REFORMING CHINA'S MONETARY POLICY FRAMEWORK TO MEET DOMESTIC OBJECTIVES

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ABSTRACT

As a result of reforms and financial sector development, the People's Bank of China (PBoC) now exerts significant control over money market interest rates. With money market conditions increasingly influencing effective commercial lending rates, the PBoC is also able to affect the cost of credit without recourse to its benchmark commercial bank rates. Furthermore, interest rates are an important determinant of investment spending in China, via the user cost of capital, and aggregate economic activity influences inflation. Hence, greater use of interest rates in implementing monetary policy would enhance macroeconomic stabilisation while avoiding a number of drawbacks of the current quantity-based approach. In addition, increased flexibility in the exchange rate would enhance its role in offsetting macroeconomic shocks and allow the PBoC more scope to tailor monetary policy to domestic macroeconomic conditions. Concurrently, changes in the PBoC's policy stance should be predicated on informed judgments based on the monitoring of a set of indicators in conjunction with a flexible inflation objective as the nominal anchor.

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1. Introduction and conclusions

The People's Bank of China (PBoC) began to function exclusively as a central bank in 1984. Since then, much progress has been made in improving the conduct of monetary policy. China's monetary policy framework has gradually moved away from a planned administrative system resting on credit rationing to a more market-based regime with money growth as the main intermediate target. As part of this transition, interest rates have been liberalised, making them more responsive to market signals, and the tools of monetary policy have been modernised. The banking sector has also undergone significant reform (see OECD, 2010) and the economy has become far more responsive to market-based policy measures.

Officially, the objective of Chinese monetary policy is "to maintain the stability of the value of the currency and thereby promote economic growth".[2] It is not clear whether this refers to maintaining the domestic purchasing power of the currency - *i.e*., the price level - or the exchange rate. In practice, the State Council has also charged the PBoC with achieving price stability, employment growth, external balance, and financial stability.[3] The PBoC is further responsible for promoting financial sector liberalisation. The central bank is not independent and needs the permission of the State Council to change policy settings.

The 11th Plan called for interest rate liberalisation and improvement in the transmission mechanism of monetary policy. From this perspective, this paper evaluates China's monetary policy framework and suggests ways in which it could be strengthened. It begins by reviewing the targets and instruments used by the PBoC to influence money market conditions (Section 2). As outlined in Section 3, as a result of a number of factors, including ongoing interest rate reform and a stronger banking sector, China's money market is becoming more integrated with different market segments increasingly linked *via* arbitrage. The PBoC now has considerable control over short-term interest rates in the interbank market and increasing leverage over longer-term rates through the term structure. Going forward, the monetary policy framework needs to place less emphasis on quantity-based liquidity controls and more on interest rate changes. The PBoC's benchmark commercial bank lending and deposit rates, which do not influence economic activity and are becoming increasingly irrelevant in the conduct of monetary policy, ought to be progressively phased out.

In Section 4, the paper goes on to review the effects of monetary policy on the real side of the economy and presents evidence on the effects of interest rate changes on economic activity. In particular, capital formation at the firm level is shown to be sensitive to changes in interest rates *via* the user cost of capital. In addition, the results of estimating a Phillips curve for China, which are presented in Section 5, show that changes in aggregate demand pressures influence inflation. This implies that the transmission mechanism is effective in China and that monetary policy can enhance stability by playing a greater role as a macroeconomic shock absorber. However, as discussed in Section 6, the current exchange rate regime limits the policy options available to the PBoC and the effectiveness of monetary policy more generally and prevents the value of the currency from moving to offset macro shocks. Finally, Section 7 argues the case for allowing greater exchange rate flexibility and moving towards a flexible inflation objective as the nominal anchor. This would permit monetary policy to make a greater contribution to macroeconomic stability and reduce the costs and risks of sterilising foreign reserve inflows.

2 . See the PBoC's website: http://www.pbc.gov.cn/english/huobizhengce/objective.asp.

3 . According to Governor Zhou Xiaochuan, as cited in Liu and Zhang (2007).

2. The *modus operandi* of the PBoC

China's monetary policy framework has evolved considerably since the mid-1980s. From 1984 until 1997, the PBoC issued base money and implemented monetary policy under a system of central bank lending and credit controls. The PBoC provided liquidity to state-owned banks, which then lent money to state-owned enterprises (SOEs), often at negative real interest rates. Since the establishment of the development banks in 1994, central bank lending has mainly been used to subsidise rural credit cooperatives or rescue insolvent financial institutions and no longer as a means of influencing monetary conditions.

