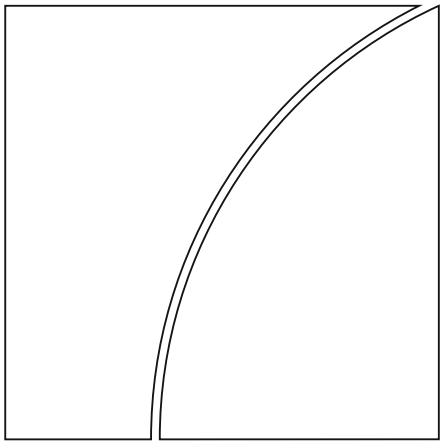
BANK FOR INTERNATIONAL SETTLEMENTS



BIS Working Papers

No 641

China's evolving monetary policy rule: from inflation-accommodating to anti-inflation policy

by Eric Girardin, Sandrine Lunven and Guonan Ma

Monetary and Economic Department

May 2017

JEL classification: E52, E58, O11, O52.

Keywords: monetary policy in China, People's Bank of China, Taylor rule, inflation targeting, discrete-choice model, open-economy model

BIS Working Papers are written by members of the Monetary and Economic Department of the Bank for International Settlements, and from time to time by other economists, and are published by the Bank. The papers are on subjects of topical interest and are technical in character. The views expressed in them are those of their authors and not necessarily the views of the BIS.

This publication is available on the BIS website (www.bis.org).

ISSN 1020-0959 (print)
ISSN 1682-7678 (online)

China's evolving monetary policy rule: from inflation-accommodating to anti-inflation policy

Eric Girardin, Sandrine Lunven and Guonan Ma[1]

Abstract

This paper aims to enhance the understanding of China's monetary policy rule since the mid-1990s, focusing on the role of inflation. It investigates the rule followed by the People's Bank of China (PBoC) by considering both the structural economic transformation of China and its evolving monetary policy framework.

Our newly constructed monthly composite discrete monetary policy index (MPI), which combines price, quantity and administrative instruments, shows a change in style towards smoother but more contractionary policy moves from 2002 onwards. The estimation of a dynamic discrete-choice model à la Monokroussos (2011) implies that, from this point onwards, the conduct of monetary policy has been characterised by implicit inflation targeting. While the PBoC's behaviour up to 2001 was reminiscent of that in the inflation-accommodating G3 economies of the United States, euro area and Japan up to 1979, it has been characterized since 2002 by a policy rule similar to the post-1979 anti-inflation (forward-looking) policy of the G3. An accurate estimation of the monetary policy rule from 2002 needs to consider China as an open economy, as a result of its rapid liberalisation of trade and finance after its WTO accession. As such, the influence of US interest rates has become increasingly significant for Chinese monetary policy.

Keywords: monetary policy in China, People's Bank of China, Taylor rule, inflation targeting, discrete-choice model, open-economy model

JEL classification: E52, E58, O11, O52.

[1] Eric Girardin is a professor of economics at Aix-Marseille University, Aix-Marseille School of Economics, CNRS, EHESS and was visiting the Bank for International Settlements (BIS) when the paper was written; Sandrine Lunven is a quantitative economist at TAC ECONOMICS, and a former PhD student at Aix-Marseille University-AMSE; Guonan Ma is currently an adjunct professor of City University of Hong Kong and was a senior economist at the BIS when the paper was written. The views expressed in this paper are those of the authors and do not necessarily represent the views of the BIS. The authors thank George Monokroussos for sharing his program and Bat-el Berger for her able research assistance. We thank Andrew Filardo, Dong He, Aaron Mehrotra, Pierre Siklos and James Yetman for their constructive comments.

Contents

1. Introduction

While Chinese monetary policy is not officially targeting inflation[2], it has helped deliver good inflation performance in the new millennium, with low (2.3% on average) and mildly persistent[3] inflation, in sharp contrast to high (8.4% on average) and persistent inflation in the 1990s. Such a major change in inflation performance raises the question of possible underlying changes in the conduct of monetary policy (policy framework and objectives) in the new millennium. Added to the massive liberalisation and transformations in the Chinese economy, it is likely that China's monetary policy rule has evolved[4] over the past two decades. Such changes may have been obscured by the multiplicity of price, quantity and unobserved instruments used to varying degrees and alternatively by China's monetary authorities, as well as evolving in a discrete way, unlike the continuous movements of reference benchmark monetary policy interest rates in most OECD countries.

In this paper we aim first at constructing a new discrete monetary policy index (MPI), able to assess the policy style and its changes, by capturing the evolving mix of China's monetary policy rates, as well as liquidity management tools, the varying intensity of their use, and the key role of administrative window guidance. Second, the paper will use this discrete index to estimate a PBC monetary policy rule in order to determine whether the major transformations associated with the new millennium in China have been matched by a shift in the weights of the arguments of the People's Bank of China (PBC) reaction function, able to rationalize in part the sharp improvement in inflation performance. The extent to which a shift could also correspond to a movement from a closed economy to an open economy reaction function will be granted special attention.

The fast-evolving context of monetary policy in China points to the potential importance of three key historical transformations. The first one refers to institutional reforms that enhanced the responsibility and role of the People's Bank of China (PBoC) as a central bank, whose status was legally confirmed in 1995. Monetary policy settings may also have changed with China's financial integration in the world through rapid trade and financial liberalisation, particularly since the country's WTO accession in 2001. Thus, the PBoC may have had to take global financial forces into account when navigating the trilemma through the regulation of capital flows and the sterilisation of foreign exchange inflows, particularly as the exchange rate regime switched back and forth from a de facto dollar peg to a managed float (Ma and McCauley (2011)). Finally, the rapid development of and increased job creation by the private sector in the 1990s, accompanied by SOE reform (particularly new wage-setting rules), is likely to have increased the sensitivity of investment and consumption

[2] This is not a unique case. Filardo and Genberg (2009), examining the inflation performance in the Asia-Pacific region, argue that formal inflation targeting is not the only monetary policy framework capable of delivering price stability.

[3] See Filardo and Genberg, 2009. The persistence of inflation is defined as the tendency for inflation to stay away from its average level for a protracted period when perturbed.

[4] The theoretical formulation of the 'inflation targeting problem' introduced by Svensson (1997) helps understand potential sources of instability in a central bank's reaction function. Indeed, he argues that, since the Taylor rule is the solution of the central bank minimization of its loss function under the constraint of the structure of the economy, changes in the reaction function can be explained through changes in the preference function of the authorities and/or the structure of the economy.

to the cost of capital and prices, generating the need for the authorities to take private agents' expectations into account in monetary policy-setting.

Therefore, it is probable that China's monetary policy rule has evolved as a by-product of the liberalisation and transformation of the Chinese economy since the early 1990s. Among a large number of studies, Cogley and Sargent (2001, 2005), Kim, Kishor and Nelson (2006) and Boivin (2006) have highlighted structural changes in the US monetary policy rule, estimating the well-known Taylor rule (1993) that relates a policy rate to the output gap and inflation. Yet few papers have turned to China's experience. Among them, Zheng et al (2012) conclude that the magnitude of the response to inflation was larger during 1998–2002 than in previous periods, meaning that the PBoC paid increased attention to inflation. Chen and Huo (2009) find two structural changes in the Chinese monetary policy rule, around 1998 and 2002–03. Moreover, they conclude that the monetary policy rule is characterised by both backward- and forward-looking behaviour. Finally, while the literature often confirms the significant role of external factors in advanced economies (see eg Ball (1999) and Svensson (2000); for the UK example Adam, Cobham and Girardin (2005)), it lacks a comprehensive analysis of such an influence on China's monetary policy decisions.

To understand China's evolving monetary policy, a good measurement of monetary policy is crucial. Recent work in this direction is based on an approach, pioneered by Gerlach (2007), who constructed a discrete monetary policy index for the case of the ECB. Such an approach is even more relevant in the Chinese case. As the PBoC employs a battery of price- and quantity-based instruments, no single policy tool can properly represent its monetary policy, partly because the importance of each of them has varied over time (Xiong (2012)).

Three papers have contributed to such an approach in the case of China. First, He and Pauwels (2008), estimating a discrete-choice model over the period 1992–2007,[5] conclude that the monetary policy framework can be characterised as "implicit inflation targeting". Indeed, the deviation of CPI inflation from an implicit target and the deviation of broad money growth from the announced target, but not the output gap, appear significant in the monetary policy rule estimation. Second, Xiong (2012), examining the PBoC's statements in its quarterly Monetary Policy Executive Report from 2001 to 2010, concludes that, in a forward-looking ordered probit model, inflation plays a key role in determining the PBoC's policy moves. Third, Shu and Ng (2010), compiling indices of the PBoC's policy stance on the basis of meeting notes and policy statements, find that growth and inflation are key monetary policy determinants and that the PBoC appears to follow a rule of thumb, using historical averages rather than official goals as a policy target.

We build in part on the works of He and Pauwels (2008) and Xiong (2012), and construct a new instrument-based monetary policy index (MPI) by combining the multiple price, quantity and administrative instruments deployed by the PBoC into a discrete variable. However, our measure goes one step further by taking into account the magnitude of monetary policy changes. It does so by converting each instrument change in terms of a "27 basis-point equivalent" change. This allows us to interpret and compare long-term coefficients to standards (1.5 for inflation and 0.5 for the

[5] Their measure is based on changes in the lending and deposit rates, changes in the reserve requirement ratio, and open market operations as measured by changes in outstanding central bank bills.

output gap), as suggested by Taylor (1993) in analysing the US monetary policy rule (which uses a target rate).

Moreover, we use this index to estimate a dynamic monetary policy rule using the Bayesian method proposed by Dueker (1999) and Monokroussos (2011), that is, by combining data augmentation and single-move Gibbs sampling of the Markov-Chain Monte Carlo literature. This approach has many advantages, such as taking into account the discrete nature of the monetary policy index. We also examine the relative weight of the backward- and forward-looking aspects in the Chinese monetary policy rule, as well as the effect of US monetary policy in an open economy version of our specification.

Our paper, therefore, makes three contributions to the literature as follows, both through the novel measure of the monetary policy represented by our composite monetary policy index (MPI) and via the estimation of the monetary policy rule characterising the monetary policy of the PBoC.

First, our new monetary policy index (MPI) more accurately captures the gradual change towards a more market-oriented financial system, as well as the evolving mix of policy instruments and liquidity management tools. It also provides a way to take administrative window guidance into account. Indeed, omitting such aspects would lead to a biased measurement of monetary policy, particularly during the Global Financial Crisis (GFC). The index shows two contrasting regimes before and after 2002. The PBoC's monetary policy during 1993–2001 is characterised by a relatively expansionary approach (to price stability) and a policy style of big but infrequent moves. By contrast, policy from 2002 to 2013 featured a relatively contractionary approach and a style of small but frequent steps[6].

