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WHAT PROMPTS THE PEOPLE'S BANK OF CHINA TO CHANGE ITS MONETARY POLICY STANCE? EVIDENCE FROM A DISCRETE CHOICE MODEL

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Abstract

In this paper, we model the policy stance of the People's Bank of China (PBoC) as a latent variable, and the discrete changes in the reserve requirement ratio, policy interest rates, and the scale of open market operations are taken as signals of movement of this latent variable. We run a discrete choice regression that relates these observed indicators of policy stance to major trends of macroeconomic and financial developments, which are represented by common factors extracted from a large number of variables. The predicted value of the estimated model can then be interpreted as the implicit policy stance of the PBoC. In a second step, we estimate how much of the variation in the PBoC's implicit stance can be explained by measures of its policy objectives on inflation, growth and financial stability. We find that deviations of CPI inflation from an implicit target and deviations of broad money growth from the announced targets figured significantly in PBoC's policy changes, but not output gaps.

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Executive Summary:

- *Analysis of monetary policy in China suffers from the lack of a good measure of the policy stance of the PBoC. Short-term interbank interest rates are not necessarily a good measure due to the segmentation of credit markets. Also, even though the PBoC announces monetary aggregate targets, they are changed infrequently (once a year) and their controllability is questionable. This paper attempts to estimate a measure of the PBoC's policy stance by studying the PBoC's policy actions. It aims to answer the following questions: Is PBoC's behaviour predictable? Can we measure the monetary policy stance of the PBoC by making use of the signals sent by observed changes in the policy instruments? How much of the variation in the PBoC's implicit stance can be explained by measures of its policy objectives? What is the relative importance of PBoC's stated objectives in influencing its policy actions?*

- *We take the view that the PBoC's monetary policy stance should be determined by current macroeconomic developments and the PBoC's outlook. Because the information set that is relevant to PBoC's actions is not known to the public and can be large, we extract common factors representing the major trends of macroeconomic and financial developments from a large number of data and use them as determinants of the PBoC's policy stance.*

- *We then estimate a discrete choice model, where the left-hand-side latent variable is the PBoC's implicit policy stance measured from the observed signals of change in PBoC's policy instruments, and the common factors are the explanatory variables. We take the fitted or predicted values of the dependent variable as an index of PBoC's implicit monetary policy stance.*

- *In a second step, we illustrate the usefulness of the implicit stance measure by estimating a quasi-policy rule of the PBoC. We estimate how much of the variation in the implicit PBoC stance can be explained by measures of the stated policy objectives, after controlling for foreign exchange inflows arising from balance of payments surpluses. We find that deviations of CPI inflation from an implicit target and deviations of broad money growth from the announced targets figured significantly in PBoC's policy changes, but not output gaps. These findings are consistent with a characterization of the monetary policy framework in China as one of "implicit inflation targeting".*

- *The model we constructed in this paper should be seen as a first step toward a better understanding of PBoC's monetary policy stance. Nevertheless, even this first step has delivered some useful insights. It shows that it is possible to derive an implicit index of PBoC's monetary policy stance from the observed changes in its policy instruments. It also shows that PBoC's desired policy stance can be reasonably well explained by its stated policy objectives, especially CPI inflation.*

- *In terms of predictive power of the discrete choice model, the model predicts well decisions of "no change"; it does a reasonably good job of predicting "tightening" decisions, but does a poor job of predicting "loosening" decisions. In general, it appears that the timing of PBoC's policy response is difficult to predict reliably. This may to an important extent reflect the fact that we do not have a large number of observations to work with to estimate the model. As we accumulate more data points of PBoC's actual policy changes, the performance of the model is likely to improve.*

- *The predictive power of the model is also constrained by the institutional features of the monetary decision-making process in China, which can be characterized as "PBoC proposes but the State Council disposes." There may be important and variable time lags between PBoC's proposal and State Council's disposal. Also, the information set containing the pertinent variables that PBoC uses to propose policy decisions may be different from the information available to the public when the decision is announced.*

- *Overall, the latent variable model appears to be a promising approach to studying the monetary policy stance of the PBoC, which uses multiple policy instruments, both observed and unobserved, and operates in a complex institutional framework.*

I. INTRODUCTION

With the growing influence of the Chinese economy, monetary policy decisions of the People's Bank of China (PBoC) have received increasing attention. Just like there are professional "Fed watchers", there are also an expanding number of professional "PBoC watchers". However, predicting PBoC's behaviour has been a difficult exercise. This is not only because the monetary policy decision making process is complicated, but also due to the fact that little formal empirical research has been done on the subject. While a number of recent papers have described PBoC's policy framework (e.g., see Geiger 2006, Laurens and Maino 2007, Peng, Chen and Fan 2006) and have attempted to model PBoC's behaviour rules (e.g., Liu and Zhang, 2007), we are not aware of any paper that conducts a formal analysis of PBoC's actual behaviour.

Research on monetary policy effects or transmission mechanisms in China also suffers from the lack of a good measure of the monetary policy stance of the PBoC. Unlike the Fed or other major central banks, the PBoC does not have an obvious operational target that can be used as a main indicator of its policy stance. Short-term interbank interest rates are not necessarily a good measure due to the segmentation of credit markets (Liu and Zhang, 2007). Also, even though the PBoC makes annual announcements of targets on monetary aggregates, these indicative targets are not a good indicator of PBoC's policy stance, which changes throughout the year along with the macroeconomic and financial conditions of the economy.

Thus, while we know that PBoC is in action when we observe that it announces a hike in the reserve requirement ratio, a change in the policy deposit and lending interest rates, or a sudden surge in the outstanding amount of central bank bills, its policy stance is in fact hidden behind the policy actions. Moreover, not all of the monetary policy actions in China are observed. An obvious example is "window guidance". In addition, while the PBoC is the official agency in China in charge of the *implementation* of monetary policy, the decision power of monetary policy in fact lies with the State Council, or the cabinet. In other words, "PBoC proposes but the State Council disposes", which may imply that some of the desired policy actions by the PBoC may be undertaken in a different format ("administrative measures") or by another government agency (e.g., the National Development and Reform Commission).

This paper attempts to fill the void and aims to answer the following questions: Is PBoC's behaviour predictable? Can we measure the monetary policy stance of the PBoC by making use of the signals sent by observed changes in the policy instruments? How much of the variation in the PBoC's implicit stance can be explained by measures of its policy objectives? What is the relative importance of PBoC's stated objectives in influencing its policy actions?

In this paper we estimate a linear index of the monetary policy stance of the PBoC, but we draw information about it from the observed changes in monetary policy instruments as well as macroeconomic and financial variables that may have figured in PBoC's policy thinking. We take the view that the PBoC's monetary policy stance should be determined by current macroeconomic developments and the PBoC's outlook for the economy in the near future. Because the information set that is relevant to PBoC's actions is not known to us or the public and can be large, as a first step, we extract common factors representing the major trends of macroeconomic and financial developments from a large number of nonstationary time-series and using them as determinants of PBoC's policy actions. We use a robust technique proposed by Bai and Ng (2004) to estimate both stationary and nonstationary common factors from large panels without requiring the errors to be stationary. We then estimate a discrete choice model, where the left-hand-side latent variable is the PBoC's implicit policy stance measured from the observed changes in PBoC's policy instruments, and the common factors are the explanatory variables. We take the fitted or predicted values of the dependent variable as an index of PBoC's implicit monetary policy stance.

The approach to estimate the discrete choice model in this paper follows the methodology used by Hu and Phillips (2004b), who classifies the Fed's decision-making to change the fund rate into three categories (a 'triple choice' approach): 'increase', 'decrease' or 'no change'. Their paper analyses the persistence and possible asymmetry in Fed's decision making and explore how well macro variables help predicting the timing and direction of these decisions. Their methodology is particularly relevant as it is robust when the dependent and explanatory variables are nonstationary. The common factors depicting macroeconomic and financial trends in China turn out to be mostly nonstationary. It seems sensible to think that such nonstationarity arises from the fast-paced growth of the Chinese economy. More generally, such qualitative response models appear appropriate as it can help to tackle the multi-instruments strategy used by the PBoC. We thus describe the observed policy actions by PBoC with a

'triple choice' indicator variable, where the choices are signals for a "tighter", "looser" and "no change" stance.