More recently, money growth has replaced credit rationing as the main intermediate target of monetary policy. The PBoC sets annual target growth rates for money supply and bank credit that are deemed consistent with policy objectives. Over the course of the year, the PBoC adjusts policy settings in line with developments in intermediate targets and other macroeconomic variables. In practice, notwithstanding instability in the money multiplier and unpredictable liquidity growth given the current exchange rate regime, the PBoC has been reasonably proficient at hitting its money supply and bank credit targets (Table 1). In 2009, however, the full-year target for M2 growth was reached by end-March as liquidity was dramatically increased in response to the global economic recession. GDP growth targets have often been exceeded, particularly in recent years, whereas inflation targets have been both over- and undershot.

Table 1. PBoC targets and outcomes

	M1		M2		CPI inflation		GDP	
	Target	Actual	Target	Actual	Target	Actual	Target	Actual
1998	17	12	16-18	15.8	5	-0.8	8	7.8
1999	14	14.5	14-15	16	2	-1.4	8	7.6
2000	15-17	19.7	14-15	16.1	1	0.4	8	8.4
2001	13-14	14	15-16	14.1	1-2	0.7	7	8.3
2002	13	16	13	15.1	1-2	-0.8	7	9.1
2003	16	19.1	16	20	1	1.2	7	10
2004	17	16.4	17	16.2	3	3.9	7	10.1
2005	15	11.7	15	14.8	4	1.8	8	10.4
2006	14	14.5	16	18.1	3	1.5	8	11.6
2007	No target	21	16	17.5	3	4.8	8	13
2008	No target	13.6	16	16.6	4.8	5.9	8	9
2009	No target		17		3-4.8		8	

Source: PBoC and CEIC.

The PBoC has a number of instruments at its disposal to achieve its money supply and credit growth targets. Open market operations (OMOs) and changes in the required reserves of the commercial banks have become the predominant tools with which the PBoC influences base money and money market conditions more generally. The PBoC conducts OMOs using repos and central bank bills. Periodic changes in reserve requirements have also become an important tool, mainly used in recent years to sterilise foreign reserve inflows.

As well as using quantity-based tools to control liquidity, the PBoC controls a range of interest rates in the economy to varying degrees. The PBoC sets benchmark interest rates for commercial bank lending and deposits across a range of maturities. It also sets interest rates on refinancing credit extended to the banking system, the rediscount rate, and rates paid on the required and excess reserves of the commercial banks deposited at the central bank. The yields on PBoC bills, which are used in OMOs to sterilise foreign currency inflows, are also under the influence of the central bank. In comparison to OMOs and required reserves, policy interest rates play a secondary role in monetary policy implementation and the PBoC changes them less frequently and typically by a smaller amount than central banks elsewhere (Anderson, 2007).

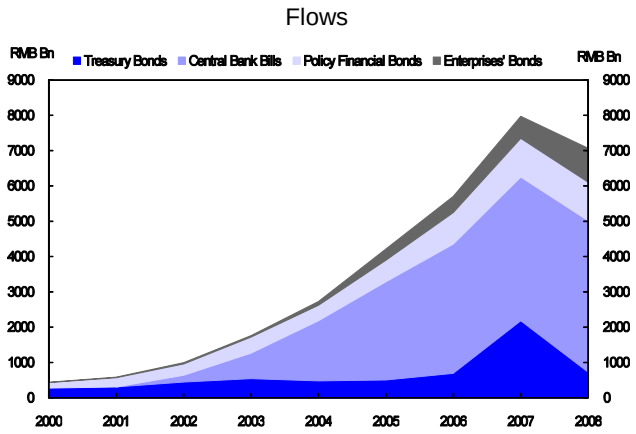
As well as quantity-based and, to a lesser extent, price-based instruments, the PBoC still uses a form of administrative guidance to influence bank lending. Since bank-specific credit ceilings were removed in 1998, the PBoC has held monthly meetings with commercial banks to outline its concerns about credit conditions across sectors. The practice has since become institutionalised with the PBoC publishing notices aimed at curbing lending in particular sectors from time to time. The PBoC also regularly reports on its "window guidance" in its *Quarterly Monetary Policy Reports*. Administrative guidance has been instrumental in slowing credit growth during periods of rapid expansion, such as in the early 2000s, and increasing it more recently in response to the global recession. According to Geiger (2006), window guidance can be effective because the governor of the PBoC ranks above officials in charge of the commercial banks in the Chinese political hierarchy.