Second, the paper provides empirical evidence that highlights the contrast between the monetary policy rules over these two different periods. From 2002, the PBoC appears to have engaged in a regime that looks a lot like informal inflation targeting, with a weight on inflation higher than unity, and a hybrid reaction function that takes into account forward-looking aspects of inflation (whatever the measure of inflation expectations used). This finding is shown to be robust to the use of alternative MPIs. Furthermore, the PBoC's change of style may seem to share some similarities with the break in behaviour at the G3 central banks pre- and post-1979, as they moved from an inflation-accommodating to an anti-inflationary policy. Not surprisingly, the era of China's *Great Inflation* during the 1990s has been followed by a period of low inflation and strong growth.

Finally, we find that constraining the estimated monetary policy to a closed-economy case (with only domestic factors) leads to an over-estimated output coefficient. We also show evidence for the impact of US monetary policy on China. Indeed, the US shadow Fed funds rate appears to have played a significant role in China's monetary policy decisions since 2002, consistent with the de facto financial opening following China's WTO accession in late 2001 (Ma and McCauley (2013, 2014)).

The rest of the paper is organised as follows. Section 2 describes the conduct of monetary policy in China since 1993. Section 3 discusses the estimation method, data

[6] An early version of the results for this second subsample appeared in Girardin et al. (2014)

and the construction of our MPI, while Section 4 presents the estimation results and robustness tests. The final section concludes.

2. China's evolving policy style since 1993

The question of a proper measurement of monetary policy changes is crucial in China's case. The PBoC has a dual mandate for price stability and economic growth, similar to those of some G3 central banks. However, its conduct of monetary policy differs significantly from the behaviour of central banks in most major OECD economies. These central banks typically implement monetary policy focusing on a short-term interbank interest rate, such as the fed funds rate for the United States and EONIA for the euro area.

Analysing the PBoC policy stance is a challenging task, mainly because there is no single principal policy rate as the key operating target in the Chinese monetary framework. Instead, the PBoC deploys multiple policy tools to implement its policy. Accordingly, conventional measures of monetary policy have drawbacks: the China (CHIBOR) or even the Shanghai (SHIBOR) Interbank Offered rates are not good proxies because of liquidity issues at least initially (Garcia-Herrero and Girardin (2013)), and the high segmentation of credit markets (He and Pauwels (2008)).

Therefore, to better gauge China's monetary policy, we first construct a new Monetary Policy Index (MPI) to be used subsequently as the left-hand variable in the estimation of the policy reaction function. This index aggregates the multiple individual instruments employed by the PBoC, which can be grouped into three categories: (i) price-based instruments, such as the partially regulated bank deposit and lending rates as well as interest rates on required and excess reserves and the lending rate on the PBoC refinancing;[7] (ii) quantity-based instruments, such as the reserve requirement ratio (RRR) and open market operations (OMOs); and (iii) administrative window guidance to influence bank lending, which is not directly observable.

All these instruments may in turn influence money (interbank) market interest rates, which can also be affected by other demand and supply factors in the broader financial system. However, the use of these instruments has evolved over time (Xiong (2012)). Before 1998, the credit plan was the PBoC's main instrument for controlling credit and money supply, while the interest rates on deposits and loans were occasionally adjusted. The PBoC started conducting OMOs on a regular basis in 1998 but mostly favoured this instrument for a while after 2002 to sterilise foreign exchange interventions. The RRR was first introduced in 1998, but the PBoC actively and heavily used this tool only from late 2007 onwards to drain liquidity, mainly because it became more cost effective from the PBoC's point of view than OMOs (Ma et al (2011)). Finally, it is worth noting that policy rates and the RRR are often adjusted one after the other, in the same direction, to reinforce their tightening or easing effects.

Our new approach to measuring the monthly changes in China's monetary policy consists of first converting a given change in each of the individual instruments in the same month into a "27 basis-point equivalent change in the policy rate" and then

[7] Since July 2013, bank lending rates have no longer been directly regulated by the government.

aggregating them into an overall monetary policy index. We then cumulate these monthly aggregate changes into our MPI. One important contribution of our paper is to develop an MPI that not only measures policy changes in terms of the three states of tightening, loosening and neutral, but also captures the scale of such policy changes in terms of the 27 basis-point equivalent changes. Finally, we also suggest alternative MPIs for robustness tests. Appendix A details the MPI's construction.

Box 1

Measuring monetary policy in China

There is no single policy tool, interest rate or other instrument, that can properly summarise the monetary policy of the PBoC. This points to the need for a composite measure that can reflect the changing mix of policy instruments used by the PBoC. We take on this challenge by constructing a new monthly Monetary Policy Index (MPI) in four main steps. (i) Converting a given monthly change in each instrument into a 27-basis-point equivalent change of the policy rate. (ii) Combining these equivalents for all instruments under consideration into a monthly aggregate change in monetary policy. (iii) Modifying these aggregate changes by taking into account possible window guidance and by adjusting for the effects of the Chinese New Year and one-off institutional changes. (iv) Cumulating these aggregate changes into a monthly MPI as the left-hand-side variable in the reaction function to be estimated.

The first step is to compute a monthly "27 basis-point equivalent" change in the policy rate for each instrument (Table A-1). This 27 bp change (25 bp since 2010) corresponds to the usual move on all regulated bank deposit and lending rates and interest rates paid and charged by the PBoC. Then, we follow He and Pauwels (2008) in assuming a typical 50 bp RRR change to be equivalent to a 27 bp change in the policy rate. Finally, we convert a given net liquidity change from open market operations (OMOs) into an equivalent 27 bp rate change in the following way. OMOs consist of PBoC bills issuance and non-bill OMOs, such as PBoC repos, reverse repos and outright bond transactions. A net monthly liquidity withdrawal or injection from OMOs is viewed as a tightening or easing move. He and Pauwels (2008) and Xiong (2012) take the threshold of CNY 200 billion as equivalent to a 50 bp change in the RRR. We assume this threshold to be equivalent to a 27 bp change, while CNY 350 billion is equivalent to a 54 bp change and CNY 500 billion to a 81 bp change.

Number of changes for each monetary policy instrument — Table A.1.

	1993–2001	2002–May 2013	"27 bp equivalent" change
Lending and deposit rates	11	16	27 bp (then 25 bp)
Interest rate on required reserves	9	2	27 bp
Lending rate to refinancing	11	6	27 bp
RRR	2	37	50 bp
Open market operations[1]	0	27	…

[1] For open market operations the number of changes corresponds to all monthly net liquidity injections or withdrawals that are caused by these operations and larger than RMB 260 billion in absolute terms (see Table 3 for further explanation).

Source: CEIC.

The second step is to combine these monthly 27 bp equivalent changes in various instruments. We adopt the following simple aggregation rules: (i) If different policy instruments move in opposite directions in a given month, we sum their monthly "27 bp equivalent" variations. In this case we allow the changes of these different instruments to offset each other. (ii) If all policy instruments move in the same direction in that month, we keep only the instrument change that gives rise to the maximum monthly "27 bp equivalent change". In this case, we do not take into account multiple variations of different instruments. The intuition is that the PBoC typically changed both deposit and lending rates in the same direction by 27 bp, which should not be regarded as a policy move of 54 bp. Also, the PBoC rarely changed the two quantity instruments in the same direction. Finally, a mix of a quantity move and a rate move in the same direction should be viewed as a change in the quantity tool to ensure that money market rates move in line with the prevailing bank deposit and lending rates. Due to such considerations, we take only the maximum changes when two instruments move in the same direction to avoid double-counting.

Therefore, our measure of changes in monetary policy presents two characteristics. First, all instruments have equal weight. The focus is on the presence of the policy change itself. Second, it enables us to interpret coefficients in a similar way to the Taylor rule, as it captures the magnitude of instrument changes, an addition to the pure qualitative-variable approaches used in Gerlach (2007) for the ECB, and He and Pauwels (2008) and Xiong (2012) for the PBoC.

The third step is to take into account possible informal credit quotas and window guidance, which are not directly observable, and to adjust for the effects of the Chinese New Year and one-off institutional changes. First, following Xiong (2012), we approximate the unobserved policy changes via administrative window guidance by unusual loan-growth acceleration. We define a "minus 27 bp equivalent change" if year-on-year loan growth is above 20% and accelerating and a "minus 54 bp equivalent change" if loan growth is above 30% and accelerating.① Such a phenomenon is particularly observable around 2003 and 2009. It is particularly important to take this feature into account since directing a record growth in bank credit, through window guidance for the State-Owned banks, was the means adopted by the Chinese authorities to side-step the difficulties met by Quantitative Easing in the G3 to stimulate bank credit growth.

Then, we adjust for the effect of Chinese New Year, as liquidity is usually injected before this festival period and withdrawn soon afterwards. We remove such liquidity injections/withdrawals when constructing our MPI. Third, we also remove the big 500 bp RRR cut in March 1998, as it was not a monetary policy signal but simply part of the PBoC's operations to recapitalise commercial banks and unify the reserve requirement system.② The fourth step simply cumulates these estimated monthly monetary policy changes into a single MPI, starting from 1993.

① This is an ad hoc method that takes only partial account of possible policy changes via window guidance but it at least allows us to reflect to some extent the extremely expansionary monetary policy observed in 2009. The basic idea is that an explosive acceleration of loan growth without changes in other observable policy instruments may likely relate to window guidance operations. Moreover, alternative indicators related to credit acceleration in China have been examined (broad money growth and the growth in total social financing, a broad measure of financing in the economy). Such indicators are strongly correlated and identify quite similarly two periods of unusual loan-growth acceleration in 2003 and 2009. Therefore, we examine window guidance only through the analysis of loan-growth acceleration.

② After the March 1998 RRR cut of 500 bp, commercial banks used the new liquidity to purchase government bonds, and the proceeds of these bonds were then injected into the commercial banks as equity capital (Mo (1999), Ma and Fung (2002)).

The resultant measure shows an interesting historical pattern of monetary policy changes, with two contrasting regimes before and after 2002, in terms of both policy changes and policy style (Graph 1, left-hand panel). First, after the initial policy of stabilisation, monetary policy changes were generally large and negative in the 1993–2001 period, as part of the government's policy package against deflationary pressures arising from both domestic corporate restructuring and competitive currency devaluation by its neighbours during the East Asian financial crisis. By contrast, the 2002–13 period shows mostly positive moves amidst strong growth, a large external surplus and some emerging price pressure before the GFC.

