Inflation and China's monetary policy reaction function: 2002–2013

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Abstract

Our paper attempts to enhance the understanding of China's monetary policy rule, which may help explain the country's 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 role of inflation in the conduct of monetary policy by the People's Bank of China (PBC) in the New Millennium, 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 hybrid (backward- and forward-looking), dynamic, discrete-choice model for the period 2002–13.

Three main results arise from the paper. First, the Chinese monetary policy changes under PBC Governor Zhou from 2002 onwards have been relatively hawkish and smoothed. Second, the PBC appears to have built up a monetary policy framework similar to implicit flexible inflation targeting, with a hybrid reaction function, seemingly taking into account the forward-looking aspect of inflation. Third, the PBC's behaviour post-2002 resembles that of the post-1979 anti-inflation policy of the G3 central banks, albeit with a high output weight typical of emerging economies.

Keywords: monetary policy in China, People's Bank of China, Taylor rule, inflation targeting

JEL classification: E52, E58, O11, O52

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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 role of inflation in China's monetary policy decisions helping to deliver good inflation performance, while policy 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)).

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 calibrating the changes in these instruments in a way that allows for an interpretation of this new measure in terms of a "27 basis point equivalent" change in the policy rate.

To capture the characteristics of the monetary policy rule in China, we proceed to estimate a 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. We also examine the relative weight of the backward- and forward-looking aspects in the Chinese monetary policy rule for the period 2002–13.

Our paper contributes to the literature with the following three main findings. First, our new monetary policy index (MPI) shows that, under the Zhou Governorship of 2002–13, monetary policy features relatively hawkish changes and a style of small but frequent steps. Second, the chapter provides empirical evidence that the PBC has engaged in a regime that looks a lot like informal flexible inflation targeting, with a weight on inflation similar to levels seen in other major economies (with a long-term coefficient higher than unity). Moreover, China's central bank has been using a hybrid reaction function, both backward-looking and taking into account forward-looking aspects of inflation, 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 Federal Reserve. Third, the paper presents empirical evidence that the rule followed by the PBC over the period 2002–13, under the Governorship of Zhou Xiaochuan, shares similarities with the post-1979 anti-inflationary policy of G3 central banks. While the weight on output is 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. Section 4 discusses the estimation method and data, and Section 5 presents the estimation outcomes. The final section concludes.

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 et al (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 conclude that the two broadly track each other in most cases but policy responses sometimes lagged behind the business cycle.

Focusing on movements of the Taylor rule over time, Zheng et al (2012) use a regime-switching forward-looking specification estimated with the two-step maximum likelihood procedure of Kim et al (2006). They 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 2002–03. 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 interbank offered rate (CHIBOR) as the policy rate, along with Xie and Luo (2002). As Garcia-Herrero and Girardin (2013) argue, the liquidity in the CHIBOR market 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.

Therefore, 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 the 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 deviations of broad money growth from the announced targets figure significantly as determinants of the 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. They test various objective variables and find 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.

3. Measuring monetary policy in China

A proper measurement of monetary policy changes is crucial in China's case. The PBC's conduct of monetary policy differs significantly from that of 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 United States 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 on required and excess reserves, or PBC refinancing;[2] (ii) quantity-based instruments, such as the reserve requirement ratio (RRR) and open market operations (OMOs); and (iii) administrative window guidance, which the PBC also uses to influence bank lending, and which is not directly observable. These instruments may in turn influence 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. 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.