3. Financial markets and interest rates

3.1 The influence of the PBoC on the interbank market

The interbank market for bonds started operating in 1997 and has since developed quickly (Figure 1). As discussed in OECD (2010), the rapid growth in China's bond market has been facilitated by financial sector liberalisation and the market infrastructure for borrowing and lending reserves among banks is now well established. Although issued bonds have typically been short-term, bonds of longer maturities are being increasingly offered and turnover and liquidity have grown rapidly. In January 2007, a market-driven reference curve for the onshore money market - the Shanghai Inter-Bank Offered Rate (SHIBOR) - began to operate officially. With the notable exception of corporate paper, market interest rates, including interbank rates, bill discounting rates and bond yields are fully liberalised and move flexibly to clear markets for borrowing and lending reserves.[4] Despite recent progress, however, China's bond market is still relatively small both compared with other countries and relative to the size of bank lending within China.

Figure 1 Bond market issuance



Source: Chinabond.

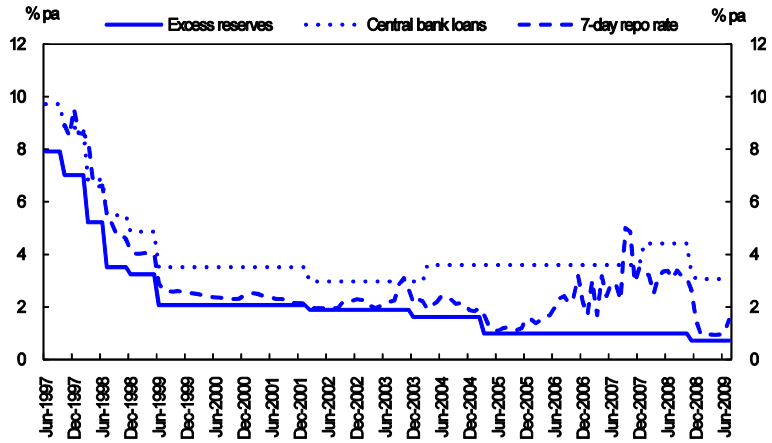
Since 2002, when PBoC bills were first issued, a relatively deep and liquid market has developed and they are now the largest bond type on offer. The central bank uses PBoC bills of various maturities to conduct OMOs aimed at achieving its liquidity targets. In 2004, the PBoC introduced a range of innovations to improve the effectiveness of its OMOs, including the introduction of a three-year and a

4. The Third Plenary Session of the 14th Communist Party Central Committee set out the broad direction of interest rate liberalisation in November 1993. In 2002, the 16th National Congress reiterated the call for interest rate reform with the aim of improving the efficiency with which financial resources are allocated. In 2003, the Third Plenary Session of the 16th Central Committee called for market-determined interest rates steered by the PBoC consistent with economic objectives.

one-year future dated bill. In addition, the PBoC increased the frequency of its OMOs auctions, extended the length of the trading period and linked the bill trading system with the payment system so that settlement can be done on a payment-on-delivery basis. Consistent with the PBoC's reliance on quantity-based measures for implementing monetary policy, bill auctions are usually conducted as fixed-quantity tenders with a variable interest rate, although fixed-interest-rate auctions have been used as well from time to time. There is also an active repo market that the PBoC can use to manage the supply of reserves, although in practice it has not used it much.

The PBoC has considerable leverage over short-term money market interest rates. By setting the interest rate it pays on excess reserves, the PBoC effectively imposes a floor in the interbank market. In principle, the PBoC's base or benchmark rate, at which it lends to banks and other financial institutions, should impose a ceiling. In practice, however, the PBoC does not issue loans at this rate and there has been no lending through the base lending window since 2001. As a result, money market rates occasionally spike above the base lending rate when liquidity is short. Until the onset of the global financial crisis, the PBoC had progressively increased the spread between the interest rate on excess reserves and base lending to encourage banks to trade amongst themselves in the interbank market (Figure 2).