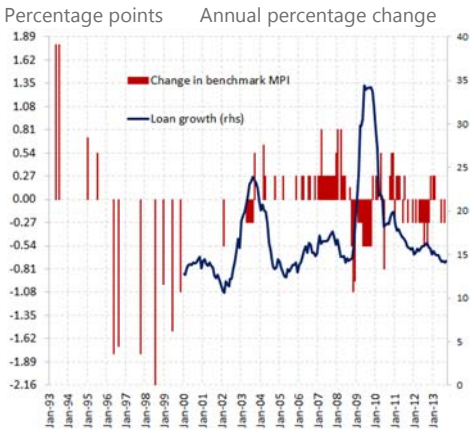
Second, our benchmark MPI measure also highlights distinct monetary policy styles between these two periods. The pre-2002 period features mostly larger but less frequent policy moves, while the subsequent period is characterised by relatively smaller but more frequent policy steps, i.e. a smoother and less abrupt policy style. Table 1 further confirms the different policy styles between these two periods. While all monthly monetary policy moves during the 1993–2001 period are equal to, or larger than, a 54 basis-point equivalent change in the policy rate, 70% (52 out of 74) of the policy changes during the second period of 2002–13 are 27 basis-point equivalent or less.[8] Also, there was on average one policy move per annum before 2002 but more than six from 2002.

[8] Adding the changes in different instruments in the same month would of course imply a different count.

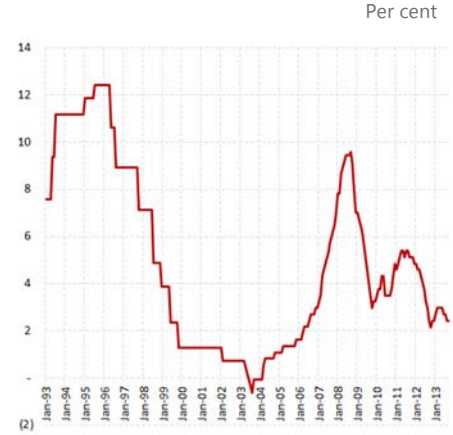
Monetary policy index in China

Graph 1

Changes in monetary policy[1]



Benchmark monetary policy index (MPI) [2]



[1] 27 basis-point equivalent change in policy rate. [2] The starting point of the MPI in January 1993 is taken as the one-year lending rate in that month. Estimation results are not sensitive to this arbitrary initial normalisation.

Sources: CEIC; authors' calculations.

In other words, the PBoC appeared to conduct monetary policy before 2002 with larger and less frequent moves but to operate with smaller but more frequent steps afterwards. This observation is consistent with a possible shift by the PBoC to smooth out monetary policy changes, thus calling for the inclusion of an "interest rate smoothing" aspect in our empirical specification. Indeed, Clarida et al (2000) argue that, except in response to occasional large shocks, central bank behaviour is less destabilising when it tends to change the short-term interest rate by multiple small steps in the same direction than when infrequent large changes are applied. A possible explanation of this shift is institutional, with a more prominent role for the PBoC as a central bank (but still under the control of the State Council, which decides on all moves except possibly for the RRR).

Number of changes in the monetary policy index (MPI)

In absolute terms

Table 1

	<27 bp	27 bp	54 bp	>54 bp	Total
1993–2001	0	0	1	10	11
2002–May 2013	1	51	15	7	74
Whole period (1993–May 2013)	**1**	**51**	**16**	**17**	**83**

Source: authors' calculations.

In addition, three important economic transformations that would induce a clear change in policy style include the gradual liberalisation of interest rates, the influence of private sector expectations after a number of reforms at the end of the 1990s and the rapid de facto opening of cross-border financial flows following China's WTO accession in 2001. Institutional, economic and financial reforms would have amply justified the need for the monetary authorities (State council and PBoC) to change their behaviour and adopt a more predictable monetary policy rule.

Finally, we transform our measure of the changes in monetary policy into a Monetary Policy Index (MPI) by cumulating the monthly variations from January 1993

onwards (Graph 1, right-hand panel). This procedure enables us to interpret the coefficients of the explanatory variables in line with the Taylor rule conventions.

In sum, our MPI, while still leaving some room for future improvements, enjoys a number of distinct advantages. First, it builds and improves upon the past efforts of He and Pauwels (2008) and Xiong (2012). Second, it considers more policy instruments than previous studies and captures the evolving mix of interest rates, liquidity management tools and window guidance. Third, it attempts to better reflect the magnitude of changes in various instruments by combining them in a single index and appears able to better capture the important shifts in Chinese monetary policy. Finally, it allows us to interpret the index as multiples of a 27 basis-point equivalent change in the policy rate in our subsequent empirical estimation of the Taylor rule in China.

3. Methodology and data

This section describes the data issues and discusses the methodology which allows us both to deal with the discrete nature of MPI changes and to interpret our findings along the Taylor-rule specification in the case of China.

3.1 Estimating the Taylor rule with a discrete variable

Our empirical analysis is based on the methodology of Monokroussos (2011), which is itself an extension of the approach suggested by Dueker (1999). The main benefit of this approach is to take into account the discrete nature of monetary policy changes, which, as pointed out by Dueker (1999), poses special challenges to empirical analysis. Such an approach belongs to the family of multinomial ordered probit models which is especially suited to the Chinese context where monetary policy interventions are multiples of 27 basis points and can be ranked (a 54 basis-point rise is considered as more restrictive than a 27 basis-point rise). As in probit models in general, one models a continuous latent variable, the PBoC's *desired level* of the MPI, which determines the behaviour of the observed discrete variable. The standard specification of the hybrid (both backward- and forward-looking in terms of inflation) Taylor rule is described as follows:

$$MPI_t^* = \beta_0 + \beta_1 MPI_{t-1}^* + \beta_2 \pi_{t-1} + \beta_3 y_{t-1} + \beta_4 E_{t-1}\pi_{t+1} + \beta_5 X_{t-1} + \varepsilon_t \qquad (1)$$

$$\varepsilon_t \sim N(0, \sigma_t^2)$$

where MPI_t^* is the desired level of the MPI_t, π_{t-1} is lagged inflation, $E_{t-1}\pi_{t+1}$ is the expectation of future inflation, y_{t-1} is lagged output and X_{t-1} denotes lagged external factors, in this case a shadow federal funds rate.[9] ε_t is a normally distributed, mean-zero error term. β_1 represents an indicator of the degree of smoothing of interest-rate equivalent changes. β_1 close to zero (unity) suggests little (lots of) smoothing of policy rates. If $\beta_4 = 0$, equation (1) is reduced to a pure backward-looking monetary

[9] We have also tried to evaluate the effect of other external factors (such as the effective exchange rate and foreign exchange reserves). However, results are not presented in the paper as their coefficients were insignificant.

policy rule. We will estimate both the pure backward-looking and hybrid specifications.

In this framework, monetary policy decisions are made when the latent variable MPI_t^* moves far enough from the observed policy index. Moreover, such a difference governs which changes, among the limited number of possibilities, have to be applied:

$$\Delta MPI_t \in \text{category } j \text{ if } MPI_t^* - MPI_{t-1} \in \left(c_{j-1}, c_j\right), j = 1, \cdots, J \tag{2}$$

where MPI_t is the observed index, which changes by only one of J possible values at discrete points in time, and $c_0, c_1, \cdots, c_J$ are the threshold coefficients for movement between the J possible categories of changes. Therefore, the difference between MPI_t^* and the last observed index MPI_{t-1} provides a pressure index for the central bank to make potential monetary policy decisions while the intensity of changes is taken into account by the threshold coefficients. Since the majority of policy changes are of two sizes (27 bp and 54 bp), we assume four threshold coefficients to make sure that such changes are captured: {–0.5, –0.10, 0.10, 0.5}[10].

As explained in detail in Monokroussos (2011), the estimation of such a dynamic probit model is complex and requires a difficult computational exercise (with high-order multiple integrals with no closed-form solution). In general, the most appropriate way to estimate the model is the maximum likelihood technique. The likelihood is the probability of the joint T-period event that has been observed, given $\tilde{X}_T$:

$$\Pr[\Delta MPI_1 \in \text{category } j_1, \Delta MPI_2 \in \text{category } j_2, \cdots, \Delta MPI_T \in \text{category } j_T | \tilde{X}_T] \tag{3}$$

Thus, this likelihood is a T-dimensional multiple integral with a T-variate Gaussian density. In addition, let Ω_t denote the information set at period *t*, including the explanatory variables up to period t and the observed dependent variable up to period t-1. Then, the *conditional event probability for period t* is:

$$\begin{aligned} &\Pr[\Delta MPI_t \in \text{category } j \,|\Omega_t] \;= \Pr\left[MPI_t^* - MPI_{t-1} \in \left(c_{j-1}, c_j\right) \,\middle|\, \Omega_t\right] \\ &= \Pr\left[c_{j-1} + MPI_{t-1} < MPI_t^* < c_j + MPI_{t-1} \,\middle|\, \Omega_t, j = 1, \cdots, J, t = 1, \cdots, T\right] \end{aligned} \tag{4}$$

Solving equation (4) by backward substitution, we have:

$$MPI_t^* = \mu_t + \Gamma_t + \zeta_t MPI_0^* + \xi_t \tag{5}$$

where μ_t is a sum of constants, Γ_t also a sum containing lags of the explanatory variables, ζ_t a function of the lagged MPI, MPI_0^* the dependent variable for the initial period, and ξ_t a sum containing the error terms multiplied by the coefficient of lagged MPI. By substituting (5) in (4), we obtain:

$$\begin{aligned} &\Pr[\Delta MPI_t \in \text{category } j \,|\Omega_t] \\ &= \Pr\left[\begin{matrix} c_{j-1} + MPI_{t-1} - \mu_t - \Gamma_t - \zeta_t MPI_0^* < \xi_t^* \\ < c_j + MPI_{t-1} - \mu_t - \Gamma_t - \zeta_t MPI_0^* \end{matrix} \middle| \, \Omega_t\right] \end{aligned} \tag{6}$$

To overcome the *multiple integral problem* which complicates the estimation[11] we adopt the same methodology as Monokroussos (2011), relying on the Markov-Chain Monte Carlo literature (MCMC) through a *Gibbs sampling algorithm with data*

[10] Alternative threshold coefficients have been tested and do not significantly impact the results of the estimation

[11] For complementary details on the multiple integral problem, see the appendix of the paper of Monokroussos (2011).

augmentation, whereby simulated samples of the latent variable are generated through their model-implied conditional distributions.

