### Fourth regression

<table>
<thead>
<tr>
<th>Dependent variable: Monetary stance indicator</th>
</tr>
</thead>
<tbody>
<tr>
<td>Constant</td>
</tr>
<tr>
<td>Inflation rate</td>
</tr>
<tr>
<td>Real GDP Growth rate</td>
</tr>
</tbody>
</table>

59
<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Observations</td>
<td>52</td>
</tr>
<tr>
<td>Std. Error</td>
<td>1.144</td>
</tr>
<tr>
<td>$R^2$</td>
<td>0.332</td>
</tr>
<tr>
<td>Adjusted $R^2$</td>
<td>0.305</td>
</tr>
</tbody>
</table>

* and ** denote significant at the 1% and 5% level respectively.

The t-statistics are stated in the parentheses.