Figure 2. Short-term money-market interest rates



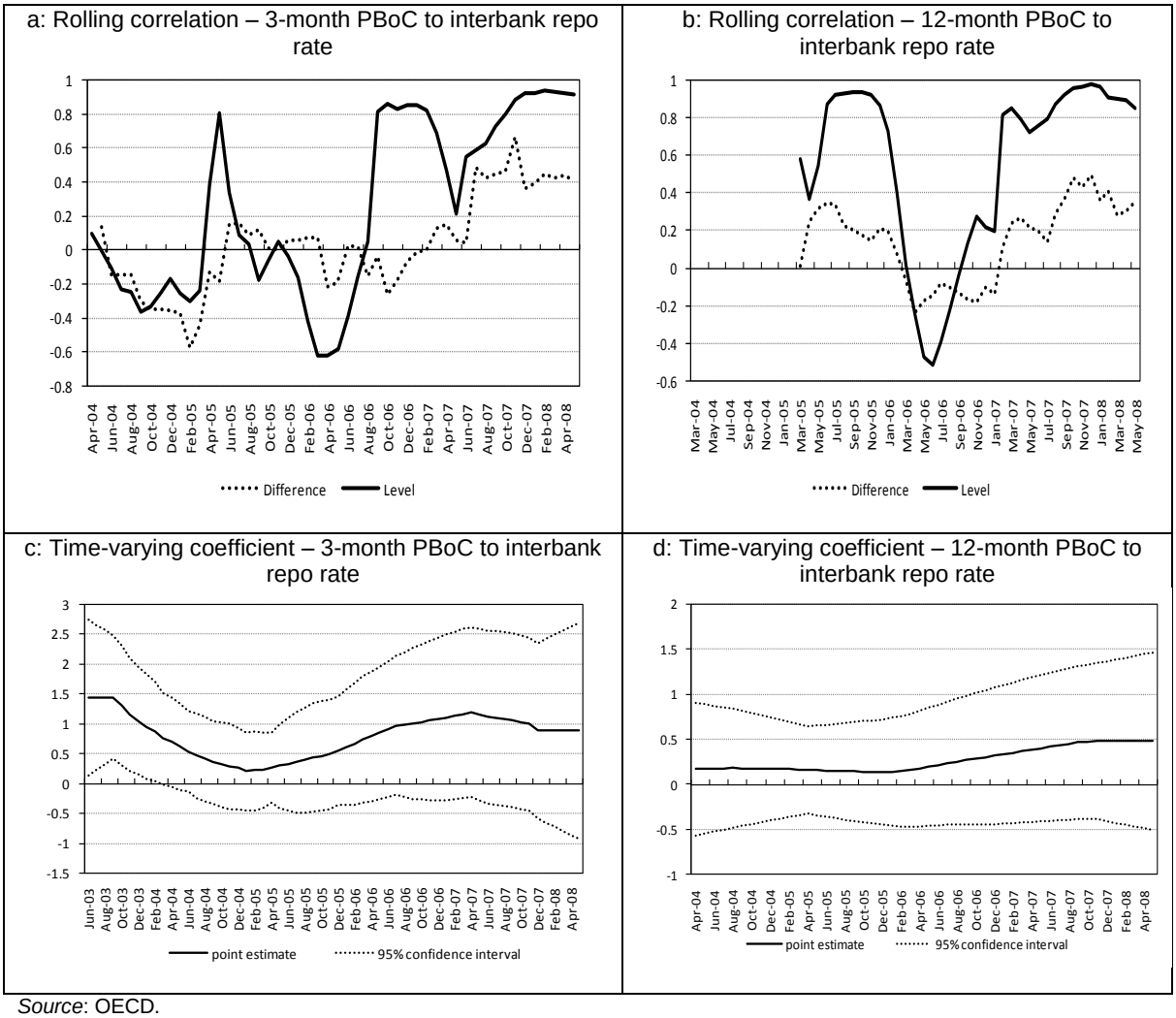
Source: CEIC.

The interest rates under the control of the PBoC have started to have a stronger influence on interest rates in the interbank market. Both rolling correlations and regressions with time-varying coefficients (Box 1) indicate that the pass-through of changes in three-month and one-year PBoC bill rates to interbank repo rates of the same maturity has increased markedly since 2006 (Figure 3). Although these correlations are not as strong as in OECD countries, where central banks stand ready to lend or borrow at the policy interest rate, PBoC control over interbank interest rates is becoming increasingly significant.