This MCMC estimation strategy consists in dividing the set of parameters into a multi-block setup of one block per latent variable, $\lambda_{1i} = \{MPI_t^*\}, t = 1, \cdots, T$, one block for the variance, $\lambda_2 = \{\sigma^2\}$, and one block for the coefficients of the explanatory variables, $\lambda_3 = \{\beta_0, \beta_1, \beta_2, \beta_3, \beta_4, \beta_5\}$. The first step consists in specifying initial values of the coefficients of the explanatory variables using ordinary least squares (OLS) estimation. Then, the second step consists in cycling through the following conditional distributions:

$$\begin{gathered}
\lambda_{1_1}^{(i+1)} \text{from } p_{mpi_1^*}\left(\lambda_{1_1} \middle| \lambda_{1_2}^{(i)}, \cdots, \lambda_{1_T}^{(i)}, \lambda_2^{(i)}, \lambda_3^{(i)}, Y_T\right), \\
\vdots \\
\lambda_{1_T}^{(i+1)} \text{from } p_{mpi_T^*}\left(\lambda_{1_T} \middle| \lambda_{1_1}^{(i)}, \cdots, \lambda_{1_{T-1}}^{(i)}, \lambda_2^{(i)}, \lambda_3^{(i)}, Y_T\right) \\
\lambda_2^{(i+1)} \text{from } p_2\left(\lambda_2 \middle| \lambda_{1,\cdots,T}^{(i+1)}, \lambda_3^{(i)}, Y_T\right) \text{ and} \\
\lambda_3^{(i+1)} \text{from } p_3\left(\lambda_3 \middle| \lambda_{1,\cdots,T}^{(i+1)}, \lambda_2^{(i+1)}, Y_T\right)
\end{gathered} \tag{7}$$

where Y_T denotes the entire history of the data for periods 1,…,T and i indicates the iteration of the Gibbs sampler.[12] The multiblock setup of one block per latent variable is employed to implement the technique of *data augmentation*, whereby the latent variables are generated from their model-implied conditional distributions $p_{mpi_1^*}, \ldots, p_{mpi_T^*}$. The point estimates and confidence intervals of the parameters of this paper are based on the means and the quantiles of their simulated marginal posterior distributions.

3.2 Data

The data series used span the period from January 1993 to May 2013. The end of our sample at mid-2013 is dictated by the introduction around this date of a number of new monetary policy instruments, such as the Standing Lending Facility (SLF) and Short-term Liquidity Operations (SLO), and the fact that the post-2013 period is too short to be examined separately. Data used to construct the MPI are all from the PBoC and are described in Box 1. The CPI index is obtained from the OECD's Main Economic Indicators website. For the economic activity variable, we use the level of industrial output in constant renminbi as reported by CEIC. As the year-on-year series precisely matches the IMF-reported annual industrial output growth series (collected from China's National Bureau of Statistics (NBS)) from January through December 2001, we took these 12 months as benchmark levels from which we obtained the levels of industrial output for subsequent and previous months by applying the IMF year-on-year growth rates. The effect of the Chinese New Year implies that, for January and February, the year-on-year growth rates of industrial output are often distorted. We took the average of the year-on-year growth rate over January and February, and applied this same rate to the 2001 monthly levels forward and backward. On several occasions, particularly in 2006 and 2007, the NBS did not report year-on-year growth rates for January. We then used the same year-on-year growth rate as reported for February. Seasonality in the series thus generated for the level of industrial output did not seem to be invariant over time. Accordingly, we filtered out stochastic

[12] For technical aspects of the algorithm (for generating the variance, the coefficients of the explanatory variables and the latent dependent variables, please refer to the appendix of Monokroussos (2011).

seasonality using unobserved component models (with the STAMP module in Ox implementing Harvey's 1989 approach).

We use raw data on inflation and output growth rather than the usual output gap and deviations from the inflation target. The reason is that, in China, such official targets are not announced as true objectives to be attained, as observed in G3 economies, but are rather published as guidance. As a result, economic growth (inflation) has generally been higher (lower) than the targets over the past 20 years, which implies that official targets cannot be considered to be good measures of potential or steady-state values.

Then, we test three different indicators for the monthly expectation of future inflation in China. (1) The first one is the PBoC depositors' survey of price expectations.[13] This survey series is published at the end of each quarter referring to expectations with respect to the next quarter.[14] However, its main drawback is that it is available only over a short period, since 2001. We normalise the indicator, constraining it to lie within the same range as inflation.[15] (2) In addition, we consider the inflation forecast provided by Consensus Forecasts, available since 1995. While available on a monthly frequency, it is mostly a lagging indicator of inflation (see Appendix A). Moreover, the PBoC survey measure is a reflection of consumers' expectations, while the Consensus Forecast is mainly based on overseas China watchers. (3) Finally, we build our own new quarterly indicator of inflation expectations estimated on the basis of PBoC business survey data that have been available since the mid-1990s (see Appendix A). The main advantage of this indicator is that it enables us to evaluate the hybrid specification since the mid-1990s and to compare the estimation results based on different inflation expectation indicators since 2002.

Finally, this paper aims at evaluating the sensitivity of China's monetary policy decisions to those of the United States. Here, the challenge stems from the fact that, post-crisis, the United States has implemented an extraordinary loosening of monetary policy using unconventional instruments. Considering that many central banks have lowered their policy interest rates to, or near, zero, the use of official policy interest rates may not capture the actual state of monetary policy. Therefore, we use the shadow interest rate for the United States as estimated by Wu and Xia (2015).

4. The estimation results of China's monetary policy rule

This section presents our estimation results of China's monetary policy rule in three steps. The first step compares the estimated monetary policy rules before and since 2002 to take into account the identified change in style in the PBoC's conduct of monetary policy and to evaluate a possible hybrid monetary policy rule by including

[13] The PBoC started in 2001 to conduct a quarterly survey of price expectations in China, based on a 20,000-person sample of price rise expectations one quarter ahead. These surveys are published in the PBoC's Quarterly China Monetary Policy Report.

[14] As we assume that this represents expectations for the whole quarter, we need to take its lagged value in the estimation with monthly data. We also tested including that variable with no lag, or using a monthly quadratic interpolation, but both generated very similar results to those presented.

[15] However, the unavailability of the series prior to 2001 could potentially be a source of omitted variable bias, as pointed out by James Yetman.

both backward- and forward-looking aspects. In the second step, we set China's monetary policy rule in an international perspective. The final step provides some robustness tests based on alternative MPIs. Our discussion here focuses mainly on the long-term estimated coefficients of the monetary policy rule, while Appendix B presents detailed results of the estimated short-term coefficients.

4.1 From an inflation-accommodating to an anti-inflationary policy

A comparison of the monetary policy rules before and since 2002 will help highlight the evolving nature of the PBoC's policy. Section 2 has shown evidence of the distinct policy styles of the PBoC before and since 2002 in terms of the instruments used, as well as their magnitude and frequency of changes. Moreover, 2002 marks a possible new start for Chinese monetary policy in the wake of China's WTO entry, the change in national leadership (leading to the appointment of a new PBoC Governor, Zhou Xiaochuan, succeeding Dai Xianglong), a growing private sector, and other gradual economic and financial reforms.

Implied long-term coefficients of the reaction function – closed economy

Table 2

PBoC monetary policy	Inflation (1)	Expected inflation (2)			Total inflation (1)+(2)	Output (3)
		PBoC(A)	Estim.(B)	Cons.(C)		
1993-2001 period						
(a) Backward-looking rule	0.1	…	…	…	0.1	**1.3**
(b) Hybrid rule B	-0.2	…	0.6*	…	0.4	**0.9**
(c) Hybrid rule C	-0.1	…	…	0.7	0.6	0.3
2002-May 2013 period						
(d) Backward-looking rule	**2.0**	…	…	…	**2.0**	**1.7**
(e) Hybrid rule A	**1.1**	**1.0**	…	…	**2.1**	**1.3**
(f) Hybrid rule B	0.5*	…	**1.6**	…	**2.1**	**0.7**
(g) Hybrid rule C	1.4*	…	…	1.0	**2.4**	**1.7**

(1) equals $\beta_2/(1-\beta_1)$, (2) for $\beta_4/(1-\beta_1)$, (3) $\beta_3/(1-\beta_1)$ and 4) $\beta_5/(1-\beta_1)$ in equation (1).

Significant coefficients are in bold. * means significant at 10%.

Estimation with the expected inflation indicator from Consensus Forecast starts in 1995.

The hybrid rule A, B, C respectively use three different expected inflation indicators: the PBoC depositor survey on expected future prices, our estimation based on business survey indicators and the Consensus Forecast one.

Source: Authors' calculations.

Tables 2 and 3 summarise the long-term estimated coefficients of the monetary policy rule over the following two subperiods within the sample of January 1993–December 2013: (i) January 1993–December 2001 and (ii) January 2002–May 2013. For each subperiod, we examine both backward- ($\beta_4 = 0$ in Equation (1)) and forward-looking aspects ($\beta_4 <> 0$ in Equation (1)) using three different expected inflation indicators: (A) extracted from the PBoC depositor survey on expected prices,[16] (B) estimated based on business survey indicators, and (C) based on the Consensus Forecast (see Appendix A for details). Table 2 presents the closed-economy Taylor rule estimates by including only the domestic variables (inflation and economic activity). Then, Table 3 explores the relevance of an open-economy Taylor rule

[16] As the PBoC survey on expected future prices has only been available since 2001, the introduction of this variable in the monetary policy rule is only possible over the second subperiod.

whereby Chinese monetary policy also responds to international variables such as the US shadow fed funds rate.

Consider first the estimates of the closed-economy version shown in Table 2. Our empirical results convey a number of key messages. First, they highlight the substantial differences in the determinants of China's monetary policy and their respective influences on the policy rule between the periods before and since 2002. The 1993–2001 period is characterised by an inflation-accommodating policy with inflation coefficients not significantly different from 0 (as shown in Appendix B) or weakly significant (at 10%) when including inflation expectations. In all cases, the implied long-term inflation coefficient appears on average much lower than unity. Conversely, output growth seems to play a dominant role in the conduct of monetary policy in China over 1993–2001 (except in equation c), with an implied average long-run coefficient significantly close to, or higher than, unity (in the range 0.9–1.3). It is important to remember that the PBoC was fighting against the economic slowdown then, owing to the stabilisation policy of 1993, domestic corporate restructuring and the Asian Financial Crisis. This heritage from the 1990s largely explains the higher weight given to output growth.

Second, a noticeable shift in the conduct of monetary policy is observable since 2002 with almost all coefficients significantly different from 0 and a substantial increase in the long-term inflation coefficient (now close to 2), consistent with the so-called Taylor principle. While expected inflation did not seem to play any role during 1993–2001, the PBoC appears to have used a hybrid reaction function since 2002 by taking equally into account backward- and forward-looking aspects in its monetary policy decisions. Interestingly, the response to overall inflation is quite similar for all three inflation expectation proxies. Moreover, the long-term response to expected inflation is in each case close to, or higher than, unity. This is no surprise to the extent that a central bank implicitly targeting inflation has to take into account inflation expectations, since these expectations provide useful signals with respect to the credibility of the central bank and its long-run inflation objective. If economic agents view the central bank as credible, inflation expectations are more likely to be well anchored. Therefore, our results show that, with price liberalisation and labour market reforms, inflation expectations play a role because they may start to directly influence wage and price setting in an increasing number of sectors, which in turn drives current inflation. These may help explain the PBoC's move from 2002 towards a hybrid reaction function that takes into account both expected and past inflation.