In a second step, we illustrate the usefulness of the implicit stance measure with a simple model to estimate a quasi-policy rule of the PBoC. We estimate how much of the variation in the implicit PBoC stance can be explained by measures of the stated policy objectives, such as output gap, and deviation of inflation and money growth from target, after controlling for foreign exchange inflows arising from balance of payments surpluses.

The paper is organised as follows. The next section provides a description of the PBoC's multi-instrument monetary policy framework and defines theoretically a policy stance for the PBoC. Section 3 presents the specification of the factor model and the discrete choice model. Section 4 describes the data and the common factors extraction. Section 5 estimates the PBoC's implicit monetary stance. Section 6 illustrates the use of the implicit stance measure by estimating a quasi-policy rule of the PBoC. Section 7 concludes.

II. THE MONETARY POLICY FRAMEWORK IN CHINA

2.1 Policy targets

According to the "Law on the People's Bank of China", "the aim of monetary policies shall be to maintain the stability of the currency and thereby promote economic growth." Thus the PBoC has a dual mandate, similar to that of the US Federal Reserve. Even though it is not explicitly stated in the law, there is also an understanding that PBoC has the mandate of maintaining stability of the Chinese financial system, reflecting its role as the lender of last resort. The policy implementation framework has evolved since the mid-1990s from relying on quantity-based instruments into a mixture of both quantity and price-based instruments. Although the PBoC does not appear to have an official articulation of its policy framework, it can be described as follows:

- (Implicit) final targets: inflation, growth, and financial stability
- (Indicative) intermediate targets: M2, and banking system credit growth
- (Implicit) operating targets: reserve money, with an eye on short-term interbank interest rates

- Policy instruments: various policy interest rates (including rediscount, re-lending, base lending and deposits rates), reserve requirements, open market operations, and "window guidance"

2.2 Policy instruments

The PBoC actively uses the following main policy instruments which are easily observed by the public: the reserve requirement ratio (RRR), central bank deposit and lending rates, commercial bank benchmark deposit and lending rates, and open market operations through central bank bills. In this paper, we concentrate on the RRR, commercial bank one-year deposit and lending rates, and changes in the outstanding net amount of central bank bills. (Table 1 and Figures 1 to 4) Other policy instruments that cannot be easily observed by the public include foreign exchange interventions, window guidance and administrative measures. Foreign exchange interventions are used by the PBoC to influence the level or the change of the renminbi exchange rate.[2] Window guidance gives nonbinding direction to financial institutions on credit growth and sector allocation. Administrative measures are specifically targeted at commercial banks when loan growth is judged to be too rapid.

The RRR is a quantity-based instrument to manage banking system liquidity. The PBoC reduced its reserve requirement ratio throughout the late 90s. It remained constant at 6 percent until 2003. Since then the PBoC has progressively raised the RRR, and from 2006 onwards has initiated changes in the RRR much more frequently than before. The RRR was cut twice in the late 90s and was raised 14 times between September 2003 and November 2007. In April 2004, the PBoC changed its system of RRR to a differentiated system in which banks with below-standard capital adequacy ratio or asset quality are subject to higher required reserves. Note that it is often the case that the PBoC announces a change in the RRR to be effective at an ulterior date, usually 2 weeks after having made the announcement. Hence, in order to find out what information

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[2] The renminbi exchange rate is not treated as an explicit monetary policy instrument in this paper for reasons of simplicity. We have run a separate model using daily data since July 2005 to detect changes in the speed of appreciation of the RMB against the USD. The formal specification of the model is: $\log(y_t) = \phi_0 + \phi_1 \log(y_{t-1}) + \varepsilon_t$ where $\log(y_t)$ is the logarithm of the RMB/USD exchange rate. The hypothesis tested is that both ϕ_0 and ϕ_1 are stable over the full sample period. We find that the dates when the speed of RMB appreciation accelerates correspond to the months we coded as having policy tightening signals coming from the four observed instruments used in this paper. In other words, the speed of appreciation of the exchange rate does not provide additional information on the PBoC's policy stance.

the PBoC uses to make its monetary policy decisions at given points in time, the relevant date used is the announcement date rather than the effective date.

In general, the PBoC makes less frequent changes in the commercial bank benchmark deposit and lending rates than the RRR. The PBoC has been in the multi-year process of liberalising controls on commercial bank interest rates, and its influence on the cost of credit in the Chinese economy has been gradually reduced. In October 2004, the PBoC removed the upper limit of lending rates and only kept the lower limit. Bank deposit rates were also deregulated except a ceiling set by the benchmark rate. In other words, now commercial bank lending rates are subject to a floor and deposit rates to a ceiling. Lending and deposit rates are almost always changed together in the same direction, except in April 2006 when the lending rate was increased and the deposit rate remained unchanged.

The PBoC started conducting open market operations (OMO) on a regular basis in 2002. Since then, the stock of outstanding central bank bills has increased substantially, reflecting the large need to sterilise the impact on banking system liquidity of heave foreign exchange inflows. The outstanding central bank bills also include the so-called “targeted bills”, which are sold to some specific commercial banks at given points in time. The net changes in the outstanding net amounts from month to month could be volatile. Throughout 2007, the PBoC increasingly used RRR jointly with OMOs. On a number of occasions, maturing central bank bills, which correspond to increased interbank liquidity, were matched with an increase in RRR, with minimal net impact on interbank liquidity. It is thus important to take both instruments into account when drawing conclusions about changes in PBoC’s policy stance.

Figure 1: Reserve requirement ratio

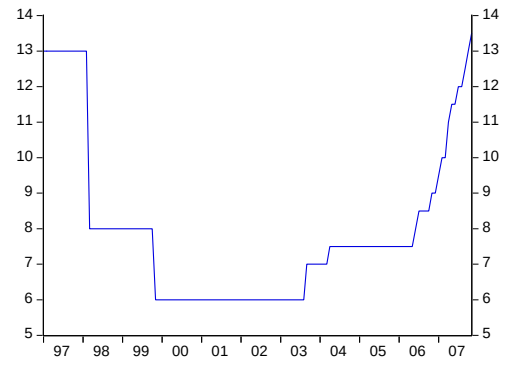


Figure 2: Lending rate

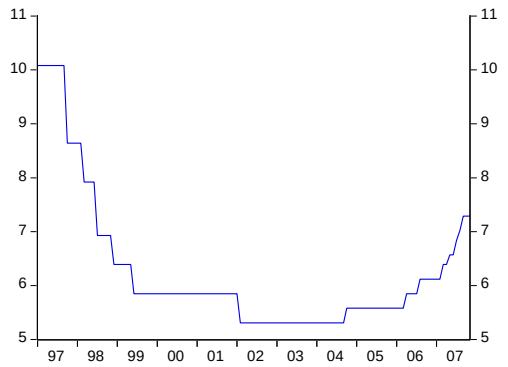


Figure 3: Deposit rate

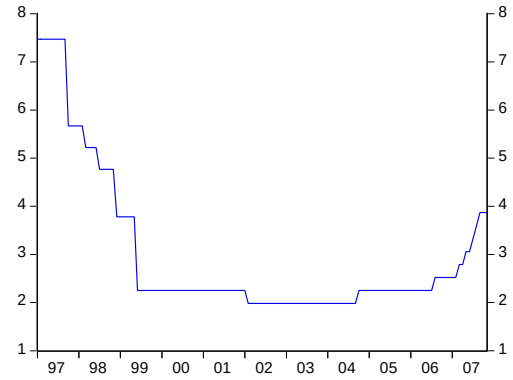
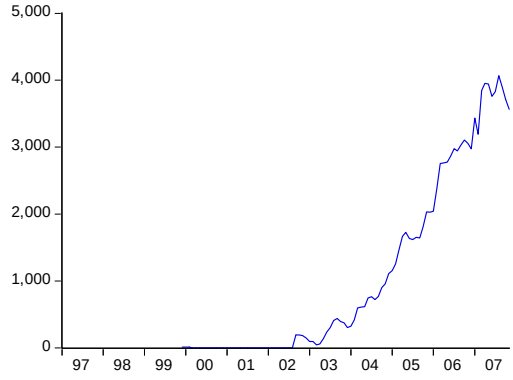


Figure 4: Net outstanding amount of central bank bills (in bn of yuan)



2.3 Defining a "policy stance"

In this section, we define a generic monetary policy stance variable, which is not observed but can be inferred from observed changes in PBoC's policy instruments.