Another important consideration for the effective transmission of monetary policy is the extent to which interest rate changes at the short end of the yield curve influence the long end. Policymakers typically influence short rates, but spending and consequently inflation are usually related to interest rates at longer maturities. The stronger the relationship between short and long interest rates, the more leverage the central bank has along the yield curve, thereby increasing the likelihood of real activity correlating with changes in monetary policy. In OECD countries, this relationship has changed over the past few decades, reflecting the relative importance of, *inter alia*, inflation expectations as a driver of bond yields (Cournède *et al*., 2008). In China, the impact of quarterly changes in 90-day interest rates on 10-year bond yields has increased since 2005 and is currently broadly comparable to that in a number of OECD countries (Figure 4).[5]

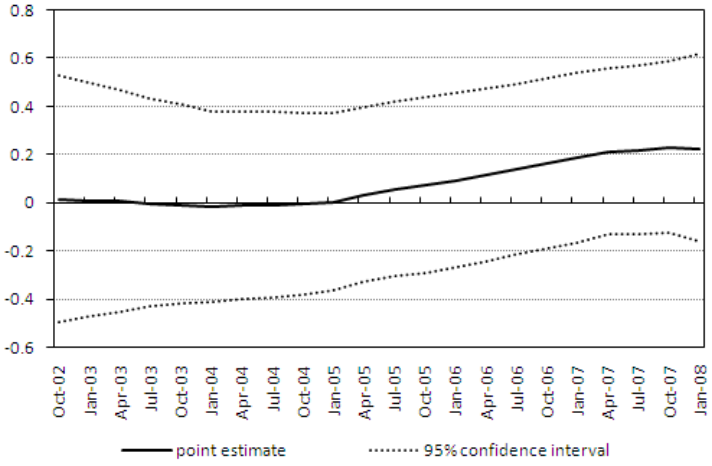
5 . In the case of China (Figure 4), the 95% confidence intervals around the point estimates of the impact of short rates on long rates includes zero. This is also the case when this technique is applied to some OECD countries and reflects the influence of other important determinants of long-term interest rates (Cournède *et al*., 2008).

Figure 3. The impact of changes in PBoC bill rates on interbank interest rates



Source: OECD.

Figure 4. The response of long to short rates in China

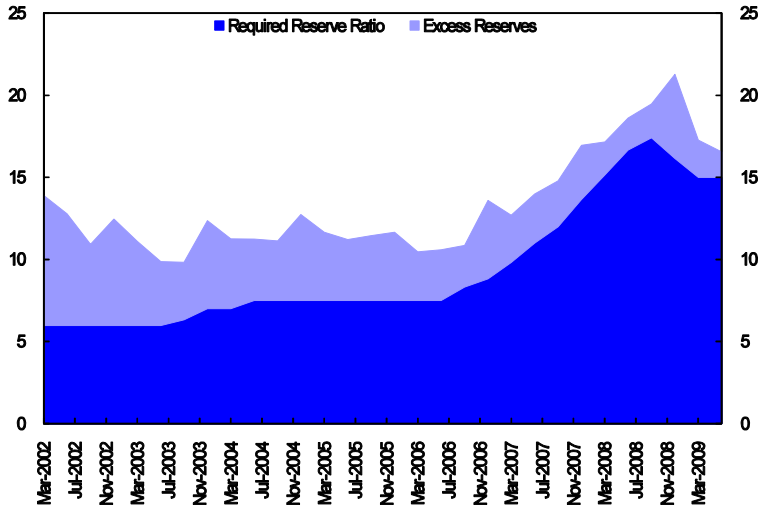


Note: the solid line is the coefficient estimate and the two dotted lines are the upper and lower 95% confidence intervals.

Source: OECD.

A significant reduction in the amount of excess reserves held by the banking sector is one important reason why China's money market has become more sensitive to the actions of the PBoC and different market segments have become more integrated. In early 2002, excess reserves accounted for almost 8% of bank deposits, more than doubling the size of bank reserves deposited at the PBoC (Figure 5). By the start of 2009, excess reserves had fallen to under 2.5%. Hence, banks are now more likely to need to borrow in the money market to cover their liabilities and are therefore more sensitive to money market rates. Even so, excess reserves in the Chinese banking system remain high compared with the norm in other countries for a number of reasons.[6] As discussed below, high liquidity in the banking system is an inevitable consequence of the current exchange rate regime coupled with generally large capital inflows. In addition, the relatively small size of China's bond market means that banks have only limited options for investing their large deposit base. Finally, the interest rate paid by the PBoC on excess reserves effectively lowers their opportunity cost.