Third, the response to output from 2002 onwards is more ambiguous than over the previous period, with the long-term output coefficient generally above unity when including only domestic variables (except f, wherein it is 0.7). This weight on output is larger than in mature economies but largely in line with the estimates for emerging economies in general (Hofmann and Bogdanova (2012)) and India in particular (Singh (2010), Patra and Kapur (2012)). It may reflect both a strong preference for output and the structure of the economic transmission mechanism (see Hayo and Hofmann (2006)).

However, it may be questionable to include only domestic variables, particularly since 2002, as China has rapidly opened its door to trade. More specifically, given the Chinese currency's managed peg to the US dollar, and still binding Chinese capital controls, the influence of US monetary conditions on China's monetary policy decisions remains an open issue (Ma and McCauley (2008, 2011)). All the more so since China's WTO accession in late 2001, to the extent that a high degree of trade

openness is known to enable agents to sidestep capital controls, leading to de facto financial opening (Aizenman (2004); Ma and McCauley (2014)). To shed light on this question empirically, we include a US shadow fed funds rate, developed by Wu and Xia (2015), in an open-economy Taylor rule formulation. The estimation results are shown in Table 3.

Implied long-term coefficients of the reaction function – open economy

Table 3

PBoC monetary policy	Inflation (1)	Expected inflation (2)			Total inflation (1)+(2)	Output (3)	US shadow rate (4)
		PBoC(A)	Estim.(B)	Cons.(C)			
1993–2001 period							
(a) Backward-looking rule	0.1	…	…	…	0.1	**1.3**	0.4
(b) Hybrid rule B	-0.2	…	0.6*	…	0.4	**0.9**	0.5
(c) Hybrid rule C	-0.1	…	…	0.8	0.7	0.2	0.4
2002–May 2013 period							
(d) Backward-looking rule	**1.7**	…	…	…	**1.7**	**0.8**	**1.3**
(e) Hybrid rule A	**1.1**	**0.9**	…	…	**2.0**	0.5*	**0.9**
(f) Hybrid rule B	0.5*	…	**1.3**	…	**1.8**	-0.3	**1.1**
(g) Hybrid rule C	**1.1**	…	…	1.3	**2.4**	**0.8**	**0.9**

(1) equals $\beta_2/(1-\beta_1)$, (2) for $\beta_4/(1-\beta_1)$, (3) $\beta_3/(1-\beta_1)$ and 4) $\beta_5/(1-\beta_1)$ in equation (1).
Significant coefficients are in bold. * means significant at 10%.
Estimation with the expected inflation indicator from Consensus Forecast starts in 1995.
The hybrid rule A, B, C respectively use three different expected inflation indicators: the PBoC depositor survey on expected future prices, our estimation based on business survey indicators and the Consensus Forecast one.
Source: Authors' calculations.

The results reveal that the long-term output coefficient becomes weakly significant and close to 0.5–0.8 in (d), (e) and (g) while it is not significant in (f). Moreover, the decline in the output coefficient over the second period (compared with the closed economy cases) is accompanied by a rise in the coefficient of the shadow fed funds rate, significant and close to, or above, unity. This means that the external factor, as represented by the US shadow fed funds rate, appears to have played a more significant role in Chinese monetary policy decisions since 2002, consistent with increasing trade (and thus financial) openness and changing monetary policy management in China.

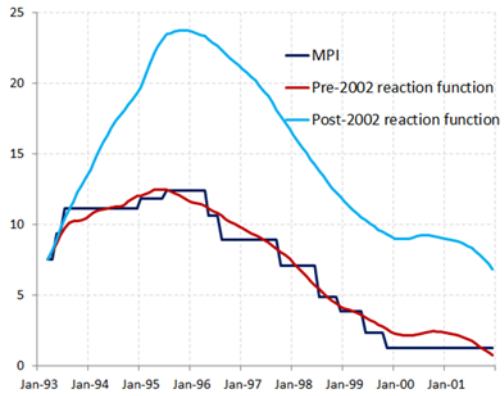
The management of currency appreciation and capital inflows (through foreign exchange intervention), when navigating the trilemma, can in part explain the influence of the US policy rate in China's monetary policy function reaction. As Table 3 shows, the coefficient on the US shadow fed funds rate is estimated to be positive in all the cases, against a backdrop of currency-appreciation expectations, a crawling dollar peg and large external surpluses before the fed fund rate hit the zero lower bound in 2008. One possible explanation is the China-US rate differential as an important factor influencing carry-trade-related hot money flows during 2002–13. In response, the PBoC tended to avoid moving against the US fed funds rate, hence the positive coefficient on the latter variable. By contrast, currency expectations were more volatile in the 1993–2001 period, hence the smaller estimated coefficient for this episode.

Finally, Graph 2 illustrates the PBoC's changing behaviour by plotting the fitted MPI from estimating the open economy hybrid reaction function with our own proxy of inflation expectations over the two periods before and since 2002. First, this demonstrates the good accuracy of our estimation plotted by the red line over 1993–2001 and the blue line over 2002–13. Second, it clearly illustrates the change in the PBoC's behaviour, particularly during periods when monetary policy was tightening. Indeed, the behaviour since 2002 would suggest a firmer anti-inflationary policy than observed in mid-1995, when inflation exceeded 20%. Similarly, the pre-2002 policy style would have resulted in a more gradual increase of the index during the commodity price boom (around 2004–08). Thus, our empirical evidence lends support to the argument that the PBoC seems to have moved from an inflation-accommodating policy before 2002 to an anti-inflationary policy thereafter. In other words, starting around 2002, the PBoC's monetary policy has come to resemble that of an informal inflation targeter.

Fitted MPI over 1993–2001 and 2002–13[1] Graph 2

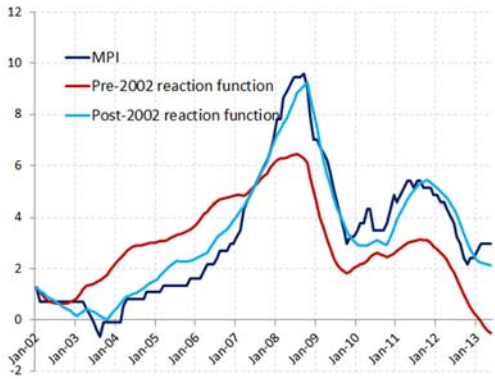
Over the period 1993–2001

Per cent



Over the period 2002–13

Per cent



[1] The starting point of the MPI (in March 1993 and January 2002) is used to estimate it over each subperiod. The red and light blue lines draw the fitted MPI based respectively on the pre- and post-January 2002 estimated coefficients of the open-economy hybrid reaction function with our own proxy of inflation expectations.

Sources: Authors' calculations.

Finally, Table 4 evaluates the predictive accuracy of the different specifications of the monetary policy rules to determine whether open-economy hybrid rules are more informative than those estimated with a closed-economy specification and outperform them. Therefore, we calculate the mean absolute error (MAE) for each specification. Overall, we find that the backward and hybrid models are equivalent in minimising the errors over the 1993–2001 period. While forward-looking aspects are not significant in the pre-2002 estimation, and the backward model appears as the appropriate specification. The hybrid specification that considers external factors and forward-looking aspects clearly outperforms the backward model over the period since 2002, confirming the changed monetary policy behaviour, taking into account forward-looking aspects as well as US monetary policy. More precisely, the PBoC survey and our estimated inflation expectations proxy for China seem to outperform the inflation expectation indicator provided by the Consensus.

Mean absolute error (MAE) of estimated values Table 4

	1993–2001	2002–13
Pre-2002 estimation		
Closed economy – Backward model	0.59	1.96
Open economy – Hybrid B (Estim.)	0.64	1.83
Open economy – Hybrid C (Consensus)	0.51	2.21
Post-2002 estimation		
Closed economy – Backward model	3.91	0.90
Open economy – Hybrid A (PBoC)	2.39	0.61
Open economy – Hybrid B (Estim.)	6.42	0.57
Open economy – Hybrid C (Consensus)	8.17	0.79

Source: Authors' calculations.

4.2 China's policy rule in international perspective

It is instructive to compare the Chinese experience with that of other major central banks across different periods. As Table 2 shows, for China, the 1993–2001 period is characterised by a dominant overall response to output and a weak response to inflation. During the subsequent period of 2002–13, the PBoC appears to turn more anti-inflationary, with inflation (both backward- and forward-looking) playing a greater role in its conduct of monetary policy (with a long-term inflation coefficient close to 2).

Table 5 summarises the comparable results for G3 central banks. They include the results of Monokroussos (2011) for the US Fed during the pre- and post-Volcker periods, the results by Clarida et al (1998) for the Fed during the periods before and after October 1982 (the start of new operating procedure), the Bundesbank (after the founding of the EMS in March 1979) and the Bank of Japan (after April 1979, a period of significant financial market deregulation).

Implied long-term coefficients in G3 reaction functions Table 5

	Inflation[1]	**Output**[2]
US Fed reaction function		
Pre-Volcker period (1969–August 1979)[3]	0.5	2.2
Volcker-Greenspan period (August 1979–mid-1998)[3]	1.9	0.5
Volcker-Greenspan period (October 1982–December 1994)[4]	1.8	0.6
Other G3 reaction functions		
Bundesbank (April 1979–December 1993)[4]	1.3	0.25
Bank of Japan (April 1979–December 1994)[4]	2.0	0.1

[1] Expected inflation as independent variable. [2] Output gap as independent variable. [3] MCMC estimation by Monokroussos (2011). [4] GMM estimation by Clarida et al (1998).

Sources: Clarida et al (1998) and Monokroussos (2011).

As Clarida et al (1998) show, all the G3 central banks started targeting inflation in an implicit way from the late 1970s onward, after a decade of high inflation. The subsequent Great Moderation was interpreted then as a sign of "the broad success of monetary policy in these countries over this time period" (Clarida et al (1998)).

Despite major differences in the economic context between the late 1970s and early 2000s, a comparison of the Chinese and G3 reaction functions shows some interesting similarities. First, the pre-2002 period in China may seem quite similar to the pre-1979 period in the G3 countries (as represented here by the United States), with a relatively weak overall response to inflation, of around 0.5. Thus monetary policies during these initial periods seem to have accommodated inflation, typically raising the nominal interest rate by less than the increase in inflation, thus resulting in a lower real interest rate.

Second, the estimated responses to inflation by the G3 central banks[17] during the post-1980 period, and by the PBoC during the period since 2002, also contrast starkly with the earlier episodes. Indeed, for both China and the G3, the long-term inflation coefficients for these subsequent periods appear substantially higher relative to those of the initial periods. In fact, these subsequent weights on inflation are close to 2.0 in both the G3 and China, meaning that central banks became much more anti-inflationary in the latter episodes. These comparative findings strengthen the argument that the PBoC may have, over time, aimed at adopting a "state of the art" monetary policy rule, with the long-term coefficients in its reaction function converging towards the international benchmark values typical of major central banks.

