Inflation and China's monetary policy reaction function: 1995-2011

By Eric Girardin, Sandrine Lunven and Guonan Ma [1]

Abstract

Our paper attempts to enhance the understanding of China's monetary policy rule, which may help explain its remarkable inflation performance over the past decade, in spite of the absence of explicit inflation targeting. In particular, we aim to shed light on the evolving role of inflation in the conduct of monetary policy by the People's Bank of China (PBC) since the mid-1990s, when both the underlying economy and its monetary policy framework were transformed. We develop a new monetary policy index (MPI) in China by combining quantity, price and administrative instruments and estimate a recursive hybrid (backward- and forward-looking), dynamic, discrete-choice model allowing us to include time-varying aspects into the policy reaction function.

Three main results arise from the paper. First, the Chinese monetary policy changes before 2002 may be characterised as relatively dovish and blunt. But after 2002, under PBC Governor Zhou, such changes were more hawkish and smoothed. Second, the PBC appears to have gradually built up a monetary policy framework similar to implicit flexible inflation targeting since 2002, with a significant rise in the weight on inflation in the reaction function and a gradual shift since 2008 towards a hybrid reaction function, seemingly increasingly taking into account the forward-looking aspect of inflation. Third, while PBC's behaviour pre-2002 bore resemblance with that of the pre-1979 inflation-accommodating G3 countries, it shifted after 2002 towards the post-1979 anti-inflation policy of the G3, albeit still with a high output weight typical of emerging economies.

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

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1 Introduction

With China's rising role in the global economy and markets, economists have become more interested in understanding the complexity of its financial system development and the way its central bank conducts monetary policy.

China's economic performance has been impressive over the past decade, with high GDP growth (around 10% per annum) and low CPI inflation (around 2% on average). An interesting question concerns the evolving role of inflation in China's monetary policy decisions helping to deliver good inflation performance, while it is not officially targeting inflation. 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. This paper attempts to determine the relevance of the 'price stability paradigm' in the case of China, defined as a strong response to price developments to achieve low and stable inflation (Creel and Hubert, 2010).

The monetary policy framework and objectives in China may have changed over the past two decades. 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, through changes in either the preference function of the authorities or (and) the structure of the economy. In the case of China, the People's Bank (PBC) employs a battery of price- and quantity-based instruments and their relative importance has varied over time (Xiong, 2012). Also, the Chinese economy has undergone substantial liberalisation and transformation since the early 1990s. Therefore, we have strong reasons to suspect that China's monetary policy rule may also have evolved over time.

Many questions over China's monetary policy rule remain open, most importantly the issue of the appropriate left-hand-side variable. Indeed, properly measuring the monetary policy changes is crucial to a better understanding of the conduct of monetary policy in China. Conventional measures of monetary policy have many drawbacks (for an overview, see Garcia-Herrero and Girardin, 2013). To address these drawbacks, we build on the work of He and Pauwels (2008) and Xiong (2012) and construct a new aggregate measure of China's monetary policy, by combining the multiple price, quantity and administrative instruments deployed by the PBC. However, our measure goes one-step further by combining these instruments in a way that allows for an interpretation of this new measure in terms of a 27bps equivalent change in policy rate.

To capture the characteristics of the monetary policy rule in China, we proceed to estimate a recursive, dynamic, hybrid discrete-choice model. We use the Bayesian method proposed by Dueker (1999) and Monokroussos (2010), combining *data augmentation* and *single-move Gibbs sampling* of the Markov Chain Monte Carlo literature. The model they use has many advantages, such as taking into account the discrete nature of the monetary policy instrument and allowing for asymmetries and time-varying coefficients, while not imposing abrupt breaks. Indeed, this method contrasts with a split-sample approach which requires postulating a structural break date. We also examine the relative weight of the backward- and forward-looking aspects in the Chinese monetary policy rule.

Our paper contributes to the literature with the following three main findings. First, our new monetary policy index (MPI) shows two contrasting regimes before and after 2002. The PBC monetary policy during 1995-2001 is characterised by relatively dovish changes and a policy style of big but infrequent moves, while that under the Zhou Governorship of 2002-11 features relatively hawkish changes and a style of small but frequent steps.

Second, the paper provides empirical evidence that the PBC has steadily moved to a regime that looks a lot like informal flexible inflation targeting, with a significant rise in the weight on inflation towards levels seen in other major countries (with a long-term coefficient higher than unity). Moreover, China's central bank has gradually turned towards a hybrid reaction function, initially more backward-looking but seemingly increasingly taking into account forward-looking aspects of inflation (mostly since 2008), with an overall coefficient of inflation higher than the 1.5 level originally suggested by Taylor (1993) as describing the monetary policy rule of the US Fed.

Third, the paper presents empirical evidence that the rule followed by the PBC, while still featuring emerging-economy characteristics, shows strong similarity with the G3 central banks. Indeed, we find a substantial contrast in the conduct of monetary policy before and after 2002 under the Governorship of Zhou Xiaochuan. Despite considerable differences in the economic context, this contrast is strikingly similar to the pre- and post-1979 contrasts for the G3 central banks, moving from an accommodating-inflation (and more output-sensitive) to a much more anti-inflationary policy. While the weight on output remains much higher in the PBC's monetary policy rule than in those of the G3 central banks, it is on a par with those of most other emerging economies.

The rest of the paper is organised as follows. Section 2 presents the literature, while Section 3 describes the construction of a new measure of the monetary policy changes in China. The section 4 discusses the estimation method and data, while Section 5 presents the estimation outcomes. The final section concludes.

2 Lessons from the monetary policy rule literature

This section first briefly reviews the literature on the theoretical framework of the Taylor-rule reaction function and the main empirical studies of China's monetary policy rule, before summarising the implications of China's economic reforms for its monetary policy rule.

2.1 Taylor-rule reaction function

A large part of the literature has been devoted to the understanding of the monetary policy rules employed by major central banks. The obvious starting point is the famous Taylor rule (1993), expressed as:

$$i_t^* = r^* + \delta_1 y_t + \delta_2(\pi_t - \pi^*) \qquad (1)$$

This rule models the desired or targeted nominal short-term interest rate i^* as a function of the output gap y_t, π_t inflation, and its target level π^* and r^* the equilibrium level of the real interest rate. Accordingly, since the real interest rate actually drives private decisions, the size of the inflation coefficient, δ_2, needs to ensure that the nominal interest rate is raised enough to increase the real interest rate as a response to a rise in inflation (Taylor 1993, and Woodford 2001). This so-called "Taylor principle' implies that δ_2 should exceed unity. Conversely, δ_2 lower than 1 would indicate an accommodative behavior of the interest rate to inflation which may result in self-reinforcing inflation. In parallel, the coefficient of output, δ_1, should be positive .