Figure 5. Required and excess reserves



Source: CEIC.

3.2 The response of bank lending to money-market conditions

Money markets are one of the key links between a country's financial system and its real economy. For that link to work, banks must be able to absorb and pass on changes in the cost of funds in the money market to bank clients. This point is especially salient in China given that bank lending is by far the largest source of outside financing for investment. Liu and Zhang (2007) report that the banking sector intermediates about 75% of financial capital in China, implying that bank lending rates, to a large extent, determine the marginal cost of capital for the entire economy.

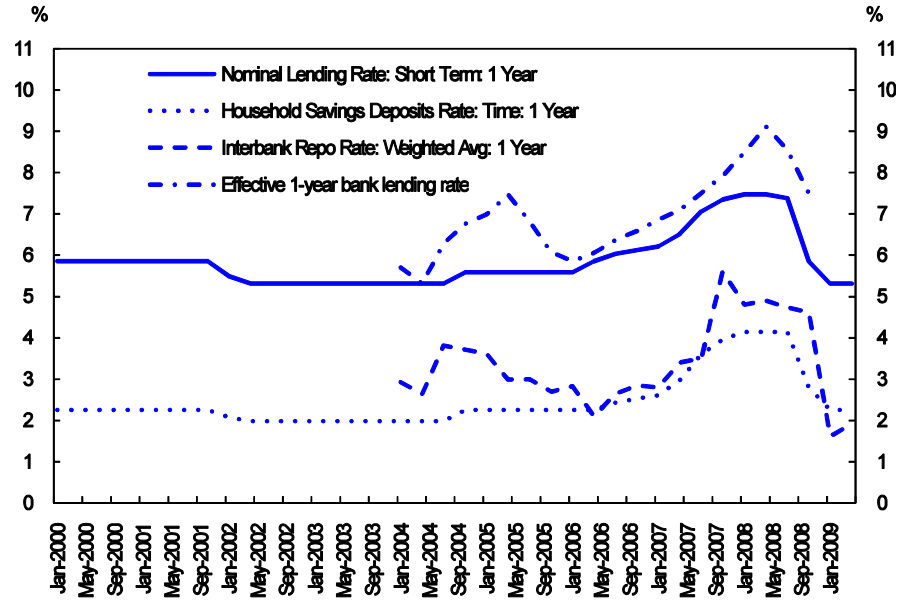
As mentioned, the PBoC sets benchmark interest rates for commercial bank lending and deposits across a range of maturities. Until 2004, the interest rates set by the commercial banks were not permitted to deviate from the benchmark rates by more than 10%. Since then, the bands of permissible interest rates around the benchmark rates have been progressively widened and commercial bank lending rates are now only subject to a floor, and deposit rates to a ceiling (Figure 6).[7] This has significantly increased the extent to which commercial banks are free to set interest rates and has consequently reduced the role of the PBoC's benchmarks for macroeconomic control. However, the ceiling on deposit rates does still appear to be binding, with effective deposit

6 . For example, in the United States and euro area, excess reserves are typically of the order of 1% or less of total deposits.

7 . Interest rate ceilings on loans still apply, however, for the rural credit cooperatives.

rates clustered around the benchmark and real deposit rates close to zero or negative for long periods (Porter and Xu, 2009).[8]

Figure 6. Commercial lending rates and the repo rate



Source: CEIC, PBoC, OECD.

With commercial banks increasingly profit-oriented and relying more on the money market as a source of funding and the central bank adjusting regulated rates more in line with market rates, the relationship between the effective commercial bank lending rate and money market rates is strong. For example, since 2004, the correlation between the effective one-year bank lending rate and the one-year repo rate has been 0.81, significant at the 99% level of confidence. Even so, as discussed in OECD (2010), commercial banks are still not yet generally pricing loan risk efficiently and lending remains biased towards SOEs.