Let **A** be the set of all observed and unobserved policy instruments at the disposal of the PBoC. Let $\mathbf{I} \subseteq \mathbf{A}$ be the set of observed and quantified policy instruments, namely commercial bank deposit (*d*) and lending rates (*l*), reserve requirement ratio (*rrr*), and net outstanding central bank bills (*nocb*), then we define the policy stance as follows:

Definition 1: $\exists f : \mathbf{A} \to \mathbf{S}$ such that $s_t \in \mathbf{S}$ and $(\mathbf{o}_t, \bar{\mathbf{o}}_t) \in \mathbf{A}$:

$$s_t = f(\mathbf{o}_t, \bar{\mathbf{o}}_t)$$

with $\mathbf{o}_t = \{d_1,\ldots,d_T, l_1,\ldots,l_T, rrr_1,\ldots,rrr_T, nocb_1,\ldots,nocb_T\} \in \mathbf{I}$, $\bar{\mathbf{o}}_t$ is the vector of unobserved instruments and $\mathbf{S} = \{s_1,...,s_T\}$ for $t = 1,...,T$ and where f is a function that maps set **A** onto **S**.

s_t is a variable that depend directly on the outcomes of each random observed and unobserved policy instrument in set **A**. The set **S** captures the broad monetary policy stance of the PBoC at any given time *t*.

Next, we estimate a discrete choice model to provide a measurement of the s_t variable.

III. THE MODEL

3.1 The basic model

Consider the following model

$$s_t^* = \hat{F}_t'\theta + \varepsilon_t \quad t = 1,...,T \qquad (3.1)$$

where ε_t is the error term and the dependent variable s_t^* is unobserved and represents the PBoC's implicit monetary policy stance.[3] The implicit monetary policy stance is the underlying monetary policy direction to smooth the monetary condition in China. It is determined by a set of common factors ($\hat{F}_t$) embodying the current macroeconomic and financial developments and the PBoC's perception of the outlook. $\hat{F}_t$ is estimated from a large-scale factor model written as

$$X_{it} = \lambda_i' F_t + \xi_{it} \quad t = 1,...,T \quad i = 1,...,N \qquad (3.2)$$

where ξ_{it} is the idiosyncratic component, F_t are the common factors that need

[3] The errors are assumed to be iid and exogenous. This assumption is rather complex to relax and the current econometric literature has yet to tackle this issue for nonstationary discrete modelling.

to be estimated and X_{it} is the data gathering various piece of economic and financial information, composed of *N* time-series. The motivation in using the common factor approach over specific variables in (3.1) is due to the consideration that, since we do not know exactly what drives the policy stance, a large data set avoids too narrow a selection of key variables and selection bias. The variables composing X_{it} and the methodology to extract common factors are explored in the next sections.

3.2 Extracting policy signals

The PBoC's implicit policy stance is specified through a triple-choice discrete model, where $y_t = -1$ denotes a looser implicit stance, $y_t = 0$ denotes no change in the implicit policy stance and $y_t = 1$ is a tighter one. Moreover, one observes

$$\begin{cases} y_t = -1 & \text{if} \quad s_t^* < \mu_0^1 \\ y_t = 0 & \text{if} \quad \mu_0^1 \le s_t^* \le \mu_0^2 \\ y_t = 1 & \text{if} \quad s_t^* > \mu_0^2 \end{cases} \tag{3.3}$$

where μ_0^1 and μ_0^2 are the threshold parameters.

The actual policy stance of the PBoC at time *t* is

$$\begin{cases} s_t = s_{t-1} - \Delta_t & \text{if} \quad y_t = -1 \\ s_t = s_{t-1} & \text{if} \quad y_t = 0 \\ s_t = s_{t-1} + \Delta_t & \text{if} \quad y_t = 1 \end{cases} \tag{3.4}$$

where the changes in the implicit policy stance are $\Delta_t \in \mathbf{D}$. As in Definition 1 above, let $\mathbf{C} \subseteq \mathbf{B}$ be the set of observed and quantified incremental changes in policy instruments and define the changes in the policy stance:

Definition 2: $\exists g : \mathbf{B} \to \mathbf{D}$ such that $\Delta_t \in \mathbf{D}$ and $(\mathbf{c}_t, \bar{\mathbf{c}}_t) \in \mathbf{B}$:

$$\Delta_t = g(\mathbf{c}_t, \bar{\mathbf{c}}_t)$$

with $\mathbf{c}_t = \left\{\delta_1^d, ..., \delta_T^d, \delta_1^l, ..., \delta_T^l, \delta_1^{rrr}, ..., \delta_T^{rrr}, \delta_1^{nocb}, ..., \delta_T^{nocb}\right\} \in \mathbf{C}$ for $t = 1, ..., T$, where

$\mathbf{c}_t$ is the vector of incremental changes in deposits, lending, reserve requirement ratio and net outstanding amount of central bank bills (NOCB), $\bar{\mathbf{c}}_t$ is the vector of unobserved incremental changes in the unobserved instruments and $\mathbf{D} = \{\Delta_1,...,\Delta_T\}$ for $t = 1,...,T$ and where g is a function that maps set **B** onto **D**.

The magnitudes of the incremental changes in the instruments are different for each instrument but we record the changes as having equal weight. For example, the RRR could change by 50 basis points whereas the lending rate would change by 18 basis points. Specifically, for the case when $y_t = -1$, then:

$$\left.\begin{array}{l} d_t = d_{t-1} - \delta_t^d \\ \text{and/or} \\ l_t = l_{t-1} - \delta_t^l \\ \text{and/or} \\ rrr_t = rrr_{t-1} - \delta_t^{rrr} \\ \text{and/or} \\ nocb_t = nocb_{t-1} - \delta_t^{nocb} \end{array}\right\} \quad \text{if} \quad y_t = -1$$

where at least one δ is not equal to *0*.

Equation (3.1) – (3.4) constitutes this paper's baseline model. We use changes in at least one of the four main instruments of monetary policy as "signals" of a change in the policy stance. We also make the following three assumptions for simplicity:

Assumption 1: *All instruments have equal weight and importance.*

Assumption 2: *Changes in one or more instruments at time t imply that* y_t *will equal either "1" or "-1" depending on the direction of the change. If no change occurs, then* $y_t = 0$.

Assumption 3: *At a given time t, if there are simultaneous changes in two instruments in opposite directions (one increase and the other decrease), their signals cancel off.*

No assumption is made about the magnitude of the change (Δ_t) in

the instrument, except for NOCB as explained in the following section. Moreover, we do not require that the implicit stance be the same as the actual stance ($s_t^* = s_t$). The derived implicit stance reflects a mixture of both observed and unobserved discrete adjustments by the PBoC in its policy instruments.

IV. DATA

4.1 Discrete dependent variable

Table 1 records the events since 1997 when the level of the instruments was changed. A "1" indicates a tighter stance, while a "-1" implies a looser stance. It is not an easy task to determine in which instances the changes in the net outstanding amounts of central bank bills signal a monetary policy intervention. The challenge is to identify months with "larger" withdrawal or injections of bills which are indicative of monetary policy actions, rather than those months when the changes in the NOCB merely reflected normal liquidity management. For example, months with larger injections would signal the intention to reduce the supply of interbank liquidity. After careful analysis, we choose an arbitrary criterion, under which those months when the absolute value of net injections or withdrawals was larger than 100 billion yuan, which roughly corresponds to an average change in the RRR of 25bp, the dependent variable is coded as either "1" or "-1", whereas the months when the absolute value is less than 100 billion yuan, the dependent variable is coded "0". We feel that this criterion allows us to strike a reasonable balance between the risks of over-identifying and under-identifying the months when the changes in the NOCB truly signal a change in the implicit policy stance.

A couple of special cases are worth mentioning when coding "signals" of monetary policy changes. First, note that on four occasions (in February, October and November 2007), there were large net withdrawals of central bank bills and a corresponding increase in the reserve requirement ratio during the same months. Since a net withdrawal and a RRR increase send opposite signals, those instances were coded as "no change" in the overall monetary policy stance of the PBoC. Secondly, we discarded the large negative change in NOCB in June 2007. The reason is that the RRR was raised by 50 basis points in June, even though the change has been announced in May. Moreover, a signal of loosening stance in June would be inconsistent with the signals sent by other instruments in the previous and forthcoming months.