Over the past two decades, the literature has expanded to include various new applications and extensions of the Taylor rule. One best known strand is represented by the papers of Evans (1998), Clarida, Gali and Gertler (2000), Rudebusch (2002) and Ang, Dong and Piazzesi (2007). Specifically, they modify the Taylor rule to better correspond to the practical uses of central banks, for instance, extending the specification from a contemporary (π_t) model, as in (1), (or a backward-looking by replacing (π_t) by (π_{t-1})) to a forward-looking specification (2):

$$i_t^* = r^* + \delta_1 y_t + \delta_3(E_t\pi_{t+1} - \pi^*) \qquad (2)$$

where $E_t\pi_{t+1}$stands for expected future inflation. As pointed out by Cunningham, Desroches and Santor (2010), inflation expectations play a key role in the conduct of monetary policy, since they provide useful signals with respect to the credibility of the central bank and its long-run inflation objective. Indeed, if economic agents view the central bank as credible, inflation expectations are more likely to be well anchored, further enhancing the effectiveness of monetary policy. Moreover, inflation expectations are one of the main drivers of current inflation, because expected inflation influences current wage negotiations, price setting and financial contracting for investment. Our paper explores the evolving roles of both past and expected inflation in China's case.

A second major strand of new contributions concerns the introduction of the "interest rate smoothing" aspect in the specification. Indeed, it is generally recognized that, outside 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, rather than using large changes. Therefore, Clarida, Gali and Gertler (2000) relax the rule by specifying the following relationship for the *actual nominal interest* rate, i_t:

$$i_t = \rho(L)i_{t-1} + (1-\rho)i_t^* \qquad (3)$$

where $\rho(L) = \rho_1 + \rho_2 L + \cdots + \rho_n L^{n-1}$ and $\rho \equiv \rho(1)$. Equation (3) postulates partial adjustment of the interest rate to the target i_t^*. Specifically, the interest rate i_t is adjusted each period to eliminate a fraction $(1-\rho)$ of the gap between its current target level and some linear combination of its past values. We interpret ρ as an indicator of the degree of smoothing of interest rate changes. ρ close to zero (unity) suggests little (lots of) smoothing of policy rates. Moreover, Woodford (2001) and Sack and Wieland (2000) argue that the observed smoothing of the interest rate may indeed be optimal, even if the central bank is not explicitly concerned with interest rate volatility. Our paper attempts to identify whether the PBC embraces such policy smoothing as commonly observed among most major central banks.

Thus, by combining Equation (1) to (3), the following specification expresses a smoothed (or dynamic) hybrid (backward- and forward-looking) rule:

$$\begin{aligned} i_t &= \rho(L)i_{t-1} + (1-\rho)[r^* + \delta_1 y_t + \delta_2(\pi_t - \pi^*) + \delta_3(E_t\pi_{t+1} - \pi^*)] \\ &= \beta_0 r^* + \beta_1 i_{t-1} + \beta_2 y_t + \beta_3(\pi_{t-1} - \pi^*) + \beta_4(E_t\pi_{t+1} - \pi^*) \end{aligned} \qquad (4)$$

A third strand of the literature has taken into account the discrete nature of the monetary policy instruments. Hu and Phillips (2004) and Dueker (1999) suggest a methodology relying on the estimation of a discrete-choice model by classifying the Fed decisions to change the Fed Funds target rate in three categories: ‘increase’, ‘decrease’ or ‘no change’. Monokroussos (2010) also suggests a forward-looking and discrete-choice monetary policy reaction function for the US economy, using a much richer methodology, referred to as Markov Chain Monte Carlo simulation. This paper aims at testing such an approach in the case of China, allowing us to combine dynamic backward- and forward-looking aspects as well as to take into account the discrete nature of monetary policy instruments.

Another interesting line of recent works concerns the potential changes in the monetary policy rule (for instance changes in the coefficients in the above reaction function equations). An increasing number of studies have turned to nonlinear specifications to take into account such aspects, such as Cogley and Sargent (2001, 2002), Kim and Nelson (2006) and Boivin (2006), who suggest a forward-looking time-varying parameter specification to highlight structural changes in the conduct of US monetary policy (for a survey, see Yüksel, Ozcan and Hatipoglu, 2012).

The theoretical formulation of the ‘inflation targeting problem’ introduced by Svensson (1997) helps to understand potential sources of instability in the central bank reaction function. Indeed, the Taylor rule can initially be expressed as the reduced form of Svensson’s model. Accordingly, the reaction function results from the solution of an optimization problem in which the quadratic loss function of the authorities can be expressed as a function of the deviation of inflation from its target and of output from its potential. Such a loss function is sometimes referred to as reflecting ‘flexible inflation targeting’, since it includes output stabilization in addition to inflation stabilisation (Svensson, 2010).

In order to obtain the Taylor rule, the quadratic loss function is minimized under the constraint of the structure[2] of the economy, including IS and Phillips curves, both backward and forward looking, with the real ex ante interest rate entering the IS curve.

From this theoretical formulation, the instability of the reaction function can potentially arise from: i) the preference function of the authorities; or ii) the structure of the economy (with model uncertainty). Such sources of instability of course include reforms and deregulation, which are particularly relevant for a fast-transforming Chinese economy. In this paper, therefore, we aim to allow for time-varying coefficients in our estimation of the Chinese monetary policy rule.

2.2 Case studies on China’s monetary policy rule

Our paper builds in part on the existing literature of empirical research on the conduct of monetary policy in China, which can be divided into two main categories. The first category of works tries to transpose a specification standard for major OECD countries to the case of China. This strand of research typically models the interbank interest rate in line with the methodology of Clarida, Gali and Gertler (2000). Xie and Luo (2002) is probably the first paper formally applying the Taylor rule to the case of China in the 1990s. The paper takes a standard Taylor rule to compute the implied policy rate and compares it to the actual interest rate. They

[2] While a backward-looking model is used in Svensson (1997), a more general forward-looking version is presented in Svensson (2003; 2010).

conclude that the two broadly track each other in most cases but policy responses sometimes lagged behind the business cycle. Moreover, in their estimate over 1992-2001, they find an inflation-accommodating reaction (with a coefficient close to 0.8) and a strong reaction to output (close to 2.8).

Zhang and Zhang (2007) estimate a forward-looking Taylor rule and find that the PBC did not satisfy the Taylor principle. Others turn to nonlinear specifications, such as Zheng and Liu (2010). Zheng et al (2012) introduce a regime-switching forward-looking Taylor rule by using the two-step maximum likelihood procedure of Kim and Nelson (2006). Both papers find that the response of interest rate policy to inflation and output is time-varying. Zheng et al (2012) conclude that the magnitude of the response to inflation was larger in 1998-2002 than during previous periods. Chen and Huo (2009) consider a forward-looking Markov-switching and a time-varying parameter model to estimate the changing coefficients of the monetary policy reaction function in China. They assume that the PBC adjusts the M2 growth rate in response to inflation and the output gap and find two structural changes in the Chinese monetary policy rule, the first one around 1998 and the second around 2002-2003. Moreover, they conclude that a pure forward-looking monetary policy rule cannot fully explain the Chinese situation and that the PBC is partly backward-looking. Indeed, they show that the responses to the lagged inflation variables are statistically significant after 2002.