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

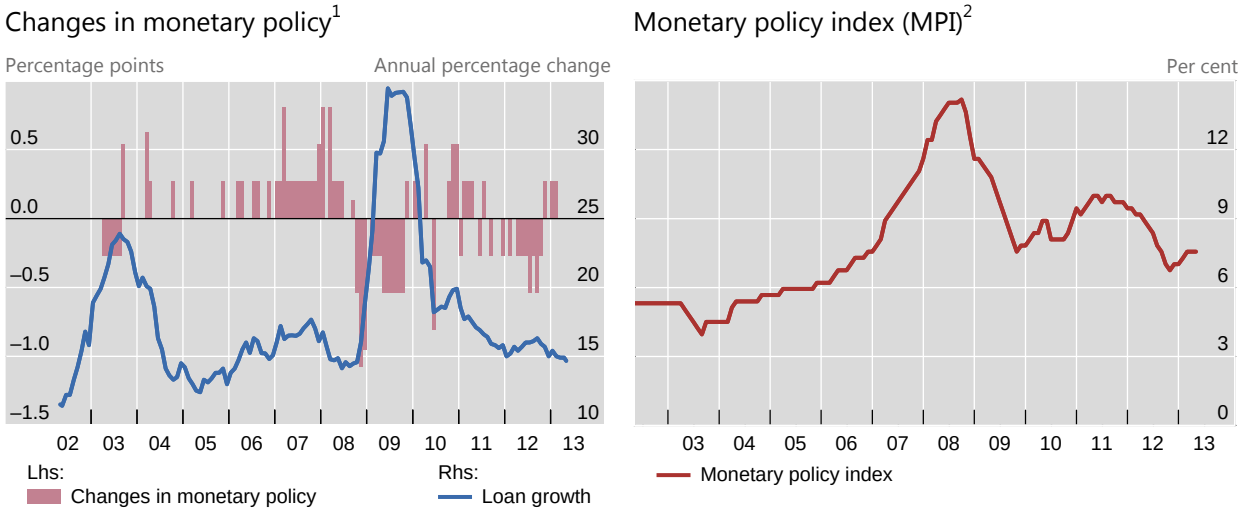
The first step is to compute a monthly "27 basis point equivalent" change in the policy rate for each instrument. This 27 bp change corresponds to the usual move on all regulated bank deposit and lending rates and interest rates paid by the PBC. Next, the RRR usually moves by 50 bp, which we assume to be equivalent to a 27 bp change in the policy rate. Finally, we convert a given net monthly liquidity change from OMOs into an equivalent 27 bp rate change in the following way. 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.

The second step is to combine these monthly 27 bp 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 "27 bp equivalent" variations. (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 PBC typically changed both deposit and loan rates in the same direction by 27 bp, which should not be regarded as a policy move of 54 bp. Also, a mix of rate and quantity tool changes 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. Therefore, our measure of changes in monetary policy 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 (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. First, following Xiong (2012), we approximate the administrative window guidance in terms of unusual loan-growth acceleration. We define a "minus 27 bp equivalent" change if year-on-year loan growth accelerates above 20% and a "minus 54 bp equivalent" change if loan growth accelerates above 30%. It is particularly important to take this into account since directing a record growth in bank credit was the means found by the Chinese authorities to sidestep the (lack of effectiveness of the) transmission mechanism which handicapped quantitative easing in the G3. Second, we adjust for Chinese New Year effects, as liquidity is typically injected before the Chinese New Year and withdrawn soon afterwards.

The resultant measure shows an interesting historical pattern of monetary policy changes (Graph 1, left-hand panel). The policy moves during 2002–13 are mostly hawkish. 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), and a period of strong growth and some emerging price pressure. The restrictive policy changes intensified during the subsequent 2006–08 episode of food price inflation and rapid foreign currency reserve accumulation. Second, this also seems to display a distinct monetary policy style, characterised by relatively small but frequent policy steps (with six policy moves a year), ie a smoothing and not abrupt policy style. Indeed, more than two thirds (52 out of 74) of the policy changes during 2002–May 2013 are 27 bp equivalent or less.

Monetary policy stance in China Graph 1



[1] 27 basis point equivalent change in policy rate. [2] The starting point of the MPI in January 2002 is taken as the one-year lending rate in that month.

Sources: CEIC; authors' computation.

Before the 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 2002 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.