Table 1: Chronology of monetary policy changes

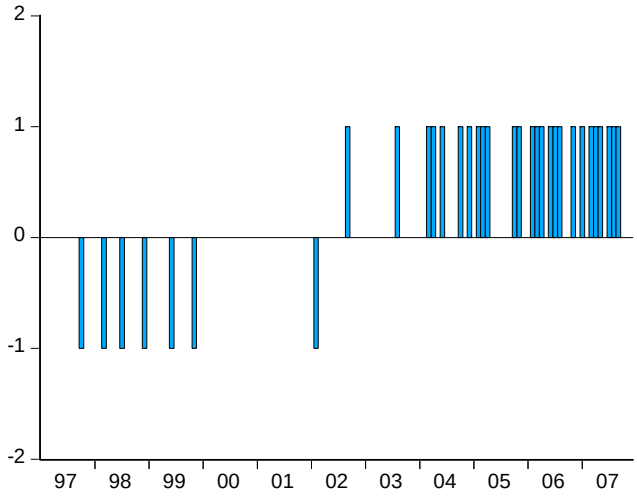
Intervention Date		Monetary Policy Instruments				
Announced	Effective	Lending rate	Deposit rate	RRR	CB bills	Coding
23-Oct-97	24-Oct-97	-1.44	-1.8			-1
21-Mar-98	*23-Mar-98*			-5		-1
n/a	25-Mar-98	-0.72	-0.45			
n/a	01-Jul-98	-0.99	-0.45			-1
n/a	07-Dec-98	-0.54	-0.45			-1
n/a	10-Jun-99	-0.54	-0.45			-1
21-Nov-99	*21-Nov-99*			-2		-1
20-Feb-02	21-Feb-02	-0.54	-0.27			-1
Sep-02					194	1
23-Aug-03	21-Sep-03			1		1
Aug-03					108	
Mar-04					178	1
11-Apr-04	25-Apr-04			0.5		1
Jun-04					132	1
28-Oct-04	29-Oct-04	0.27	0.27			1
Oct-04					135	
Dec-04					153	1
Feb-05					101	1
Mar-05					218	1
Apr-05					195	1
Oct-05					168	1
Nov-05					223	1
Feb-06					341	1
Mar-06					373	1
24-Apr-06	28-Apr-06	0.27				1
16-Jun-06	05-Jul-06			0.5		1
21-Jul-06	15-Aug-06			0.5		1
Jul-06					113	
18-Aug-06	19-Aug-06	0.27	0.27			1
03-Nov-06	15-Nov-06			0.5		1
05-Jan-07	15-Jan-07			0.5		1
Jan-07					553	
16-Feb-07	25-Feb-07			0.5		0
Feb-07					-241	
17-Mar-07	18-Mar-07	0.27	0.27			1
Mar-07					655	
05-Apr-07	16-Apr-07			0.5		1
29-Apr-07	15-May-07			0.5		
18-May-07	05-Jun-07			0.5		1
	19-May-07	0.18	0.27			
Jun-07					-186	0
20-Jul-07	21-Jul-07	0.27	0.27			1
30-Jul-07	15-Aug-07			0.5		
21-Aug-07	22-Aug-07	0.18	0.27			1
Aug-07					241	
06-Sep-07	25-Sep-07			0.5		
14-Sep-07	15-Sep-07	0.27	0.27			1
Sep-07					-173	
13-Oct-07	25-Oct-07			0.5		0
Oct-07					-184	
10-Nov-07	26-Nov-07			0.5		0
Nov-07					-144	

Note: Central Bank bills are expressed in units of billions of yuan.

It is also useful to note that, because the PBoC or the State Council does not meet regularly to make monetary policy decisions, and there is no announcement of a "no change" policy decision even if a meeting takes place, we cannot differentiate between those months when a conscious decision of no policy change was made and those months when we do not observe any signals of policy change simply because there is no policy meeting taking place. In contrast, the FOMC meetings take place on a regular basis and a "no change" decision month can be differentiated from a month when no FOMC meeting takes place.

In order to have a sufficiently large sample of monthly data to estimate the model, for the purpose of analysis, we assume that a monetary policy decision meeting takes place every month, and we code the dependent variable as "0" in those months when we do not observe any change in any one of the policy instruments. This results in a large amount of "zeroes"- or "no change" – as the value of the dependent variable relative to the number of "1" and "-1". Figure 5 depicts the discrete dependent variable. In comparison, Hu and Phillips (2004b) use US data from January 1996 until December 2001, giving a total of 64 observations (8 FMOC meetings a year) that feature 12 rate hikes and 13 cuts. In our case, we have a total of 130 observations that feature 7 instances of "loosening" and 26 instances of "tightening".

Figure 5: Discrete dependent variable y



4.2 Macroeconomic and financial series

There are 82 data series from 7 broad categories, namely real activity, money and reserves, the external sector, stock market indices, exchange rates, interest rates and prices. Some of the categories contain foreign macroeconomic and financial indicators from four of China's trading partners: the USA, the UK, the EU and Japan. Table A1 in the Appendix lists the 82 variables and their respective sources.

All relevant series were seasonally adjusted and corrected for Chinese New Year effect (by taking the averages of January and February of each year). All price variables are measured as year-on-year change, since this is how they are disseminated by the various statistical agencies in China, while the remaining series are measured in log. We test also for unit root in every series using the DFGLS test from Elliott, Rothenberg and Stock (1996) and an ADF test based on Said and Dickey (1984). The tests for nonstationarity reveal that a large part of the data is nonstationary. Table A2 shows the results of the unit root tests.

We lag the data one period since the available economic information released in month *t* will correspond to the $t-1$ data relevant to the PBoC and the State Council for making policy decisions. For example, the PBoC may increase RRR in August 2007 based on the available statistics at that time, which correspond to the data release of July 2007.

4.3 Extracting common factors

Recall the factor model from equation (3.2) for the data, X_{it},

$$X_{it} = \lambda_i' F_t + \xi_{it} \quad t = 1,...,T \quad i = 1,...,N$$

The *r*-vector F_t, which is necessary for our basic discrete choice model and the estimation of an implicit PBoC policy stance, needs to be estimated consistently. As shown above, the data set (X_{it}) is composed of a large amount of nonstationary series. Thus, estimating F_t directly becomes problematic as ξ_{it} may contain nonstationary components. Bai and Ng (2004) propose a technique to overcome the fact that some of the data series are nonstationary and estimate

both stationary and nonstationary factors in large-scale factor model, without requiring the errors (ξ_{it}) to be stationary.

We following Bai and Ng (2004) and extract the common factors through the following four steps:

1. In the presence of nonstationary elements, F_t cannot be estimated consistently; instead, we take the first-difference of equation (3.2)

$$x_{it} = \lambda_i' f_t + e_{it} \quad (4.1)$$

where $x_{it} = \Delta X_{it}$, $f_t = \Delta F_t$ and $e_{it} = \Delta \xi_{it}$

2. The optimal number of common factors for China, *r*, is determined by using the Information Criteria (IC) developed by Bai and Ng (2002). They propose three main criteria to unravel the optimal number of common factors by estimated a loss function subject to a penalty for over-fitting. The three criteria feature different penalty functions. The recommended criterion by Bai and Ng (2004) is IC3, which indicates that $r = 11$, while IC1 and IC2 both select the maximum of 15. Results are shown in Table A3.

3. Next we estimate both λ_i and f_t from the differenced equation (4.1) by the method of principal component. The principal component estimator of f_t is denoted $\hat{f}_t$.

4. Given $\hat{f}_t$, we can now cumulate each factor, yielding

$$\hat{F}_{mt} = \sum_{s=2}^{t} \hat{f}_{ms}$$

for $m = 1,...,11$. $\hat{F}_t$ is the consistent estimator of the *r*-vector F_t.

Lastly, we test for nonstationarity in the extracted common factors $\hat{F}_t$. Table A4 shows the ADF test results for the 11 common factors. Only 2 out of the 11 reject the null of a unit root. Hence, the discrete choice model in the next section needs to be modified accordingly to accommodate nonstationary regressors.

V. THE PBOC'S IMPLICIT POLICY STANCE

5.1 A qualitative response model

We turn back to the discrete model outlined in section 3.1. First recall equation (3.1)

$$s_t^* = \hat{F}_t'\theta + \varepsilon_t \quad t = 1,...,T$$

Since it has been established that some of the common factors are nonstationary, using probit or logit regression frameworks to estimate this model would be problematic. This is because when variables are *I(1)*, conventional asymptotic theory does not hold. In other words, such nonstationarity, if left uncorrected, would render the interpretation of the predictive power of our model invalid.