However, one drawback of the analyses in this category is their questionable measures of the monetary policy in China. Zheng et al (2012) choose China's inter-bank offered rate (CHIBOR) as the policy rate, along with Xie and Luo (2002) and Zheng and Liu (2010). As Garcia-Herrero and Girardin (2013) argue, the liquidity in the CHIBOR may not be deep enough, at least in the 1990s. He and Pauwels (2008) argue that short-term interbank interest rates are not a good measure of policy due to market segmentation. Besides, M2 is not controlled by the authorities and may not be a good monetary policy proxy. Finally, Guo and Chen (2012) test different instruments individually (the regulated bank deposit rate, reserve requirement rate, loan size, the short-term interbank market rate and monetary base) and conclude that none of these policy tools on its own is a good measure of monetary policy.

The second category of works aims at better measuring monetary policy, using an approach pioneered by Gerlach (2004) to construct an implicit index of the ECB's monetary policy changes from the observed changes in the policy instruments. It takes the form of a discrete variable with three classes: "hawkish", "neutral" and "dovish". Then ordered-probit techniques are used to estimate the reaction function. He and Pauwels (2008) compute a measure of PBC's policy changes by studying changes in various PBC policy instruments over the period 1992-2007. Their monetary policy rule estimation reveals that deviations of CPI inflation from an implicit target and deviation of broad money growth from the announced targets figure significantly as determinants of PBC's policy changes, but not the output gap. They conclude that these findings are consistent with a characterisation of the monetary policy framework in China as one of 'implicit inflation targeting'.

Xiong (2012) follows the qualitative-variable methodology of He and Pauwels (2008) and tests a forward-looking specification by examining the PBC's statements in its quarterly *Monetary Policy Executive Report*. He concludes that monetary policy reacts to actual output growth. But when deviations from trend levels are considered, the PBC responds more to inflation. In the forward-looking model, he finds that inflation plays a key role in determining the PBC's policy moves. Finally, Shu and Ng (2010) use a narrative approach by compiling indices of the PBC's policy stance on the basis of meeting notes and the policy statements. The paper tests various objective variables and finds that growth and inflation are key monetary policy determinants and that the PBC appears to follow a rule of thumb, using historical averages as target rather than official targets.

Both strands of the empirical studies of China's monetary policy have their own advantages and drawbacks. In this paper, we build on the existing literature of these two strands to estimate China's monetary policy rule by combining the construction of an improved monetary policy index and the use of time-varying estimation.

2.3 Implications of the Chinese economic transformation

Discussion of sources of instability in the policy reaction function points to the potential importance of economic reforms and institutional evolution in China. This underscores the need to adopt some time-varying methodology in estimating the evolving Chinese monetary policy rule. Key reforms and structural and institutional changes potentially generate changes in China's policy reaction function.

First, the Chinese labour market has evolved over the past two decades, with large-scale labour migration from agriculture to industry and from rural to urban areas. The government began in 1994 a policy of privatising and downsizing small- and medium-size state-owned enterprises (SOEs) and introduced rules to allow SOEs to set their own wages. Meanwhile, more jobs have been created outside the state sector since the mid-1900s. Thus, private agents' expectations gained importance and their behaviour may have become more forward-looking, influencing both monetary policy transmission and policy effectiveness, and highlighting the need for the authorities to be themselves increasingly forward looking.

Second, the 1990s were a period of substantial price liberalisation that affected the inflation dynamics in China (Kojima, Nakamura and Ohyma, 2005). One noted change has been the absence of episodes of double-digit inflation after 1995, as inflation has become less volatile. This new inflation pattern may relate to a combination of domestic forces, including fuller price liberalisation, "hardened" budget constraints of SOEs, the state banks' reluctance to grant loans before the 2003 recapitalisation and the expanding supply capacity. Thus inflation in China may respond more normally to market demand and supply shocks.

Third, China's WTO accession in 2001 can be another major factor influencing the domestic inflation cycles and monetary policy rules. China's exports and imports rose from 43% of GDP in 2001 to a peak of 71% in 2006 against a backdrop of globalisation. Moreover, China has, over the years, become a key player in global commodity markets. Further financial openings were initiated such as the launch of the Qualified Foreign Institutional Investor (QFII) programme in 2002 and the Qualified Domestic Institutional Investor (QDII) scheme in 2006.[3] Another major move is the government policy to promote the external use of the renminbi in trade and financial transactions since 2009 (McCauley, 2011; and He, 2012). All these changes may have further altered the transmission of monetary policy in China.

[3] The QFII programme since 2002 allowed large foreign institutional investors to invest in China's onshore stock market, while the QDII scheme in 2006 permitted Chinese institutions to invest in financial products overseas.

Fourth, the evolving Chinese exchange rate regime may have influenced monetary policy. The management of the renminbi experienced a switch from a de facto dollar peg during 1994-2005 to a managed floating from July 2005 (Ma and McCauley, 2011). To maintain relative monetary policy independence under a still heavily managed currency, China often has to regulate capital flows and sterilise foreign exchange interventions. Large external surpluses prompted the PBC to resort to a variety of monetary policy instruments, while the dollar peg forced the trade-weighted renminbi to fluctuated substantially between 2008 and 2010 (Ma, et al, 2011; Ma and McCauley, 2011).

Finally, the post-1995 period witnessed a more enhanced role of the PBC as a central bank and gradual financial liberalisation. Indeed, although the PBC assumed its responsibility as a central bank in 1983, its status as a central bank was not legally confirmed until 1995. Financial liberalisation took place gradually. The PBC rolled out additional policy instruments such as central bank bills and reserve requirements, introduced quarterly monetary policy committee meetings and quarterly monetary policy reports from 1997 onwards. All these would likely affect both the PBC's monetary policy framework as well as its implementation style.

One would expect each of these changes to impact the IS and Phillips curves. Empirical estimates on inflation persistence help bring useful lights on such potential instability, which highlight the changes in inertia in the inflation process. Zhang (2011), estimating the persistence of inflation in China since the early 1980s, finds a structural break in 1995. Such a break corresponds to a substantial fall in inflation persistence. A second break is detected in late 2003. Also, Filardo and Genberg (2009) detect a fall in persistence from 0.81 to 0.55 in the new millennium. The first break in inflation persistence in 1995 is attributed by Zhang (2011) to changes in monetary factors.

3 Measuring monetary policy in China

This section discusses both the challenges to the task of measuring PBC's monetary policy and our approach to constructing a new "Monetary Policy Index" (MPI) as the left-hand-side variable in the estimation of the policy reaction function. The challenges stem from the fact that there is no single operating target in the Chinese monetary framework and that the PBC uses a battery of price, quantity and administrative instruments. To better gauge the monetary policy, we first quantify the monthly changes in the Chinese monetary policy, by converting a given change in each of the individual instruments into a "27 basis points equivalent change in the policy rate" and then by combining these equivalents in the same month into a monthly aggregate change in monetary policy. We then cumulate these aggregate changes into our MPI. One aim is to develop a MPI that captures not only the direction but also the scale of policy changes in terms of 27bps equivalents.