4.3 Robustness tests

As our final step, Table 6 shows the long-term coefficients of the open-economy hybrid reaction function with alternative monetary policy indicators, which can be compared with the estimation results using the benchmark MPI presented in Table 2. Such a test of alternative scenarios with respect to MPI measures is surprisingly absent from the existing literature. The necessity of this step is due to the challenging task of combining the multiple instruments used by the PBoC. Details of the construction of these alternative MPIs are discussed in Box 2, which particularly highlights the benchmark MPI as the central scenario, representing approximately the average of the alternative MPIs. Moreover, differences between these alternative MPIs are noticeable from the mid-2000s onwards, particularly during monetary policy tightening periods, in 2007–08 and end-2010–11, when the PBoC faced an unfavourable combination of upward inflation pressure and economic slowdown.

As shown in Table 6, the estimated output and inflation coefficients obtained with the alternative MPIs are quite similar to our benchmark estimates. Overall, our benchmark MPI provides coefficients in the middle of those estimated with alternative MPIs. Interestingly, the estimated expected-inflation coefficients are the main drivers of differences among results with a substantially larger coefficient using MPI-A (1.7), but a lower one using MPI-C (0.3) than the one obtained with the benchmark MPI (equal to 0.9) over the period 2002–May 2013. As mentioned in Box 2, the alternative MPIs differ mostly during periods with upward-inflation pressures in 2007–08 and end-2010–11, with MPI-A implying a tighter monetary policy than alternative MPIs, while MPI-C reveals a more prudent monetary policy. So, it is not surprising to find a different impact of the expected-inflation coefficient when using these alternative MPIs.

[17] Interestingly, the estimation results for the post-1997 reaction function of the Bank of England similarly grant a large long-run coefficient for inflation (1.8, as reported by Adam et al (2005)).

Box 2

Alternative MPIs

While no metric is available to determine which MPI best represents Chinese monetary policy, it is useful to compare different versions of the MPI as well as using these alternative MPIs to conduct robustness tests in our empirical estimations to eliminate the risks of overestimating monetary policy changes or conversely of mistakenly absorbing multiple variations in only one change. For this purpose, we propose four alternative MPI measures, in addition to our benchmark MPI, which differ in the rules used to aggregate individual instruments when they move in the same direction (left-hand panel, Graph A.1). MPI (A) and (B) are generated by summing up the monthly changes across all instruments, except when only interest rates are involved. By contrast, MPI (C) and (D) are generated by summing up the monthly changes across all instruments except when the instrument changes involve any interest rate (in this case, the highest variation is kept). An additional assumption concerns the "27 bp equivalent" change for RRR. MPI (A) and MPI (C) assume a usual 50 bp change to be equivalent to a 27 bp change. MPI (B) and MPI (D) are characterised by a lower weight on RRR changes by assuming a 100 bp RRR change to be equivalent to a 27 bp change.

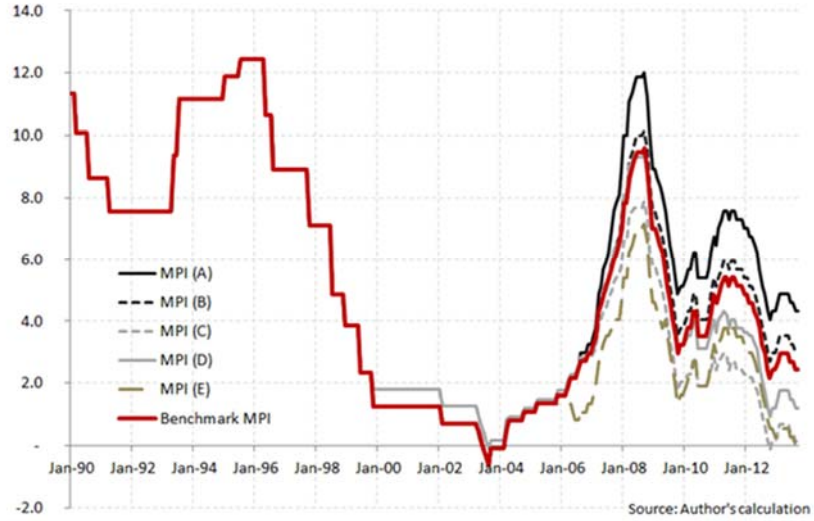
Alternative rules for constructing MPI

Graph A.1.

Aggregation rules for three MPIs[1]

Combination of instruments	Benchmark MPI	Alternative MPIs			
		MPI(A)	MPI(B)	MPI(C)	MPI(D)
Indicator selection and conversion methods					
(1) "Equivalent 27 bp" change for RRR	27 bp	27 bp	13.5 bp	27 bp	13.5 bp
(2) Window guidance proxy[2]	Loan	Loan	Loan	Loan	Loan
Aggregation rules					
(1) All move in the opposite directions	Sum	Sum			
(2) All move in the same direction					
- Interest rate instruments	Max	Max			
- Quantity instruments	Max	Sum			
- Mix of interest rate & quantity	Max	Sum		Max	

Five alternative MPIs (Per cent)



[1] "Sum" refers to summing up the monthly 27 bp equivalent changes of different instruments. "Max" refers to taking the maximum monthly 27 bp equivalent change only among all the instruments.

[2] Loan is for loan growth acceleration

Source: Authors' calculations.

The resultant MPIs based on alternative rules for constructing them highlight the benchmark MPI as the central scenario, roughly equalling the average of other MPIs. Differences between MPIs are noticeable from 2007 onwards when the PBoC introduced new instruments such as the RRR and open market operations. Obviously, they move in the same direction but the magnitude of changes differs, particularly during monetary policy tightening periods, in 2007–08 and end-2010–11, when the PBoC faced an unfavourable combination of upward inflation pressure and economic slowdown.

A few interesting observations are worth highlighting. First, the long-term inflation coefficient is almost identical across these MPI measures, in the range 0.9–1.6 over the 2002–May 2013 period. Second, the long-term coefficients on inflation and on the shadow fed funds rate appear rather implausibly large for MPI-A (3.3 for inflation as compared with 2.0 based on the benchmark MPI and 1.5 for shadow fed funds compared with coefficients close to 0.9 with other MPIs).

Implied long-term coefficients based on alternative MPIs Table 6

Over the period 2002–May 2013	Inflation (1)	PBoC expected inflation (2a)	Total inflation (1) + (2a)	Output	Shadowfed funds
Benchmark MPI	1.1	0.9	**2.0**	**0.5**	**0.9**
MPI-A	1.6	1.7	**3.3**	**1.0**	**1.5**
MPI-B	1.3	1.0	**2.3**	**0.6**	**1.0**
MPI-C	0.9	0.3	**1.2**	**0.3**	**1.0**
MPI-D	1.1	0.7	**1.8**	**0.5**	**1.3**

See the Box 2 for the construction of alternative MPIs. The open-economy hybrid reaction function is estimated with the PBoC depositor survey as inflation expectation.

Source: Authors' calculations.

5. Conclusion

This paper aims at elucidating China's evolving monetary policy during the 1993–2013 period, specifically attempting to test the implicit inflation-targeting hypothesis (through lagged or expected future inflation).

Multiple challenges stand in the way when trying to assess the changes in the monetary policy in China and to relate them to macroeconomic developments. First, no single policy instrument represents a good proxy for China's monetary policy. Therefore, we have built a new composite monetary policy index (MPI) by combining several price, quantity and administrative tools. This index seems to accurately capture the important changes in China's monetary policy. Moreover, since it is scaled in policy rate-equivalent terms, it can be interpreted in line with the conventional Taylor rule based on a target interest rate. In addition, MPIs with alternative weights on underlying instruments are also tested to assess the robustness of our findings.

Such an MPI leads us to identify a major shift in the conduct of monetary policy in China, starting in 2002, and in the relative importance of its macroeconomic determinants. Chen and Huo (2009) also found a break in the monetary policy rule around 2002–03. However, by taking into account the magnitude of changes, our paper is able to show that Chinese monetary policy featured a relatively expansionary approach and a policy style of larger but infrequent moves before 2002, while

afterwards it has been characterised by a relatively contractionary approach and a smoothing style of frequent but smaller steps. This may reflect a combination of economic liberalisation in the 1990s, a period of strong growth and increased price pressures in the 2000s, and the new policy orientation of the PBoC from 2002 onward. This break in policy style is robust to alternative MPIs, a robustness test surprisingly absent from the existing literature.

Second, we have used a Bayesian method proposed by Dueker (1999) and refined by Monokroussos (2011) to estimate a dynamic hybrid (both backward- and forward-looking) discrete-choice model. The model is estimated over two subsamples, before and since 2002, and is robust to the use of three alternative measures of inflation expectations. Our approach allows us to identify a major change in the determinants of monetary policy. Indeed, from 2002, the PBoC appears to have attached a greater weight to inflation, lending support to the argument, mentioned by He and Pauwels (2008), that its policy is similar to informal inflation targeting. This is also consistent with Zheng et al (2012), who find that the PBoC has paid increasing attention to inflation.

Moreover, our paper reveals that the PBoC seems to have gradually aimed at a "state of the art" monetary policy rule, with coefficients of inflation converging towards those of its international peers. Indeed, after 2002, the long-term coefficient on inflation in the PBoC reaction function rises and converges towards levels similar to those of the G3 central banks in the post-1979 period. Moreover, external factors, such as the US shadow fed funds rate, appear to have played a significant role in Chinese monetary policy decisions since 2002, in line with a more open Chinese economy. Moreover, the evolving Chinese exchange rate regime may have influenced the conduct of monetary policy, and the attempt to avoid large currency appreciation and massive capital inflows in the 2000s may explain the influence of the US shadow fed funds rate in China's conduct of monetary policy.

Going forward, our research can be extended in a number of directions. First, some of the liquidity management tools could be assessed relative to the scale of foreign exchange interventions so as to better differentiate between a change of monetary policy and a simple sterilisation operation. Second, we may wish to explore the potential role of the renminbi exchange rate as a direct component of China's monetary policy.

Appendix A: Construction of inflation expectation indicators based on business survey data and the Consensus Forecast

Long time series of inflation expectation surveys do not exist in the case of China. The PBoC has compiled a quarterly index of future price expectations only since 2001. Therefore, based on the work of Kaaresvitra and Mehrotra (2008), we suggest estimating an index of future price pressures based on published surveys of industrial firms' assessment of the economic situation collected by the PBoC. Our methodology consists in estimating CPI inflation with 16 different survey indicators related to price level sales, general business conditions, energy supply, raw material supply, production capacity utilisation, product sales, inventory level, domestic and overseas orders levels, funds turnover, cash inflow for sales, profitability, lending attitude of banks, fixed asset investment and equipment investment. Then we filter indicators with a stepwise method (based on information criteria). As shown in Table B.1, the method retains five relevant indicators.