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 emphasises 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 by 27 bp). 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:

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

where MPI_t^* is the desired level of the MPI_t discussed in Section 3, π_{t-1} is lagged inflation, $E_{t-1}\pi_{t+3}$ is the expectation of future inflation one quarter ahead and y_{t-1} is lagged output.[3] ε_t is a normally distributed, mean-zero error term. We interpret β_1 as an indicator of the degree of smoothing of interest rate changes. $\beta_{1,t}$ 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. Thus, equation (1) corresponds to a hybrid (backward- and forward-looking) specification.

It is worth noting that we introduce raw data on inflation and output growth rather than the usual output gap and deviations from the inflation target. The first 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) 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.

While this methodology differs from the standard model in the literature (such as Clarida et al (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.

4.2 Data

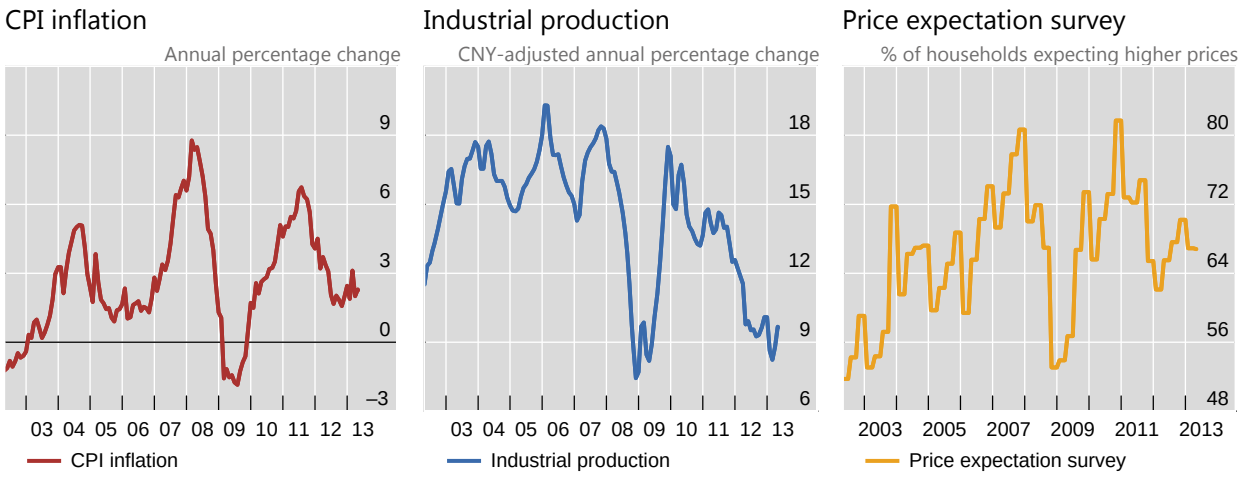
The data series used span the period from January 2002 to May 2013. For the economic activity variable, we use the level of industrial output in constant renminbi from China's National Bureau of Statistics.

Graph 2 highlights China's performance during the period 2002–May 2013, combining high output growth and low CPI inflation. This period witnesses an attractive inflation-growth trade-off, with interesting inflation and output dynamics. Indeed, CPI inflation was low on average but mostly on the rise, while output growth expanded strongly for most of the period.

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). We normalise the indicator, constraining it to lie within the same range as inflation. The PBC survey series, published quarterly (end of quarter), refers 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 and apply the same value for each month during the quarter.

[3] 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 as their coefficients were insignificant.

Inflation, industrial production and inflation expectations in China Graph 2



CNY = Chinese New Year.

Sources: People's Bank of China; CEIC; NBS; authors' computation.

5. Empirical results

We estimate a hybrid monetary policy rule which integrates both backward- and forward-looking aspects, as in Equation 1. Table 1 summarises the long-term coefficients of the PBC's hybrid reaction function over the 2002–May 2013 period.