A proper measurement of monetary policy changes is crucial in China's case. The PBC's conduct of monetary policy differs significantly from central banks in most of the major OECD economies. These central banks typically implement monetary policy using a short-term interbank interest rate as the main operating target, such as the Fed funds rate for the US and Eonia for the Euro area. Instead, the PBC deploys multiple policy tools to implement its monetary policy.

There are three main categories of policy instruments employed by the PBC: (i) Price-based instruments, such as interest rates on bank deposits and lending, as well as required and excess reserves, or PBC refinancing.[4] (ii) Quantity-based instruments, such as the reserve requirement ratio (RRR) and open-market operations (OMOs). (iii) The PBC also uses administrative window guidance to influence bank lending, which is not directly observable. These instruments may in turn influence the interbank market interest rates, which can also be affected by other market demand and supply factors in the broader financial system.

To make the task of measuring monetary policy more challenging, the mix of these instruments has evolved over time. Before 1998, the credit plan was the PBC's main instrument for controlling credit and money supply. To eliminate the excess demand for funds, the interest rates on deposits and loans were occasionally adjusted to influence the cost of funds paid by borrowers. The RRR was first introduced in 1998 but not often adjusted until the mid-2000s. The PBC started conducting OMOs on a regular basis in 1998 and selling its own bills on a meaningful scale in 2002. From late 2007, the PBC increasingly used the RRR to drain liquidity (Ma et al, 2011), mainly because its use to withdraw liquidity on a more permanent basis is more cost effective from the PBC's point of view.

Simply put, there is no single policy tool, interest rate or otherwise, that can properly summarise the monetary policy of the PBC. This points to the need for a composite measure that can reflect the changing mix of policy instruments used by the PBC. We take on this challenge by constructing a new measure of the monthly MPI in four main steps. (i) Converting a given monthly change in each instrument into an equivalent 27bps change of the policy rate. (ii) Combining these equivalents of all instruments into a monthly aggregate change in monetary policy. (iii) Modifying these aggregate changes by taking into account possible window guidance. (iv) Cumulating these aggregate changes into a monthly MPI as the left-hand-side variable in the reaction function to be estimated.

Number of changes for each monetary policy instrument

Table 1

	1995–2001	2002–June 2011	"Equivalent 27 bps" change
Lending and deposit rates	7	17	27bps (then 25bps)
Interest rate on required reserves	7	2	27bps
Lending rate to refinancing	9	5	27bps
RRR	2	34	50bps
Open market operations[1]	0	20	...

[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 260 billion RMBs in absolute terms (see Table 2 for further explanation).

Source: CEIC.

The first step is to compute a monthly "equivalent 27-basis-points" change in the policy rate for each instrument (Table 1). First, we take a 27bps (25bps since 2010) change in all regulated bank deposit and lending rates and interest rates paid and charged by the PBC as equal. Next, while the interest rates are mostly changed

[4] From July 2013, all bank lending rates are no longer directly regulated by the government.

by 27bp, the RRR usually moves by 50bp. Therefore, we assume a typical 50bps RRR change to be equivalent to a 27bps change in the policy rate. Finally, we convert a given net liquidity change from open market operations (OMOs) into an equivalent 27bps rate change in the following way. A net monthly liquidity withdrawal or injection from OMOs is viewed as a tightening or easing move. Then, the "equivalent 27bps change" is based on the percentiles calculated on the net monthly liquidity changes from OMOs, as shown in Table 3.

Note that the threshold of 85% is not selected arbitrarily. Using a slightly different variable based on net PBC bill issuance only (thus omitting the non-bill OMOs), He and Pauwels (2008) and Xiong (2012) take the threshold of RMB 200 billion as equivalent to a 50bps change in the RRR. This RMB 200bn net liquidity change corresponds to 85% of net PBC bill issuance (in absolute terms). Calculating percentiles on the net liquidity changes from OMO operations, we find that some 85% of such monthly net liquidity changes are below RMB 260bn, 90% are below 330 bn and 95% lower than 500 bn.

The second step is to combine these monthly 27bps equivalent changes of 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 "equivalent 27bps" 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 "equivalent 27bps change". In this case, we do not take into account multiple variations of different instruments.

The intuition is that the PBC typically changed both deposit and loan rates in the same direction by 27 bps, which should not be regarded as a policy move of 54 bps. Also, the PBC rarely changed the two quantity instruments in the same direction. Finally, a mix of rate and quantity tools in the same direction should be viewed as a change in the quantity tool to ensure the money market rates move in line with the prevailing deposit and lending rates. Thus, we only take the maximum changes when two instruments move in the same direction to avoid double-count.

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 as in the Taylor rule, as it captures the magnitude of instrument changes, an addition to the pure qualitative-variable approaches used in Gerlach (2004) for the ECB, and He and Pauwels (2008) and Xiong (2012) for the PBC.

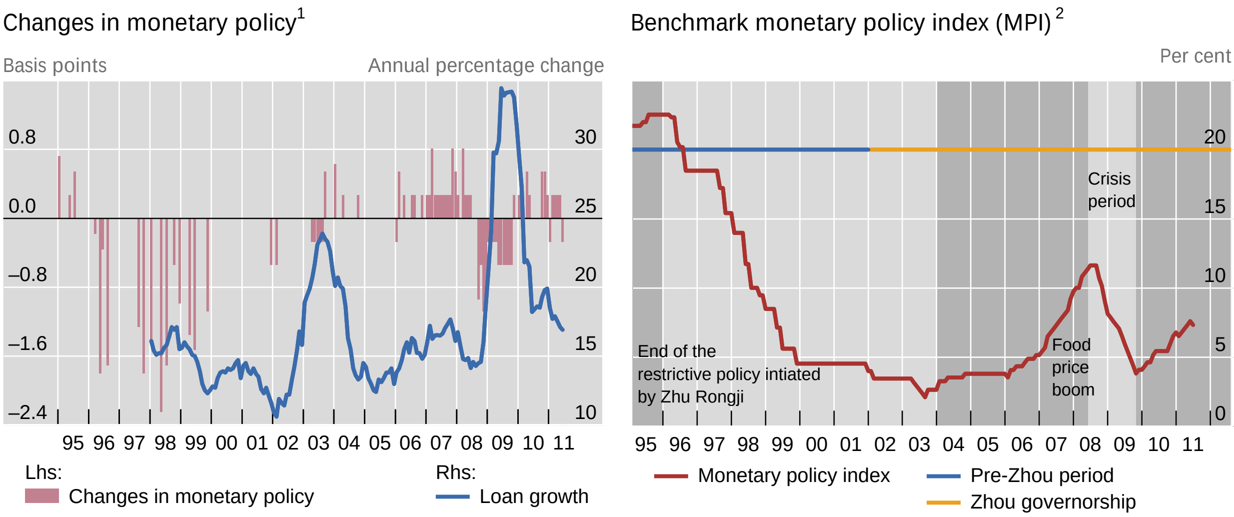
The third step is to take into account possible informal credit quotas and window guidance, which are not directly observable, and to adjust for effects of the Chinese New Year and one-off institutional changes. First, following Xiong (2012), we approximate the unobserved policy changes via window guidance in terms of unusual loan-growth acceleration. We define an "equivalent minus 27bps change" if year-on-year loan growth accelerates above 20% and an "equivalent minus 54bps change" if loan growth accelerates above 30%.[5] Second, we adjust for Chinese-New-Year effects, as liquidity is typically injected before the Chinese New Year and