To overcome this hurdle, we use a technique developed by Hu and Phillips (2004a), which are based on results obtained from Park and Phillips (2000) specifically for nonstationary discrete choice models. The latter paper showed that in the case of binary (0,1) choice models with *I(1)* explanatory variables, a string of similar decisions (same proportion of unit choices) converges to a random variables that follows an arc sine law with probability density $1/\left(\pi\sqrt{y(1-y)}\right)$. Hu and Phillips (2004a) extend this framework as Park and Phillips (2000) could be limited for empirical application. Hu and Phillips (2004b) use polychotomous choices with parametric thresholds governing choices, proposing a range of arc sine laws which allows for diverse distributional shape that permits broken consecutive sequences of similar decisions. Their model is especially useful for modelling central bank behaviour since, although central banks such as the PBoC may make similar consecutive decisions to tighten its policy, these decisions, however, are rarely unbroken over a sequence of tightening months.

Hence, following Hu and Phillips (2004a,b), equation (3.3) can be rewritten as

$$\begin{cases} y_t = -1 & \text{if} \quad s_t^* < \sqrt{n}\,\mu_0^1 \\ y_t = 0 & \text{if} \quad \sqrt{n}\,\mu_0^1 \le s_t^* \le \sqrt{n}\,\mu_0^2 \\ y_t = 1 & \text{if} \quad s_t^* > \sqrt{n}\,\mu_0^2 \end{cases} \quad (3.3)$$

where μ_0^1 and μ_0^2 are the threshold parameters which are scaled by $\sqrt{n}$, where *n* is the sample size. The scaling ensures that the threshold parameters have the same order magnitude as the dependent variable s_t^* in the case when the explanatory variables $\hat{F}_t$ are nonstationary as shown in Hu and Phillips (2004 a,b). Appendix A.1 reviews the estimation and inference procedure from Hu and Phillips (2004a) for this triple-choice discrete model when variables are nonstationary. Next we estimate the probit model (3.1) and produce some within-sample forecast from the model.

5.2 Empirical results

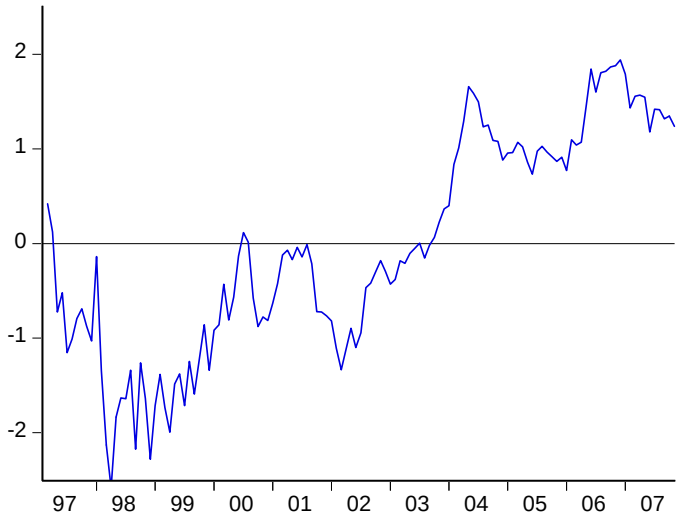
The estimation results are shown in table 2 for information purposes. Note that the estimated thresholds are asymmetric, with a weaker threshold for tighter stance. Figure 6 depicts the estimated PBoC's implicit monetary stance ($\hat{s}_t^*$), which is the predicted or fitted value of the dependent variable. A quick glance at the graph shows that the policy stance of the PBoC became increasingly tighter since 2003. It is also interesting to note that, despite the more frequent policy actions taken by the PBoC during 2007, the estimated implicit stance in late 2007 was actually looser than observed in 2006. Thus, relative to the prevailing macroeconomic conditions, the strength of policy tightening during 2007 was probably weaker than commonly thought.

Table 2: Probit results and threshold estimates

Variable	Estimates	Std
Factor 1	0.038	0.056
Factor 2	-0.003	0.192
Factor 3	-0.380	0.163
Factor 4	-0.278	0.224
Factor 5	1.007	0.906
Factor 6	-0.515	0.470
Factor 7	0.357	0.527
Factor 8	0.285	0.629
Factor 9	1.330	1.237
Factor 10	1.287	1.053
Factor 11	-1.672	1.083
μ^1	-0.215	0.042
μ^2	0.115	0.037

Notes: (1) Standard errors are in the right columns.
(2) The estimates use the BFGS procedure.

Figure 6: The PBoC's implicit monetary policy stance



We measure the goodness of fit of the model by its ability to forecast events of loosening, tightening and no change in the implicit policy stance. Table 3 presents the model's prediction of the PBoC's policy stance versus the actual signals, y_t at a given time. The diagonal elements are the number of times predicted accurately in each of the three categories. The models performances in predicting "loosening" accurately are poor. The tighter stance is more accurately predicted compared to the looser stance. Overall, the model predicts 100 out of 130, or 77%, of the observations correctly. Many of these observations are zeroes or "no change", however. When looking at the predicted changes (tighter or looser stance), the model only predicts 36% of the observations correctly. Figure 7 compares the actual signals versus the predictions by the model.

Table 3: Actual (y_t) vs predicted signals

	Loosening at time *t*	No change at time *t*	Tightening at time *t*
Loosening was predicted	0	1	0
No change was predicted	7	88	14
Tightening was predicted	0	8	12
Total	7	97	26

Notes: (1) The table depicts the model's predicted PBoC's policy stance versus the actual policy signals taken at a given time. The diagonal is the amount predicted accurately in each of the three categories.
(2) "Total" refers to the total amount in each of the categories: "loosening," "no change" and "tightening."

Figure 7: Actual vs forecast policy actions

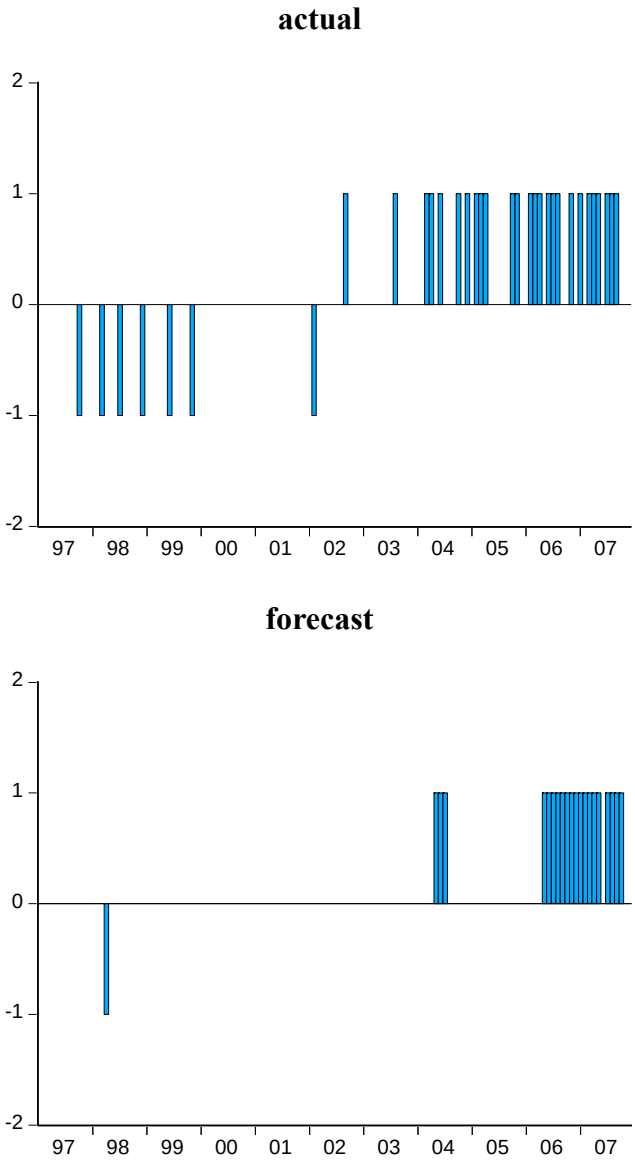
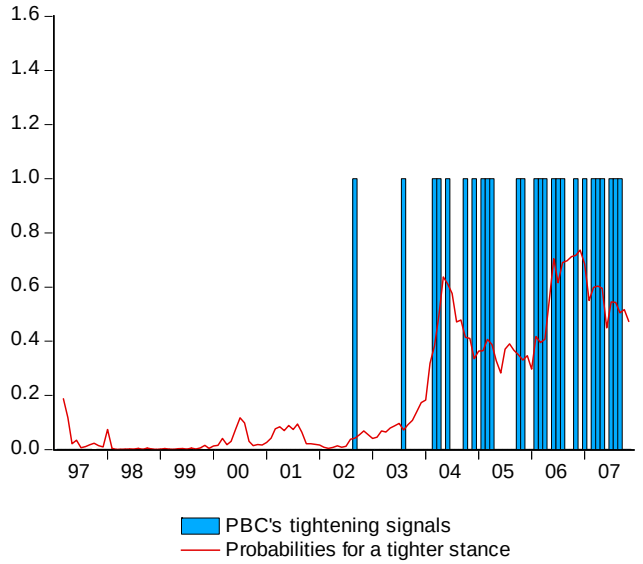
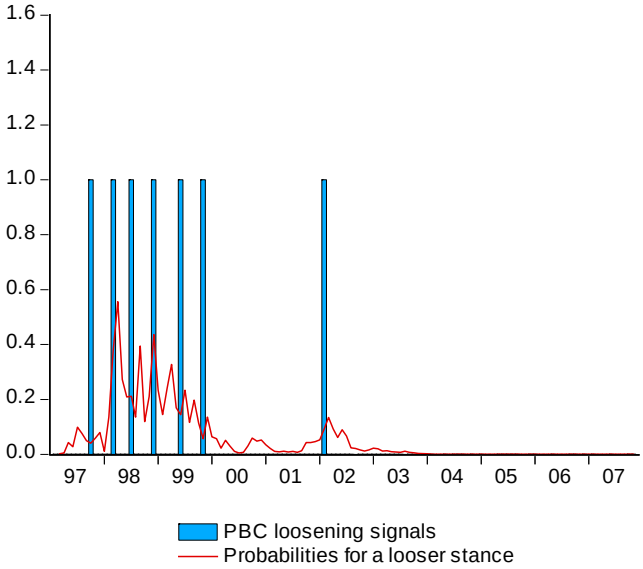