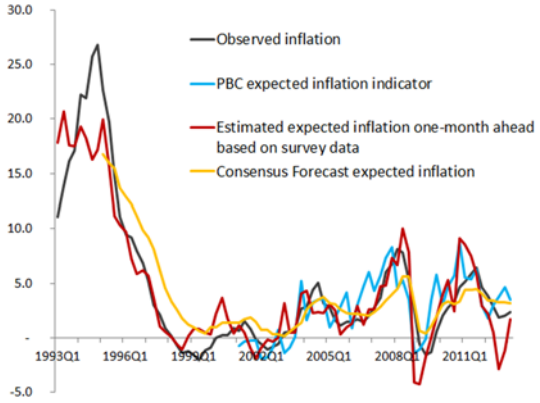
Construction of an inflation expectation indicator

Graph B.1.

Estimation of future inflation over Q1 1993–Q2 2013

	Estimate	Std. Error	T-value
Intercept	–33.34	7.76	–4.29
Lag(PriceLevelSales,-1)	0.75	0.13	5.71
Lag(EnergySupply,-1)	0.28	0.09	3.05
Lag(DomesticOrder,-1)	0.63	0.28	2.28
Lag(OverseasOrder,-1)	–0.41	0.19	–2.12
Lag(FundTurnover,-1)	–0.55	0.06	–8.50
R^2=85.3; RMSE=2.5; MAE=1.7			
SCtest=0.95, p-value=0.33			

Inflation and estimated inflation expectation



Source: Authors' calculations.

This estimated expected inflation indicator is compared with the ones published by the PBoC depositors' price expectations and Consensus Forecast[18] (Graph B.1 right-hand side). Graphically, our estimated, and the PBoC, indicators appear to lead observed inflation (by a few months) while the Consensus Forecast indicator appears to lag behind it. Then, Table B.2 (left-hand side) compares the predictive accuracy of our estimated inflation expectation indicator with the one published by the PBoC (with one lag) to forecast inflation. The Mean Absolute Error (MAE) criterion indicates that our estimated indicator outperforms the indicators published by the PBoC and Consensus Forecast in-sample, while the Consensus Forecast appears to forecast more accurately out of sample. Then, the Diebold-Mariano tests reject the alternative

[18] The Consensus Forecast indicator is based on the mean average CPI inflation projections across the different forecasters for the current and the next calendar year. Since they are fixed-event forecasts, we combine both series using the following method applied by Pierre Siklos (2010) to use them as fixed horizon forecasts. Consider a monthly forecast of inflation ( ) for calendar year t, released in month m. Denote such a forecast as FE m t where FE refers to the fixed event nature of the forecast. Hence, a forecast for the fixed event one year ahead would be written 1 FE m t. The transformation from FE to FH, where FH represents a fixed-horizon forecast, is $\pi^{FH}_{m,t} = \left[\frac{13-m}{12}\right]\pi^{FE}_{m,t} + \left[\frac{m-1}{12}\right]\pi^{FE}_{m,t+1}$

hypothesis that the PBoC and Consensus Forecast indicators forecast inflation better than our estimated indicator. Finally, Table B.2 (right-hand side) evaluates the relationship between our estimated inflation expectation indicator and the one published by the PBoC over the sample from 2001 to 2013 (the common sample for both indicators). We find that our estimated indicator of expected inflation captures quite well the evolution of the one published by the PBoC.

Comparison between our estimated expected inflation and the PBoC indicator Table B.1.

Predictive accuracy to forecast inflation

	In-sample(*)	Out sample
MAE :		
Estimated indicator (1)	1.06	1.84
PBoC indicator (2)	1.23	1.68
Consensus Forecast (3)	1.68	1.23
Diebold-Mariano test (p-value):		
(1) vs. (2)	0.98	0.10
(1) vs. (3)	0.99	0.21

(*) in-sample: 1995(1)–2010(4), out-sample:2011(1)–2013(1)
Source: Authors' calculations.

Estimation of PBoC inflation expectation over 2001(1)–2013(1)

	Estimate	Std. Error	T-value
Intercept	0.78	0.34	0.02
Lag(expinfl,0)	0.49	0.08	0.00
Lag(expinfl,2)	0.35	0.08	0.00
R^2=0.65; RMSE=1.7			

Source: Authors' calculations.

Appendix B: Detailed results based on the benchmark MPI

Table B.1 to B.4 present short-term estimated coefficients based on the benchmark MPI, respectively in closed- and open-economy specifications, both for the periods 1993–2001 and 2002–May 2013. The variable "variance" refers to the variance of the errors of equation. When explanatory variables are significant they appear in bold characters. The last two columns are the 5% and 10% quantiles of the posterior distribution.

Short-term coefficient based on benchmark MPI

Closed-economy over the period 1993–2001 Table B.1

Variable	Mean	Std.dev	Median	5%	10%
(a) Backward-looking rule					
Intercept	0.108	0.017	0.106	0.081	0.087
Variance	-0.514	0.161	-0.522	-0.798	-0.722
Lag(t-1) MPI	0.962	0.012	0.962	0.942	0.947
Lag(t-1) Inflation	0.003	0.009	0.003	-0.011	-0.008
Lag(t-1) Output	0.049	0.014	0.049	0.026	0.032
(b) Forward-looking rule B					
Intercept	0.106	0.017	0.104	0.082	0.086
Variance	-0.368	0.184	-0.367	-0.675	-0.598
Lag(t-1) MPI	0.963	0.012	0.962	0.943	0.948
Lag(t-1) Inflation	-0.009	0.011	-0.008	-0.027	-0.024
Lag(t-1) Output	0.033	0.017	0.033	0.009	0.013
Estimated expected inflation	0.024	0.016	0.025	-0.002	0.003
(c) Forward-looking rule C (*)					
Intercept	0.105	0.019	0.103	0.077	0.082
Variance	-0.198	0.358	-0.189	-0.796	-0.685
Lag(t-1) MPI	0.930	0.026	0.931	0.887	0.896
Lag(t-1) Inflation	-0.004	0.022	-0.003	-0.041	-0.034
Lag(t-1) Output	0.019	0.036	0.018	-0.040	-0.025
Consensus expected inflation	0.051	0.044	0.049	-0.024	-0.005

(*) Estimated over the 1995–2001 sample.

Source: Authors' calculations.

Short-term coefficient based on benchmark MPI

Closed-economy over the period 2002–May 2013 Table B.2

Variable	Mean	Std.dev	Median	5%	10%
(d) Backward-looking rule					
Intercept	0.075	0.012	0.074	0.058	0.061
Variance	-0.615	0.146	-0.612	-0.862	-0.803
Lag(t-1) MPI	0.977	0.012	0.977	0.957	0.962
Lag(t-1) Inflation	0.047	0.013	0.047	0.025	0.031
Lag(t-1) Output	0.040	0.010	0.040	0.026	0.028
(e) Forward-looking rule A					
Intercept	0.071	0.011	0.071	0.054	0.058
Variance	-0.564	0.144	-0.562	-0.808	-0.754
Lag(t-1) MPI	0.973	0.012	0.973	0.954	0.958
Lag(t-1) Inflation	0.030	0.014	0.030	0.007	0.012
Lag(t-1) Output	0.035	0.010	0.035	0.019	0.023
Lag(t-1) PBoC expected inflation (2a)	0.028	0.011	0.028	0.010	0.013
(f) Forward-looking rule B					
Intercept	0.064	0.010	0.063	0.050	0.052
Variance	-0.342	0.158	-0.340	-0.614	-0.546
Lag(t-1) MPI	0.971	0.012	0.971	0.952	0.957
Lag(t-1) Inflation	0.014	0.014	0.015	-0.010	-0.004
Lag(t-1) Output	0.021	0.011	0.021	0.004	0.008
Estimated expected inflation (2b)	0.045	0.011	0.045	0.027	0.030
(g) Forward-looking rule C					
Intercept	0.075	0.011	0.075	0.059	0.062
Variance	-0.655	0.166	-0.654	-0.931	-0.864
Lag(t-1) MPI	0.976	0.012	0.976	0.955	0.960
Lag(t-1) Inflation	0.034	0.025	0.033	-0.006	0.002
Lag(t-1) Output	0.041	0.010	0.042	0.024	0.029
Consensus expected inflation	0.023	0.041	0.022	-0.044	-0.030

(*) Estimated over the 1995–2001 sample.

Source: Authors' calculations.

Short-term coefficient based on benchmark MPI

Open-economy over the period 1993–2001 Table B.3

Variable	Mean	Std.dev	Median	5%	10%
(a) Backward-looking rule					
Intercept	0.108	0.017	0.106	0.084	0.087
Variance	-0.626	0.242	-0.627	-1.027	-0.923
Lag(t-1) MPI	0.959	0.013	0.959	0.938	0.943
Lag(t-1) Inflation	0.004	0.009	0.005	-0.010	-0.007
Lag(t-1) Output	0.053	0.015	0.053	0.029	0.035
Lag(t-1) fed funds	0.015	0.022	0.014	-0.019	-0.013
(b) Forward-looking rule B					
Intercept	0.107	0.018	0.105	0.082	0.086
Variance	-0.531	0.255	-0.519	-0.955	-0.864
Lag(t-1) MPI	0.959	0.013	0.959	0.938	0.942
Lag(t-1) Inflation	-0.007	0.012	-0.007	-0.026	-0.021
Lag(t-1) Output	0.039	0.018	0.039	0.010	0.016
Estimated expected inflation (2b)	0.025	0.017	0.025	-0.002	0.004
Lag(t-1) fed funds	0.022	0.023	0.022	-0.014	-0.007
(c) Forward-looking rule C (*)					
Intercept	0.106	0.021	0.103	0.077	0.082
Variance	- 0.267	0.395	- 0.263	- 0.960	- 0.805
Lag(t-1) MPI	0.929	0.028	0.929	0.882	0.893
Lag(t-1) Inflation	- 0.005	0.023	- 0.005	- 0.042	- 0.034
Lag(t-1) Output	0.012	0.039	0.014	- 0.056	- 0.041
Consensus expected inflation (2c)	0.055	0.048	0.054	- 0.023	- 0.006
Lag(t-1) fed funds	0.027	0.059	0.026	- 0.066	- 0.046

(*) Estimated over the 1995–2001 sample.