[5] This is an ad hoc method that takes account of possible policy changes via window guidance but it at least allows us to reflect to some extent the observed extremely expansionary monetary policy in 2003 and 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.

withdrawn soon afterwards. We remove such liquidity injection/withdrawal when constructing our measure of monetary policy changes. Third, we also remove the big 500bps RRR cut in March 1998, as it was not a monetary policy signal but simply part of the PBC operations to recapitalize commercial banks and unify the reserve-requirement system.

The resultant measure shows an interesting historical pattern of monetary policy changes, with two different regimes before and after 2002 in terms of both policy changes and policy style (Graph 1, the left panel). First, the 1995-2001 period witnesses mostly dovish monetary policy changes, as part of the government policy package to resist the deflationary pressures from both domestic corporate restructuring and competitive currency devaluation by its neighbours during the Asia financial crisis. The 2002-2011 period shows relatively more hawkish policy changes. The start of the Zhou Xiaochuan Governorship in December 2002 represents a combination of a liberalisation process, culminating in China's WTO accession in late 2001, a period of strong growth and some emerging price pressure. The more restrictive policy changes have intensified during the subsequent 2006-08 episode of food price inflation and rapid FX reserve accumulation. Second, these two periods also seem to display quite distinct monetary policy styles. The pre-2002 period features mostly bigger but infrequent policy moves, while the post-2002 period is characterised with relatively smaller but more frequent policy steps, i.e. more smoothing and a less abrupt policy style under the Zhou Governorship.

Monetary policy index in China — Graph 1



[1] Equivalent 27 basis points change in policy rate. [2] The starting point of the MPI in January 1995 is taken as the one-year deposit rate (11 per cent) in that month and multiplied by 2 so as to avoid subsequent negative values. Estimation results are not sensitive to this arbitrary initial normalisation.

Source: CEIC, Author's computation.

Table 2 further confirms the different policy styles before and after 2002. While more than 80% of the monthly monetary policy moves (15 out of 18) during 1995-2001 are equal to or larger than an equivalent 54 bps change in policy rate, two thirds (40 out of 61) of the policy changes during 2002-2011 are 27bps equivalent or less.[6] Also, there was on average 2.6 policy moves per annum before 2002 but 6 policy moves a year after 2002. In other words, the PBC appeared to conduct monetary policy before 2002 with bigger and less frequent moves but operate with smaller but more frequent moves afterwards.

Before the actual estimation of the policy reaction function, we transform our measure of the changes in monetary policy into a Monetary Policy Index (MPI) by cumulating the monthly variations from January 1995 onwards (right panel of Graph 1). This procedure enables us to interpret the coefficients of the explanatory variables in line with the Taylor rule conventions.

Number of changes in the monetary policy index (MPI)

In absolute terms

Table 2

	<27bps	27bps	54bps	>54bps	Total
1995–2001	1	2	3	12	18
2002–June 2011	0	40	14	7	61
Whole period (1995-June 2011)	**1**	**42**	**17**	**19**	**79**

Source: Authors' computation.

In sum, our MPI, while obviously still leaving ample 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 deployed by the PBC, especially the evolving mix of interest rates, liquidity management tools and window guidance. Third, it attempts to better reflect the magnitude of various instrument changes by combining them in a single index and appears able to better capture the important historical changes in Chinese monetary policy. Fourth, it allows the index to be interpreted as a 27bps equivalent change in policy rate in our subsequent empirical estimation of the Taylor rule equation in China. Finally, it will permit us in future works to construct alternative MPIs and to conduct robustness tests.

4 Methodology and data

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

4.1 Estimation of the Taylor rule

Our empirical analysis is based on the methodology of Monokroussos (2010) which is itself an extension of the approach suggested by Dueker (1999). This approach

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

emphasizes the discrete nature of monetary policy changes which, as pointed out by Dueker (1999), poses special challenges to empirical analysis. They propose a model belonging to the multinomial ordered probit family because the size of possible monetary policy actions is limited (such as, in our case, multiples of 27 basis points) and such actions are ranked (monetary policy is considered more hawkish when the index changes by 54 than 27bps). As in probit models in general, one models a continuous latent variable, the PBC's *desired level* for the MPI which determines the behaviour of the observed discrete variable. However, their methodology also allows the use of the standard specification of the Taylor rule by capturing the 'interest-rate smoothing' aspect and accounting for both backward- and forward-looking inflation. This equation is described as follows:

$$MPI_t^* = \beta_{0,t} + \beta_{1,t} MPI_{t-1}^* + \beta_{2,t}\pi_{t-1} + \beta_{3,t} y_{t-1} + \beta_{4,t} E_{t-1}\pi_{t+3} + \varepsilon_t \quad (7)$$

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

where MPI_t^* is the desired level of the MPI_t discussed in Section III, π_{t-1} the lagged inflation, $E_{t-1}\pi_{t+3}$ the expectation of future inflation one-quarter ahead and y_{t-1} lagged output.[7] ε_t is a normally distributed, mean-zero error term. β_1 plays the same role as ρ in Equation (3). Thus, Equation (7) corresponds to a hybrid (backward- and forward-looking inflation) specification. If we remove $E\pi$, then Equation (7) is reduced to a pure backward-looking monetary policy rule. We will estimate both the pure backward-looking and hybrid specifications.

It is worth noting that we introduce raw data on inflation and output growth rather than the usual output gap and deviations from inflation target. The first reason is that, in China, such official targets are not announced as true objectives to reach, as observed in G3 economies, but are more published as guidance. As a result economic growth (inflation) was generally higher (lower) than the targets over the past 20 years, which implies that official targets cannot be considered as good measures of potential or steady-state values. However, our time-varying specification, particularly the time-varying intercept, helps us capture potential time-varying potential growth rates and inflation targets.