Figure 8: Estimated probabilities of tighter and looser stance





We also calculate the overall probabilities of looser, tighter and no change in the stance, at the average value of $\hat{F}_t$ given the estimated coefficient θ. We find that the probability of a tighter stance $P(y_t = 1)$ is 9%, $P(y_t = -1)$ is 1% and the largest probability is on "no change" 90% of the times on average.

The forecast of Table 3 does not distinguish the magnitude of the estimated probability. In Figure 8, we report the estimated probabilities of tighter and looser monetary policy stance by the PBoC against the actual intervention signals y_t. This is rather useful as it gives us a hint of the direction of the probabilities for given events of interventions. Note that the larger estimated threshold μ^1 compared to μ^2 explains in part the poorer forecast of looser implicit stance.

In assessing the goodness of fit, several issues arise, which could explain the mismatch between the predicted results and the actual decisions. First of all, the use of monthly observations has some limitations. The PBoC changes its policy stance at any time during a given month, sometimes within the first few days and other times at the end of the month. If the change in policy stance happens at the beginning of the month rather than the end, the key economic data for the previous month's performance may not yet be released. Hence there may be a mismatch between the information available at the time of policy change and the information available to the modeller.

Secondly, there have been often time lags between the PBoC's recommendation to change policy instruments and the approval of the State Council. Thus, while the PBoC may realise in a particular month the need to change its policy stance, the implementation may happen in a different month since the State Council may need more time to achieve consensus on PBoC's proposal. Lastly, conditional on the models presented here, the PBoC's change in policy stance does not appear to be very predictable. This may to an important extent reflect the fact that we do not have a large number of observations to work with to estimate the model. As we accumulate more data points of PBoC's actual policy changes, the performance of the model is likely to improve.

VI. AN EXAMPLE TO USE THE ESTIMATED POLICY STANCE

In this section, we illustrate briefly the relevance of the implicit stance by estimating a quasi-policy rule that shows how much of the variation in the implicit stance can be explained by key variables related to the PBoC's stated objectives. We assess the importance of these stated objectives in shaping the

implicit stance estimated in the previous section. We regress the implicit policy stance on measures of PBoC's policy objectives relating to inflation, output gap, and financial stability, after controlling for the impact of foreign exchange inflows on domestic liquidity. Specifically we use the following model:

$$\hat{s}_t^* = \alpha + \beta_1\left(\pi_t^{CPI} - \pi^*\right) + \beta_2\left(y_t^{IP} - y_t^*\right) + \beta_3\left(m_t - m_t^*\right) + \beta_4 fx_t + \nu_t$$

$$t = 1,...,T$$

where π_t^{CPI} is CPI year-on-year inflation, π^* is target inflation set at 3%, y_t^{IP} is output (based on Industrial Production), y_t^* is potential output, m_t is the year-on-year growth rate of M2, m_t^* is the indicative M2 growth rate target announced every year by the PBoC. The growth of reserves, fx, is also included to control for external sector developments of the Chinese economy. We denote $\hat{s}_t^*$ as the implicit policy stance of the PBoC obtained in the previous section.

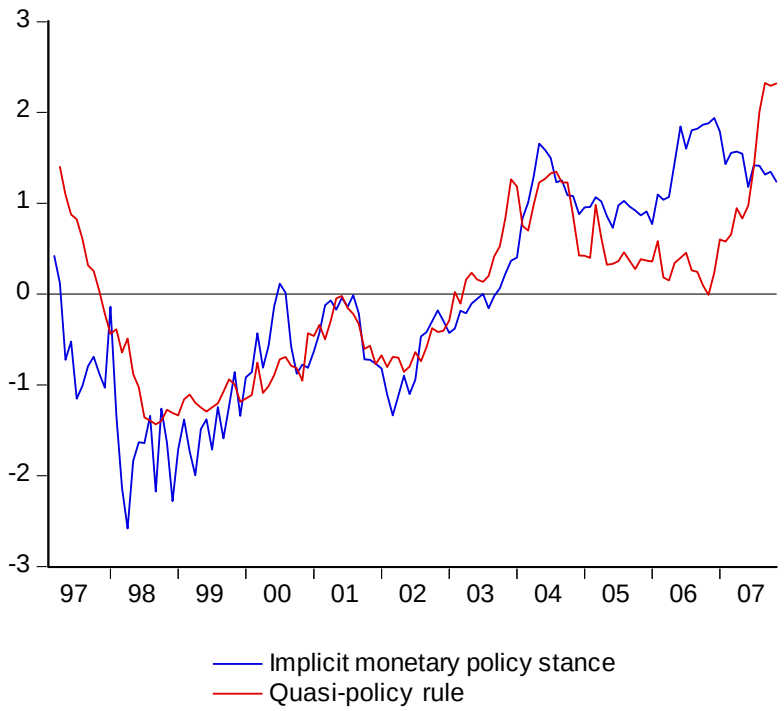
Table 4 presents the results of the model estimated using monthly data. We find that the PBoC reacts systematically to deviation of CPI inflation from an implicit target, and deviation of broad money growth from the announced targets. Furthermore, deviation of inflation has much larger explanatory power than other variables. Output gap on the other hand appears to be relatively less important statistically and quantitatively. Figure 9 presents the fitted values implied by the above model. These values tend to track quite well the implicit stance of the PBoC, except for the recent years. During 2005 – 2006, CPI inflation was relatively low, which would explain why the fitted value under-estimates the implicit stance. Furthermore, it is possible that in the recent years the PBoC has given more importance to the deviation of broad money growth from announced targets than implied by the average relationship estimated over the whole sample period. Overall, it appears that, if the PBoC had followed the estimated quasi-policy rule, its stance would have been looser in 2006 and much tighter than in 2007.

Table 4: Quasi-policy rule estimates

Variable	Estimates	Std
Constant	0.313	0.209
Inflation (dev. from target)	0.382 ***	0.046
Industrial production gap	0.015	0.020
M2 (dev. from target)	0.080 **	0.032
Reserves	0.011 **	0.005

Note: (1) Inflation year-on-year growth target is 3% and M2 is variable from year to year.
(2) */**/*** indicates significance at the 10/5/1% level

Figure 9: Quasi-policy rule vs. the implicit stance



VII. CONCLUDING COMMENTS

Because of all the inherent difficulties in modelling the PBoC's policy behaviour, the model we constructed in this paper should be seen as a first step toward a better understanding of the determinants of the PBoC's implicit

monetary policy stance. Nevertheless, even this first step has delivered some useful insights. It shows that it is possible to derive an implicit index of PBoC's monetary policy stance from the observed changes in its policy instruments. It also shows that PBoC's desired policy stance can be reasonably well explained by its stated policy objectives, especially CPI inflation. This observation is consistent with a characterization of the monetary policy framework in China as one of "implicit inflation targeting".