During 2002–13 under the Zhou Governorship, the PBC appears to have granted a substantial overall weight to inflation in the reaction function, at a level above unity, corresponding to international benchmarks. Such a result is consistent with the so-called Taylor principle. With such an anti-inflationary policy, the monetary policy of the PBC looks a lot like that of an informal inflation targeter. However, this targeting involves a high weight on output, larger than unity.

Long-term coefficients of the hybrid reaction function for China Table 1

PBC monetary policy	Inflation (1)	Expected inflation (2)	Total inflation (1) + (2)	Output
2002(1)–2013(5)	1.05	1.05	**2.1**	**1.15**

Note: short-term intercept (–0.6), and the coefficient for lagged MPI (0.97).

Source: Authors' computation.

In addition, the weight on expected inflation is substantial. 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 inflation expectations are well anchored. In addition, with the gradual price liberalisation and labour market reforms, inflation expectations may play a 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 use in the New Millennium of a hybrid reaction function that takes into account both expected and past inflation. A forward-looking component in the PBC's reaction function shows that the monetary authorities 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 (Filardo and Genberg (2009)).

It is instructive to compare the Chinese experience with that of other major central banks across different periods. Table 2 summarises the comparable results for G3 central banks. They include the estimates by Monokroussos (2010) for the Fed during the post-Volcker period, and by Clarida et al (1998) for the Fed during the period 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 et al (1998) show, all the G3 central banks started targeting inflation in an implicit way from the late 1970s onwards, 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), page 1033).

Despite major differences in the economic context between the post-1970s and 2000s, a comparison of the Chinese and G3 reaction functions shows some interesting similarity.

Long-term coefficients in G3 reaction functions — Table 2

	Inflation[1]	Output[2]
US Fed reaction function		
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 et al (1998).

Sources: Clarida et al (1998); Monokroussos (2010).

Indeed, the estimated responses to inflation by the G3 central banks[4] during the post-1979 period and by the PBC during the post-2002 period are strikingly close. Indeed, for both China and the G3, the long-term inflation coefficients are close to 2.0, meaning that such central banks' policies are anti-inflationary. These comparative findings strengthen the argument that the PBC may have adopted since the early 2000s a "state of the art" monetary policy rule, with the long-term inflation coefficient close to international benchmark values typical of major central banks. While the estimated weight on output in the PBC's policy rule is still high

[4] 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)).

relative to those for the G3, it is largely in line with the estimates for the emerging economies in general (Hofmann and Bogdanova (2012)) and India in particular (Singh (2010); Patra and Kapur (2012)). It can reflect both a high preference for output (with the usual caution that we cannot back out the implied weights in the preference function of the monetary authorities) and the structure of the economic transmission mechanism (see Hayo and Hofmann (2006)).

6. Conclusion

This paper aims at enhancing our understanding of China's evolving monetary policy during 2002–13. More specifically, we attempt to learn more about the PBC's monetary policy, the role of inflation (and output) in its reaction function and its policy style.

To meet the challenge that no single policy instrument represents a good proxy of China's monetary policy, we have built on previous work 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 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 dynamic hybrid discrete-choice model.

Our results convey a number of key messages. First, our new measure of China's monetary policy changes suggests that during the period 2002–13 the Chinese monetary policy featured hawkish changes and a smoothing style of frequent but small steps. This may reflect a combination of strong growth, increased price pressures and the new policy orientation of the PBC under the Zhou Governorship from December 2002.

Second, over that period, the PBC appears to place a large weight on inflation, lending support to the argument that its policy is similar to informal flexible inflation targeting. We also show that the PBC may be using a hybrid reaction function, both backward- and forward-looking. The PBC seems to have adopted a "state of the art" monetary policy rule, with coefficients of inflation and output growth similar to those of China's peers. Indeed, in the New Millennium the long-term coefficient on inflation in the PBC reaction function reaches similar levels to that of the G3 central banks prevailing in the post-1979 period. Moreover, 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.

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