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

$$\Delta MPI_t \in \text{category } j \text{ if } MPI_t^* - MPI_{t-1} \in \left(c_{j-1}, c_j\right), j = 1, \cdots, J \quad (8)$$

where MPI_t is the observed index which changes by only one of J possible values at discrete points in time, and where $c_0, c_1, \cdots, c_J$ are the threshold coefficients for movement between the J possible categories of change. Therefore, the difference between MPI_t^* (estimated in the reaction function) 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. Considering the majority of policy changes are of two

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

sizes (27bps and 54bps), we assume four threshold coefficients to include such changes: {-0.45, -0.10, 0.10, 0.45}[8].

While this methodology differs from the standard model in the literature (such as Clarida, Gali and Gertler, 2000), it employs a similar specification by including (both backward- and forward-looking) inflation and output as explanatory variables. Moreover, estimated coefficients are interpretable as in a standard Taylor rule.

However, as well explained in Monokroussos (2010), 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 by using the maximum likelihood technique.[9]

In order to take into account potential sources of instability in the reaction function, we use recursive estimation. This simple approach is preferred both to a Markov-Switching model as it allows potential time-varying coefficients in the reaction function, and to a rolling-window estimation which generates abrupt changes or large instability in coefficients. The recursive approach is able to detect potential time-varying coefficients and structural breaks. The starting sample used in the recursion spans from January 1995 to December 1999. Then, we recursively repeat the estimation by adding one month at a time until estimating over the whole sample.

4.2 Data

The data series used span the period from January 1995 to June 2011. For the economic activity variable, we use the level of industrial output in constant RMB. As the year-on-year series precisely matches the IMF reported annual industrial output growth series (collected from China's National Bureau of Statistics) from January through December 2001, we took these twelve 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, backward and forward.

The Chinese New Year often distorts the year-on-year growth rates in January and February. We thus take 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. 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 seasonality using unobserved component models (with the STAMP module of Harvey, 1989).

Table 3 highlights China's performance during the period from 1995 to June 2011, combining high output growth and low CPI inflation. While the post-2002 period witnesses an even more attractive inflation-growth trade-off relative to that of the pre-2002 period, Graph 3 shows that the inflation and output dynamics across these two episodes are quite different. The average CPI inflation during the pre-2002 period was much higher, mainly because of the initial double-digit

8 Alternative threshold coefficients have been tested and do not significantly impact results of the estimation

9 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 (2010).

inflation which fell remarkably afterwards. By contrast, CPI inflation during 2002-2011 was lower on average but mostly on the rise. Output growth during the pre-2002 period decelerated sharply from the initially unsustainable pace but expanded strongly for most of the post-2002 period.

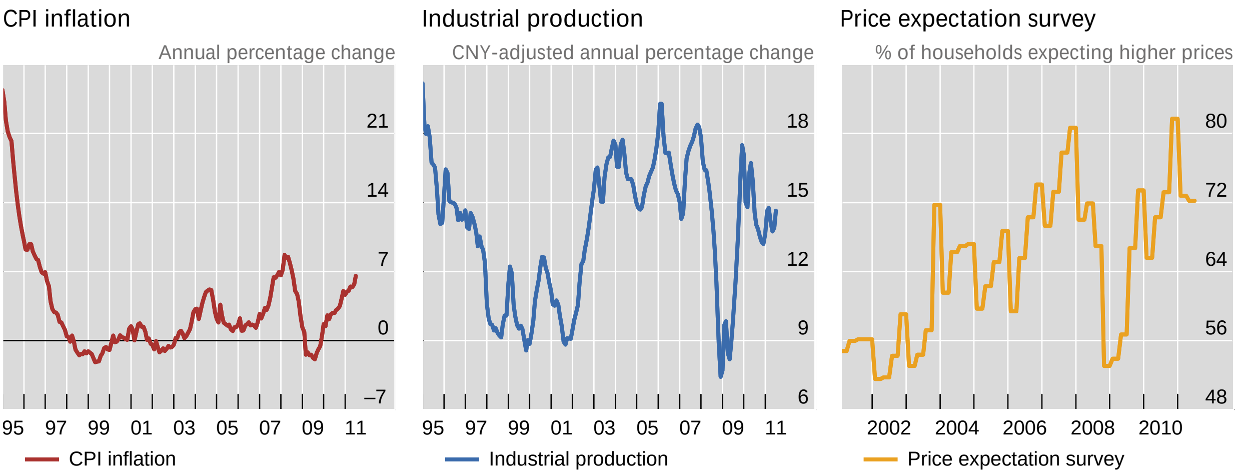
Descriptive statistics of CPI inflation and industrial growth

Mean in per cent, year on year; standard deviation in brackets — Table 3

	1995–2001	2002–June 2011	**1995–June 2011**
CPI inflation	3.9 (6.5)	2.5 (2.6)	**3.1 (4.7)**
Industrial production growth	12.2 (2.7)	15.0 (2.6)	**13.8 (3.0)**

Source: CEIC, NBS and authors' computation.

Inflation, industrial production and inflation expectations in China — Graph 2



Sources: CEIC; NBS; PBC and authors' computation.

Finally, we use the expectation of future price index from the PBC quarterly depositors' survey as our proxy of inflation expectations (the right-hand panel of Graph 2). Since this indicator is only available since 2001, it is interacted with a multiplicative dummy variable equal to zero from 1995 to 2001, and unity subsequently. Moreover, we normalize the indicator constraining it to lie within the same range as inflation. While in Consensus Forecast, the inflation variable is available since the mid-1990s, it is mostly a lagging indicator of inflation. Moreover the PBC survey measure is a reflection of consumers' expectations, while the Consensus Forecast is mostly made by overseas China watchers. The PBC survey series is published quarterly (end of quarter) referring to expectations with respect to the next quarter. As we assume that this represents expectations for the whole quarter, we will need to take its lagged value in the estimation with monthly data.

5 Empirical results

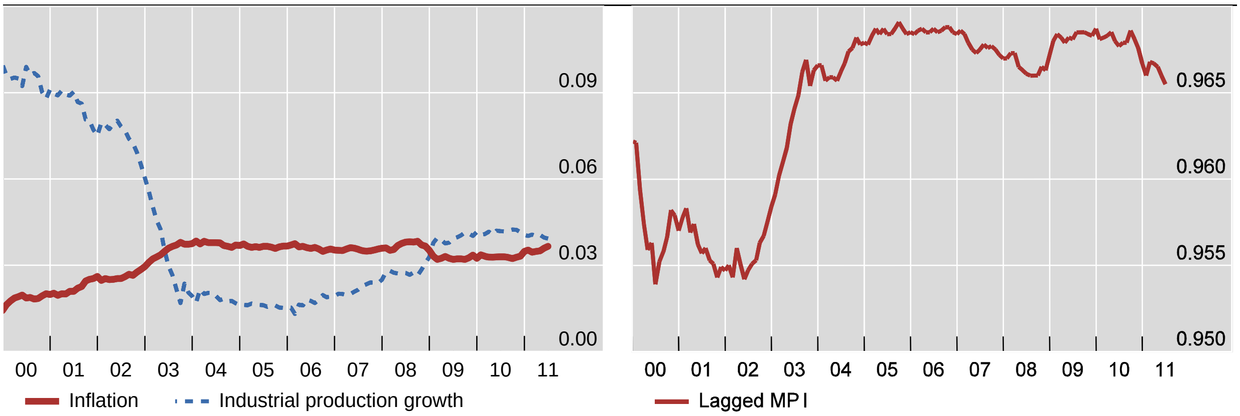
This section presents results of the estimated monetary policy rule. We first show the results of a pure backward-looking monetary policy rule and then add forward-looking aspects into the rule. We put China's monetary policy rule into an international perspective and finally offer a simple robustness test.