In terms of predictive power of the discrete choice model, the model predicts well decisions of "no change"; it does a reasonably good job of predicting "tightening" decisions, especially in the recent years but does a very poor job of predicting "loosening" decisions. Overall, it appears that the timing of PBoC's response is difficult to predict reliably. This may to an important extent reflect the fact that we do not have a large number of observations to work with to estimate the model. As we accumulate more data points of PBoC's actual policy changes, the performance of the model is likely to improve.

The predictive power of the model is also constrained by the institutional features of the monetary decision-making process in China. While the PBoC may propose that it was time to take certain policy actions based on certain macroeconomic or financial signals, the State Council may not be in a position to dispose in a timely manner since it makes decisions based on consensus. In other words, other ministries (e.g., the National Development and Reform Commission, the Ministry of Commerce, and the Ministry of Finance) will need to be on board with the proposed change in monetary policy stance before the State Council makes a decision. There may thus be important and variable time lags between PBoC's proposal and State Council's disposal. Also, the information set containing the pertinent variables that PBoC uses to propose policy decisions may be different from the information available to the public when the decision is announced.

Overall, the latent variable model appears to be a promising approach to studying the monetary policy stance of the PBoC, which uses multiple policy instruments, both observed and unobserved, and operates in a complex institutional framework.

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APPENDIX

A.1 Hu and Phillips (2004) – Nonstationary discrete choice model

Consider the following model which depicts the PBoC's implicit monetary policy stance

$$s_t^* = \hat{F}_t^{'}\theta + \varepsilon_t \quad t = 1,...,T$$

where $\hat{F}_t$ is a vector of explanatory variables and ε_t is the error term. The dependent variable s_t^* is unobserved and represents the PBoC's implicit monetary policy stance. What we observe is specified through a triple-choice discrete model, where $y_t = -1$ denotes a looser policy stance, $y_t = 0$ denotes no change in monetary policy and $y_t = 1$ is a tighter policy stance. Moreover, one observes

$$\begin{cases} y_t = -1 & \text{if} \quad s_t^* < \sqrt{n}\,\mu_0^1 \\ y_t = 0 & \text{if} \quad \sqrt{n}\,\mu_0^1 \le s_t^* \le \sqrt{n}\,\mu_0^2 \\ y_t = 1 & \text{if} \quad s_t^* > \sqrt{n}\,\mu_0^2 \end{cases}$$

where μ_0^1 and μ_0^2 are the threshold parameters which are scaled by $\sqrt{n}$ as shown in Hu and Phillips (2004 a,b) , where *n* is the sample size.

In the current triple choice model with error distribution *G*, the probability distribution of y_t written as $\text{Prob}(y_t = j) = P_j(\hat{F}_t; \theta_0, \mu_0)$ for $j = -1, 0, 1$ is given by

$$\begin{aligned} &\text{Prob}(y_t = -1) = P_{-1}(\hat{F}_t; \theta_0, \mu_0) = 1 - G(\hat{F}_t'\theta_0 - \sqrt{n}\mu_0^1) \\ &\text{Prob}(y_t = 0) = P_0(\hat{F}_t; \theta_0, \mu_0) = G(\hat{F}_t'\theta_0 - \sqrt{n}\mu_0^1) - G(\hat{F}_t'\theta_0 - \sqrt{n}\mu_0^2) \\ &\text{Prob}(y_t = 1) = P_1(\hat{F}_t; \theta_0, \mu_0) = G(\hat{F}_t'\theta_0 - \sqrt{n}\mu_0^2) \end{aligned} \quad (3)$$

Furthermore, let's define the following indicator function $\Lambda(t, j)$ as in Hu and Phillips (2004a), which takes the following three forms

$$\begin{aligned}\Lambda(t,-1) &= \frac{y_t(y_t-1)}{2} \\ \Lambda(t,0) &= 1-y_t^2 \\ \Lambda(t,1) &= \frac{y_t(y_t+1)}{2}\end{aligned} \qquad (4)$$

such that $\Lambda(t,j)=1\{y_t=j\}$ is the indicator function for $y_t=j$. The indicator function $\Lambda(t,j)$ and the probability distribution $P_j(\hat{F}_t;\beta_0,\mu_0)$ can be plugged in the following Likelihood function summing over $j=-1,0,1$

$$\log L_n(\theta,\mu)=\sum_{t=1}^{n}\sum_{j=-1}^{1}\Lambda(t,j)\log P_j(\hat{F}_t;\theta,\mu)$$

The log-likelihood function can be maximised giving Maximum Likelihood estimate of the parameter θ and μ. This paper uses a probit specification and $P_j(\hat{F}_t;\theta,\mu)$ is set to the cumulative density function of the standard normal distribution.

As shown in Hu and Phillips (2004) and Phillips et al. (2003) standard methods for statistical inference are valid asymptotically in this case even though the estimation process involves a nonlinear function $G(\hat{F}_t'\theta_0-\sqrt{n}\mu_0^1)$ of the nonstationary $\hat{F}_t$. As noted in Phillips et al. (2003), the Maximum Likelihood estimates $(\hat{\theta}_n,\hat{\mu}_n)$ of the parameters (θ_0,μ_0) converge at rate $n^{3/4}$ and have a mixed normal limit distribution as $n\to\infty$.

A.2 Data

The variables were de-seasonalised using an ARIMA procedure (X.12). More data transformation is required in order to account for Chinese New Year. The adjustment is conducted by taking an average of the month of February and January. New Year adjustments are required for industrial production (IP), retail sales (retail), fixed assets investment (FAI), exports and imports.

Table A1: List of the data series

No.	Area	Country	Series	Source
	Real activity			
1		China	Production of Primary Energy	CEIC
2			Production of Electricity	CEIC
3			Value Added of Industry	CEIC
4			Retail Sales of Consumer Goods	CEIC
5			Industrial Sales	CEIC
6			Product Sales Rate	CEIC
7			Fixed Asset Investment	CEIC
8			Foreign Direct Investment	CEIC
9			Real Estate Investment: Commercial Buildings	CEIC
10			Real Estate Investment: Office Buildings	CEIC
11			Real Estate Investment: Residential Buildings	CEIC
12			Real Estate Investment: Total	CEIC
13			Real Estate Sales: Commodity Building Sold	CEIC
14			Govt Expenditure	CEIC
15			Govt Revenue: Tax	CEIC
16			Govt Revenue: Tariffs	CEIC
17			Govt Revenue: Value Added Tax	CEIC
18			Govt Revenue: Enterprises Income Tax	CEIC
19		USA	Industrial production	CEIC
20		EU	Industrial production	CEIC
21		Japan	Industrial production	CEIC
22		UK	Industrial production	CEIC
	Money & Reserves			
23		China	M0	CEIC
24			M1	CEIC
25			M2	CEIC
26			Deposits, Quasi Money	CEIC
27			Deposits, Savings	CEIC
28			Financial Institution Deposits	CEIC
29			Financial Institution Deposits, Aggregate	HKMA
30			Financial institution loans	CEIC
31			Foreign Exchange Reserves	CEIC
	External Sector			
32		China	Exports	CEIC
33			Imports	CEIC
	Stock market indices			
34		China	Shenzhen Stock Exchange: Composite Index	CEIC
35			Shenzhen Stock Exchange: Turnover	CEIC
36			Shenzhen Stock Exchange: PE ratio	CEIC
37			Shenzhen Stock Exchange: Market Cap	CEIC
38			Shanghai Stock Exchange: Composite Index	CEIC
39			Shanghai Stock Exchange: Turnover	CEIC
40			Shanghai Stock Exchange: PE ratio	CEIC
41			Shanghai Stock Exchange: Market Cap	CEIC
	Exchange rates			
42		China	REER	CEIC
43			NEER	CEIC
44		USA	NEER	CEIC
45		EU	NEER	CEIC
46		Japan	NEER	CEIC
47			USD/EUR	CEIC
48			JPY/USD	CEIC
49			USD/GBP	CEIC