Source: Authors' computation

Short-term coefficient based on benchmark MPI

Open-economy over the period 2002-May 2013 Table B.4

Variable	Mean	Std.dev	Median	5%	10%
(d) Backward-looking rule					
Intercept	0.073	0.011	0.072	0.057	0.059
Variance	-0.429	0.181	-0.428	-0.744	-0.657
Lag(t-1) MPI	0.970	0.013	0.970	0.948	0.953
Lag(t-1) Inflation	0.055	0.014	0.055	0.033	0.037
Lag(t-1) Output	0.025	0.013	0.025	0.006	0.009
Lag(t-1) Shadow fed funds	0.027	0.014	0.027	0.003	0.009
(e) Forward-looking rule A					
Intercept	0.069	0.011	0.068	0.054	0.056
Variance	-0.353	0.174	-0.350	-0.641	-0.580
Lag MPI	0.966	0.013	0.966	0.944	0.949
Lag(t-1) Inflation	0.037	0.015	0.037	0.013	0.019
Lag(t-1) Output	0.017	0.013	0.016	-0.003	0.002
Lag(t-1)PBoC expected inflation (2a)	0.030	0.012	0.030	0.012	0.015
Lag(t-1) Shadow fed funds	0.031	0.014	0.031	0.008	0.014
(f) Forward-looking rule B					
Intercept	0.058	0.009	0.058	0.044	0.047
Variance	0.041	0.190	0.047	-0.280	-0.216
Lag(t-1) MPI	0.958	0.012	0.958	0.938	0.942
Lag(t-1) Inflation	0.020	0.015	0.020	-0.005	0.001
Lag(t-1) Output	-0.011	0.014	-0.011	-0.033	-0.029
Estimated expected inflation (2b)	0.057	0.011	0.056	0.039	0.043
Lag(t-1) Shadow fed funds	0.046	0.013	0.047	0.025	0.030
(g) Forward-looking rule C					
Intercept	0.074	0.012	0.072	0.057	0.060
Variance	-0.496	0.194	-0.496	-0.814	-0.745
Lag(t-1) MPI	0.969	0.013	0.969	0.946	0.952
Lag(t-1) Inflation	0.034	0.024	0.033	-0.007	0.002
Lag(t-1) Output	0.026	0.013	0.026	0.004	0.009
Consensus expected inflation (2c)	0.041	0.040	0.041	-0.024	-0.011
Lag(t-1) Shadow fed funds	0.029	0.014	0.030	0.006	0.011

(*) Estimated over the 1995–2001 sample.

Source: Authors' calculations.

References

Adam, C, D Cobham and E Girardin (2005): "Monetary frameworks and institutional constraints: UK Monetary policy reaction functions, 1985–2003", *Oxford Bulletin of Economics and Statistics*, vol 67, no 4, pp 497–516.

Aizenman, J (2004): "Financial opening and development: Evidence and policy controversies", *American Economic Review*, vol 94, no 2, pp 65–70.

Ball, L (1999b): "Policy rules for open economies", in J Taylor (ed), *Monetary Policy Rules*, University of Chicago Press, pp 127–56.

Boivin, J (2006): "Has US monetary policy changed? Evidence from drifting coefficients and real-time data", *Journal of Money, Credit and Banking,* vol 38, no 5, pp 1149–74.

Chen, Y and Z Huo (2009): "A conjecture of Chinese monetary policy rule: evidence from survey data, Markov regime switching, and drifting coefficient", *Annals of Economics and Finance*, vol 10, no 1, pp 111–53.

Clarida, R, J Gali and M Gertler (1998): "Monetary policy rules in practice: Some international evidence", *European Economic Review,* vol 42, no 6, pp 1033–67.

——— (2000): "Monetary policy rules and macroeconomic stability: Evidence and some theory", *Quarterly Journal of Economics*, vol 115, pp 147–80.

Cogley, T and T Sargent (2001): "Evolving post-World War II US inflation dynamics", *NBER Macroeconomics Annual*, vol 16, pp 331–73.

——— (2005): "Drifts and volatilities: monetary policies and outcomes in the post WWII US*", Review of Economic Dynamics*, vol 8, no 2, pp 262–302.

Dueker, M (1999): "Measuring monetary policy inertia in target Fed Funds Rate changes", *Federal Reserve Bank of St. Louis Review*, vol 81, pp 3–9.

Filardo, A and H Genberg (2009): "Targeting inflation in Asia and the Pacific: lessons from the recent past", *BIS Working Papers*, no 52.

Garcia-Herrero, A and E Girardin (2013): "China's monetary policy communication: money markets not only listen, they also understand", *HKIMR Working Paper*, no 2.

Gerlach, S (2007): "Interest rate setting by the ECB, 1999-2006: words and deeds", *International Journal of Central Banking*, vol 3, no 3, pp 1–46.

Girardin, E, S Lunven and G Ma (2014) "Inflation and China's monetary policy reaction function: 2002–2013", Bank for International Settlements, *BIS Papers*, no 77, pp 159-170.

Harvey, A (1989): "Forecasting structural time series models and the Kalman Filter", Cambridge University Press.

Hayo, B and B Hofmann (2006): "Comparing monetary policy reaction functions: ECB vs. Bundesbank", *Empirical Economics,* vol 31, pp 645–62.

Hofmann, B and B Bogdanova (2012): "Taylor rules and monetary policy: a global 'Great Deviation'", *BIS Quarterly Review*, September, pp 37–49.

He, D and L Pauwels (2008): "What prompts the People's Bank of China to change its monetary policy stance? Evidence from a discrete choice model", *China & World Economy*, vol 16, no 6, pp 1–21.

He, D and R McCauley (2013): "Transmitting global liquidity to East Asia: policy rates, bond yields, currencies and dollar credit", *BIS Working Papers*, no 431

Kaaresvirta J and A Mehrotra (2008): "Business surveys and inflation forecasting in China", *BOFIT Discussion Papers*, no 22.

Kim, C-J, N Kishor and C Nelson (2006): "A time-varying parameter model for a forward-looking monetary policy rule based on real-time data", University of Washington, Department of Economics*, Working Papers*, UWEC-2007-32.

Ma, G and B Fung (2002): "China's asset management corporations", *BIS Working Papers*, no 115.

Ma, G and R McCauley (2014): "Financial openness of China and India: Implications for capital account liberalisation", in L Song, R Garnaut, and C Fang (eds), *Deepening Reform for China's Long-Term Growth and Development*, Australian National University Press.

——— (2013): "Is China or India more financially open?", *Journal of International Money and Finance*, no 39, pp 6–27.

——— (2011): "The evolving renminbi regime and implications for Asian currency stability", *Journal of The Japanese and International Economies*, no 25, pp 23–38.

——— (2008): "The efficacy of China's capital controls — Evidence from price and flow data", *Pacific Economic Review*, vol 13, no 1, pp 104–23.

Ma, G, X Yan and X Liu (2011): "China's evolving reserve requirements", *BIS Working Papers*, no 360.

Monokroussos, G (2011): "Dynamic limited dependent variable modelling and US monetary policy", *Journal of Money, Credit and Banking,* vol 43, no 2-3, pp 519–34.

Patra, M and M Kapur (2012): "Alternative monetary policy rules for India", *IMF Working Paper*, no 12-118.

Shu, C and B Ng (2010): "Monetary stance and policy objectives in China: a narrative approach", *HKMA China Economic Issues*, no 1-10.

Siklos, P (2010): "Sources of disagreement in inflation forecasts: a cross-country empirical investigation", *IMES Bank of Japan Discussion paper*, no E-26.

Singh, B (2010): "Monetary policy behaviour in India: evidence from Taylor-type policy frameworks", *Reserve Bank of India Staff Studies*.

Svensson, L (1997): "Inflation forecast targeting: implementing and monitoring inflation targets", *European Economic Review*, vol 41, no 6, pp 1111–46.

——— (2000): "Open economy inflation targeting", *Journal of International Economics*, vol 50, pp 155–83.

——— (2002): "Inflation targeting: should it be modelled as an instrument rule or a targeting rule?", *NBER Working Paper*, no 8925.

Taylor, J (1993): "Discretion versus policy rules in practice", *Carnegie-Rochester Conference Series on Public Policy*, no 39, pp 195–214.

Wu J and F Xia (2015): "Measuring the macroeconomic impact of monetary policy at the Zero Lower Bound", *Chicago Booth Research Paper*, no 13-77.

Xiong, W (2012): "Measuring the monetary policy stance of the People's Bank of China: an ordered probit analysis", *China Economic Review,* vol 23, no 3, pp 512–33.

Zheng, T, X Wang and H Guo (2012): "Estimating forward-looking rules for China's monetary policy: a regime-switching perspective", *China Economic Review,* vol 23, no 1, pp 47–59.

Previous volumes in this series

No	Title	Author
640 May 2017	Understanding the determinants of financial outcomes and choices: the role of noncognitive abilities	Gianpaolo Parise and Kim Peijnenburg
639 May 2017	Supply- and demand-side factors in global banking	Mary Amiti, Patrick McGuire and David E Weinstein
638 May 2017	Assessing fiscal policy through the lens of the financial and the commodity price cycles	Enrique Alberola and Ricardo Sousa
637 May 2017	Global value chains and effective exchange rates at the country-sector level	Nikhil Patel, Zhi Wang and Shang-Jin Wei
636 May 2017	The impact of macroprudential policies and their interaction with monetary policy: an empirical analysis using credit registry data	Leonardo Gambacorta and Andrés Murcia
635 May 2017	Prudential policies and their impact on credit in the United States	Paul Calem, Ricardo Correa and Seung Jung Lee
634 May 2017	Evaluating the impact of macroprudential policies on credit growth in Colombia	Esteban Gómez, Angélica Lizarazo, Juan Carlos Mendoza and Andrés Murcia
633 May 2017	The impact of warnings published in a financial stability report on loan-to-value ratios	Andrés Alegría, Rodrigo Alfaro and Felipe Córdova
632 May 2017	The impact of macroprudential housing finance tools in Canada	Jason Allen, Timothy Grieder, Brian Peterson and Tom Roberts
631 April 2017	Arbitrage costs and the persistent non-zero CDS-bond basis: Evidence from intraday euro area sovereign debt markets	Jacob Gyntelberg, Peter Hördahl, Kristyna Ters and Jörg Urban
630 April 2017	How post-crisis regulation has affected bank CEO compensation	Vittoria Cerasi, Sebastian M Deininger, Leonardo Gambacorta and Tommaso Oliviero
629 April 2017	The beneficial aspect of FX volatility for market liquidity	Jakree Koosakul and Ilhyock Shim
628 April 2017	Is monetary policy less effective when interest rates are persistently low?	Claudio Borio and Boris Hofmann
627 April 2017	External debt composition and domestic credit cycles	Stefan Avdjiev, Stephan Binder and Ricardo Sousa
626 April 2017	Monetary policy's rising FX impact in the era of ultra-low rates	Massimo Ferrari, Jonathan Kearns and Andreas Schrimpf
625 April 2017	Scarcity effects of QE: A transaction-level analysis in the Bund market	Kathi Schlepper, Heiko Hofer, Ryan Riordan and Andreas Schrimpf

All volumes are available on our website www.bis.org.