5.1 Backward-looking monetary policy rule

The estimated short-term coefficients of the recursive dynamic backward discrete-choice reaction function are presented in Graph 3. The starting point, December 1999, represents the results of the estimation over the initial window from January 1995 to December 1999. Then, the model is recursively estimated by adding one month at a time. This clearly shows evidence of time-variation in the reaction function since the mid-1990s. Indeed, both inflation and growth appear to play a significant role over the whole period but show varying weights over time. More precisely, our empirical results highlight the substantial differences in monetary policy between the pre- and post-2002 periods. During the 1995-2001 period, output growth plays a dominant role in the conduct of monetary policy. It is important to remember that the PBC was fighting against the economic slowdown during this period, owing to the previous stabilization policy, domestic corporate restructuring and the Asian Financial Crisis. This heritage from the late 1990s mostly explains the remarkable weight given to output growth. In parallel, the coefficient of inflation, although significant, was very low compared to output.

Recursive estimation of the pure backward-looking model

Short-term coefficients of inflation, output and lagged MPI — Graph 3



Source: Authors' computation.

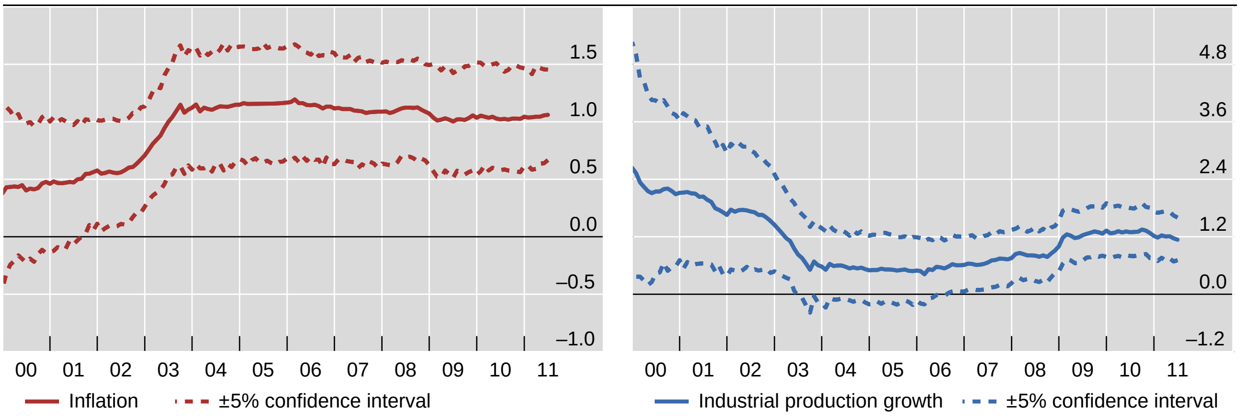
However, significant moves in both coefficients are noticeable from 2002 onwards. Indeed, we observe a sharp increase in the weight put on inflation in the reaction function (with the short-term coefficient rising by 50% (from 0.027 to 0.04) during the periods ending in 2002 and 2003). In parallel, the short-term coefficient of output growth falls to lower levels, similar to those observed for inflation before 2000. This period clearly reveals a change in PBC behaviour in the context of robust growth, widening external surplus and rising price pressure during 2003-2008. It results in a reversal in the relative weight of inflation and output growth. Interestingly, the estimated recursive coefficient of the lagged MPI (β_1) increased over this period, possibly reflecting a shift in the PBC's style of conducting monetary policy[10] under the new governor Zhou starting in December 2002. The PBC not only began to use new instruments, such as the reserve requirement ratio and open market operations, it also smoothed monetary policy changes by operating smaller but more frequent variations shown in Table 4, more in line with existing practice in large OECD countries. Finally, this new regime of monetary policy also coincides with an increase in trade openness and gradual financial reforms.

However, the Global Financial Crisis (GFC) and the sharp domestic economic slowdown might have triggered a transition around 2008 into a new phase, bringing down the weight on inflation, falling below the (rising) coefficient on output. Overall, short-term inflation and output coefficients converge to similar levels over the samples ending after 2008.

Recursive estimation of the pure backward-looking model

Long-term coefficients and confidence interval

Graph 4



Source: Authors' computation.

Graph 4 plots the recursive long-term coefficients of both output growth and lagged inflation in the monetary policy rule. During the first sub-period (1995-2001), the PBC followed an inflation-accommodating policy, with the recursive long-term coefficient of inflation much lower than unity and mostly oscillating around 0.5. The late 1990s witness a heavy recursive weight on output growth, which exceeds 2.

Then the PBC appears to have gradually changed its monetary policy framework starting around 2002, following the onset of the Zhou Governorship. More specifically, our estimated recursive long-term coefficients reveal a significant rise in the weight on inflation in the reaction function to a level above unity, converging towards international benchmarks. Such results are consistent with the so-called Taylor principle. Thus, our empirical evidence lends support to the argument that the PBC has gradually moved from an initial inflation-

[10] The presence of a break in November 2011 is indicated by a test minimizing the residual sum of squares.

accommodating policy before 2002 to a more anti-inflationary policy thereafter. This means that the monetary policy of the PBC looks a lot like that of an informal inflation targeter starting around 2002/2003. However, this targeting involves a high weight on output, larger than unity.

5.2 Hybrid (backward- and forward-looking) monetary policy rule

Graph 5 presents the preliminary results of estimating the hybrid monetary policy rule which integrates both backward- and forward-looking aspects, as in Equation 7. As the PBC survey on expected future prices is only available since 2001, the estimated coefficient of expected inflation reflects a multiplicative dummy which only activates this variable over 2001-2011, and is zero otherwise. The short time span on which this variable is available warrants some caution in interpreting the following estimation results.

The estimation of the hybrid monetary policy rule shows similar results to those of the pure backward-looking specification, highlighting the same two main distinct periods, before and after 2002. Indeed, a noticeable move in the conduct of monetary policy is observable, with an increase in the long-term recursive inflation coefficient above unity from 2002 onwards. In parallel, the recursive weight on output growth decreased in the early 2000s, followed by an increase after the onset of the GFC. In addition, the PBC appears to have gradually shifted towards a hybrid reaction function, initially more backward-looking but increasingly taking into account the forward-looking aspect in its monetary policy decisions.