	Interest rates & ratios		
50	China	ERR	CEIC
51		Real deposits	CEIC
52	USA	Federal funds rate	CEIC
53	EU	Euro Interbank overnight rate	CEIC
54	Japan	Overnight call rate	CEIC
55	UK	BoE prime lending rate	CEIC
	Prices		
56	China	CPI Food	CEIC
57		CPI Clothing	CEIC
58		CPI Household Facilities	CEIC
59		CPI Medical Care	CEIC
60		CPI Traffic, Communications	CEIC
61		CPI Recreation, Education, Cultural	CEIC
62		CPI Residece	CEIC
63		CPI Aggregate	CEIC
64		Retail Price Index	CEIC
65		Corporate Goods Price Index	CEIC
66		PPI Excavator, Producer Goods	CEIC
67		PPI Raw Material, Producer Goods	CEIC
68		PPI Manufacturing, Producer Goods	CEIC
69		PPI Aggregate, Producer Goods	CEIC
70		PPI Food, Comsumer Goods	CEIC
71		PPI Clothing, Comsumer Goods	CEIC
72		PPI Daily Use Articles, Comsumer Goods	CEIC
73		PPI Durable Goods, Comsumer Goods	CEIC
74		PPI Aggregate, Comsumer Goods	CEIC
75		PPI Aggregate	CEIC
76		Purchasing Price Index Raw Materials	CEIC
77	Japan	CPI Aggregate	CEIC
78	US	CPI Aggregate	CEIC
79	EUR	CPI Aggregate	CEIC
80	UK	CPI Aggregate	CEIC
81	Int'l	Non-fuel commodities index	IFS
82		Average oil price index	IFS

Table A2: Unit root results

Area Country	Series	DFGLS	K	ADF
Real activity				
China	Production of Primary Energy	0.34	6	0.56
	Production of Electricity	1.98	7	3.21
	Value Added of Industry	0.57	8	3.08
	Retail Sales of Consumer Goods	2.19	7	4.45
	Industrial Sales	0.72	7	1.68
	Product Sales Rate	-0.10	3	**-2.90**
	Fixed Asset Investment	2.81	1	1.96
	Foreign Direct Investment	-1.01	6	-1.01
	Real Estate Investment: Commercial Buildings	1.42	1	0.70
	Real Estate Investment: Office Buildings	0.63	3	0.83
	Real Estate Investment: Residential Buildings	2.66	1	-0.37
	Real Estate Investment: Total	2.41	0	1.71
	Real Estate Sales: Commodity Building Sold	2.79	2	0.95
	Govt Expenditure	2.63	1	0.22
	Govt Revenue: Tax	1.79	1	0.98
	Govt Revenue: Tariffs	0.60	8	-1.55
	Govt Revenue: Value Added Tax	2.30	0	0.91
	Govt Revenue: Enterprises Income Tax	1.40	5	-0.71
USA	Industrial production	0.43	5	-1.13
EU	Industrial production	1.43	7	-0.41
Japan	Industrial production	-1.31	4	-1.39
UK	Industrial production	-1.50	2	-1.74
Money & Reserves				
China	M0	0.86	8	-0.03
	M1	1.23	7	0.80
	M2	0.82	7	1.51
	Deposits, Quasi Money	0.77	7	0.43
	Deposits, Savings	-0.78	6	-1.07
	Financial Institution Deposits	0.36	5	0.23
	Financial Institution Deposits, Aggregate	1.09	7	0.43
	Financial institution loans	1.16	6	0.45
	Foreign Exchange Reserves	1.33	8	1.85
External Sector				
China	Exports	0.75	8	0.51
	Imports	1.48	8	0.30
Stock market indices				
China	Shenzhen Stock Exchange: Composite Index	0.31	2	-1.24
	Shenzhen Stock Exchange: Turnover	-0.09	6	0.56
	Shenzhen Stock Exchange: PE ratio	-1.11	1	-2.00
	Shenzhen Stock Exchange: Market Cap	1.48	2	-0.18
	Shanghai Stock Exchange: Composite Index	1.75	2	-0.19
	Shanghai Stock Exchange: Turnover	-0.36	2	0.59
	Shanghai Stock Exchange: PE ratio	-1.14	1	-1.88
	Shanghai Stock Exchange: Market Cap	1.56	7	0.21
Exchange rates				
China	REER	-1.21	1	-1.81
	NEER	-0.94	1	-2.55
USA	NEER	-0.58	2	-0.87
EU	NEER	-0.96	2	-1.07
Japan	NEER	-0.80	5	-2.17
	USD/EUR	-0.67	1	-0.39
	JPY/USD	**-2.11**	5	-2.53
	USD/GBP	0.07	2	-0.24

Interest rates & ratios				
China	ERR	**-1.99**	1	-1.75
	Real deposits	-1.04	0	-1.37
USA	Federal funds rate	-1.42	2	-2.44
EU	Euro Interbank overnight rate	-1.83	4	-2.56
Japan	Overnight call rate	-0.98	1	-2.17
UK	BoE prime lending rate	-1.57	2	-2.19
Prices				
China	CPI Food	-0.88	1	-0.80
	CPI Clothing	-0.12	1	-3.83
	CPI Household Facilities	-1.17	6	-1.02
	CPI Medical Care	-0.73	1	-2.34
	CPI Traffic, Communications	-1.53	1	-1.70
	CPI Recreation, Education, Cultural	-1.38	8	-2.24
	CPI Residece	-0.59	1	**-3.27**
	CPI Aggregate	-0.81	0	-1.41
	Retail Price Index	-0.79	2	-0.82
	Corporate Goods Price Index	-1.38	6	-1.77
	PPI Excavator, Producer Goods	**-2.25**	2	**-3.01**
	PPI Raw Material, Producer Goods	-1.86	2	-2.43
	PPI Manufacturing, Producer Goods	-1.53	3	-1.79
	PPI Aggregate, Producer Goods	**-1.92**	1	-2.27
	PPI Food, Comsumer Goods	-0.96	1	-2.27
	PPI Clothing, Comsumer Goods	-1.44	1	**-3.30**
	PPI Daily Use Articles, Comsumer Goods	-1.05	1	-0.76
	PPI Durable Goods, Comsumer Goods	0.67	8	0.28
	PPI Aggregate, Comsumer Goods	-0.56	1	-0.65
	PPI Aggregate	-1.61	1	-2.06
	Purchasing Price Index Raw Materials	-1.52	2	-2.34
Japan	CPI Aggregate	**-2.00**	0	**-3.48**
US	CPI Aggregate	**-2.02**	2	-2.13
EUR	CPI Aggregate	-1.59	5	-1.41
UK	CPI Aggregate	**-2.00**	0	-1.19
Int'l	Non-fuel commodities index	**-2.00**	3	-1.77
	Average oil price index	**-2.13**	2	**-3.30**
	5% CV	-1.91		-2.89
	10% CV	-1.60		-2.58

Notes: (1) The DFGLS test is from Elliott, Rothenberg and Stock (1996) where K is the lag selected by the MAIC, Ng and Perron (2001))

(2) The ADF test is from Said and Dicky (1984), where the lag length is set to 4.

Table A3: Number of common factors

No. Factors	IC1	IC2	IC3
0	1.153	1.153	1.153
1	-0.683	-0.673	-0.576
2	-1.148	-1.128	-0.934
3	-1.523	-1.494	-1.203
4	-1.726	-1.687	-1.299
5	-1.883	-1.834	-1.349
6	-2.023	-1.964	-1.382
7	-2.210	-2.142	-1.463
8	-2.358	-2.280	-1.504
9	-2.493	-2.405	-1.533
10	-2.627	-2.528	-1.559
11	-2.737	-2.629	**-1.562**
12	-2.840	-2.722	-1.559
13	-2.943	-2.816	-1.555
14	-3.031	-2.894	-1.536
15	-3.107	-2.959	-1.505
16	-3.191	-3.034	-1.483
17	-3.281	-3.114	-1.466
18	-3.366	-3.189	-1.445
19	-3.460	-3.274	-1.432
20	**-3.534**	**-3.337**	-1.399

Table A4: Unit root test for factors

	ADF	
Factor	Unit Root	Test Stat
1	No	**-3.27**
2	Yes	-2.85
3	Yes	-1.81
4	Yes	-1.27
5	Yes	-0.68
6	Yes	-2.23
7	No	**-3.00**
8	Yes	-2.06
9	Yes	-2.16
10	Yes	-2.59
11	Yes	-1.95
	5% CV	-2.89
	10% CV	-2.58