Recursive estimation of the hybrid model

Long-term coefficients and their confidence intervals

Graph 5

Source: Authors' computation.

Indeed, by adding forward-looking aspects in the estimation after 2000 we find that, from 2008 onwards, the modest decline in the recursive coefficient of lagged inflation may have been compensated by a gradual increase of the weight on expected inflation which appears to become significant and positive after 2007 (Graph 5). This increase coincides with the global commodity price surges peaking around mid-2008. It is not a surprise as such commodity price booms are mostly explained by speculation, itself generated by expected price rises, which implies forward looking behaviour. Accordingly, a central bank implicitly targeting inflation understands that inflation expectations have to be considered in the conduct of monetary policy, notably to evaluate its own credibility and to ensure that its long-run inflation objective is well anchored. In addition, with the gradual price liberalisation and labour market reforms, inflation expectations may play a bigger role because they directly influence wage negotiations and price setting in China, which in turn drive current inflation. These may help explain the PBC's gradual shift towards a hybrid reaction function that takes into account both expected and past inflation.

A more forward-looking PBC reaction function shows that the PBC may have started to take into account the need to anchor inflation expectations (showing the vigilance advised by Zhang and Clovis, 2010), after a period when inflation may have become less persistent and less responsive to shocks.

5.3 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. Within this perspective, in addition to the previous recursive estimates, we conduct sub-sample fixed parameter estimates. Table 4 thus summarises the long-term coefficients of the PBC's backward-looking and hybrid reaction functions over the pre- and post-2002 sub-samples. For the period of 1995-2001, output plays a major role, while the coefficient of inflation is very low. Over the subsequent period of 2002-11, the PBC appears to turn more anti-inflationary, with inflation (both backward- and forward-looking) playing a bigger role in its conduct of monetary policy.

Long-term coefficients of the hybrid reaction function for China — Table 4

PBC monetary policy	Inflation (1)	Expected inflation (2)	Total inflation (1) + (2)	Output
Pre-Zhou period (1995–2001)	0.6	...	**0.6**	**1.8**
Zhou Governorship (2002–2011)	1.1	0.8	**1.9**	**1.2**
Whole period (1995–June 2011)	1.1	0.6	**1.7**	**1.0**

Short-term intercept respectively (-0.7), (-0.6), (-0.4), a and lagged MPI respectively at (0.95), (0.97), (0.97) for each of the periods.

Source: Authors' computation.

Table 5 summarises the comparable results for G3 central banks. They include the results by Monokroussos (2010) for the US Federal Reserve during the pre- and post-Volcker periods, by Clarida, Gali and Gertler (1997) for the US Federal Reserve during the periods of before and after October 1982 (the start of a 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).

As Clarida, Gali and Gertler (1997) 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, Gali and Gertler, 1997, page 1033).

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 similarity. Firstly, the pre-2002 period in China is 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, accommodated inflation, typically raising the nominal interest rate by less than the increase in inflation, thus resulting in a lower real interest rate. Also, the initial monetary policy regimes in both cases reveal a very strong reaction to output (at 2.2 in the G3 and 1.8 in China).

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 (2010). [4] GMM estimation by Clarida, Gali and Gertler (1998).

Sources: Clarida, Gali and Gertler (1998) and Monokroussos (2010).

Secondly, the estimated responses to inflation by the G3 central banks[11] during the post-1979 period and by the PBC during the post-2001 period also contrast starkly. 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 PBC may have over time gradually aimed at adopting a "state-of-the-art" monetary policy rule, with the long-term coefficients in its reaction function steadily converging towards international benchmark values typical of major central banks.

While the estimated weight on output in the PBC's policy rule is still high relative to those for the G3 and may testify to the Chinese preference for job creation, it is largely in line with the estimates for the emerging economies (in general, Hofmann and Bogdanova, 2012; and India in particular, Singh, 2010, and Patra and Kapur, 2012). It can reflect both a high preference for output and the structure of the economic transmission mechanism (see Hayo and Hofman, 2006).

[11] 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).

6 Conclusion

This paper aims at enhancing our understanding of China's evolving monetary policy during 1995-2011. More specifically, we attempt to learn more about the changes in the PBC's monetary policy, the evolving role of inflation (and output) in its reaction function and its varying policy style over time.

To meet the challenge that no single policy instrument represents a good proxy of China's monetary policy, we have built on previous works to develop a new composite measure to better gauge the changes in monetary policy by combining many price, quantity and administrative tools. Our constructed monetary policy index (MPI) seems to capture the important changes in China's monetary policy well and enjoys the advantage of being interpretable in line with the conventional Taylor rule based on a target interest rate.

To deal with the multiple challenges of marked instability, smoothing behaviour, both backward- and forward-looking aspects, and discrete choices in the Chinese monetary policy rule, we have used a Bayesian method proposed by Dueker (1999) and refined by Monokroussos (2010), to estimate a recursive dynamic hybrid discrete-choice model. We have also estimated the basic hybrid model over the two sub samples of before and after 2002 for comparison purposes.

Our results convey a number of key messages. First, our new measure of China's monetary policy changes suggests two distinct regimes before and after 2002. Before 2002, the Chinese monetary policy is featured with dovish changes and a policy style of bigger but infrequent moves, while afterwards it is characterised with relatively hawkish changes and a smoothing style of frequent but smaller steps. This may reflect a combination of gradual economic liberalisation in the 1990s, a period of strong growth and increased price pressures in the 2000s and the new policy orientation of the PBC since 2002 under the Zhou Governorship.

Second, following the inauguration of the Governorship of Zhou Xiaochuan in December 2002, the PBC appears to begin attaching a greater weight on inflation, lending support to the argument that its policy is similar to informal flexible inflation targeting. We also show for the first time that, since 2008, the PBC may have gradually shifted towards a hybrid reaction function, initially more backward-looking but increasingly more forward-looking. The PBC seems to have gradually aimed at the "state-of-the-art" monetary policy rule, with coefficients of inflation and output growth converging towards that of China's peers. Indeed, after 2001, the long-term coefficient on inflation in the PBC reaction function rises and converges towards the similar levels of the G3 central banks prevailing in the post-1979 period. Besides, the emerging economy character of China still matters, as the current weight on output is larger than those in the G3 countries but similar to the average for emerging economies.

While no metric is available to determine which MPI best represents the Chinese monetary policy, there is benefit in comparing different versions of the MPI as well as using these alternative MPIs to conduct robustness tests in our empirical estimations. For this purpose, we will consider alternative MPI measures in future work, to boost the confidence in our MPI and to permit robustness tests.

Going forward, our research can be extended in a number of other 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 sterilization operation. Second, we may wish to explore the potential role of the renminbi exchange rate as a direct component of China's monetary policy. Third, we may examine ways of modelling inflation expectations in China. Finally, we may further experiment with different forms of objective variables such as deviation from either official targets or historical trends.

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