3.3 The way forward for interest rate reform

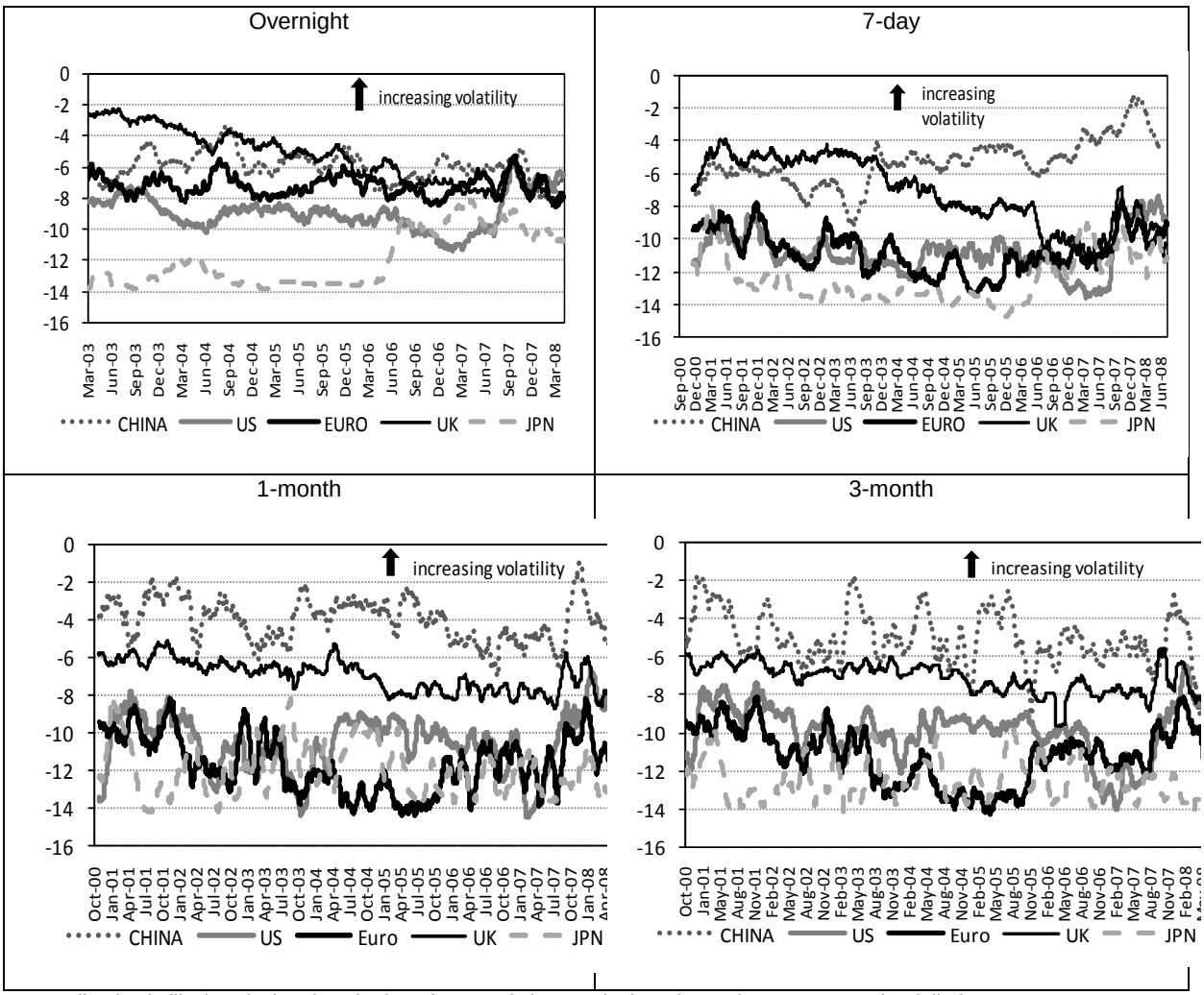
China's monetary policy implementation framework needs to evolve to keep pace with a rapidly-changing economy or risks losing its effectiveness. Targeting money growth with quantity-based instruments has been a natural evolution for Chinese monetary policy from the era of credit rationing. In addition, the PBoC's substantial sterilisation operations, which, as discussed below, are necessary to absorb large capital inflows under an inflexible exchange rate regime, also predispose the PBoC towards a quantity-based approach to liquidity management. Although quantity-based frameworks have an important role to play in countries with shallow and under-developed financial markets, interest rates are a key macroeconomic price in more advanced economies and ensuring that they operate freely and transmit changes in monetary policy is a crucial prerequisite for an efficient allocation of capital.

One important disadvantage of the PBoC's quantity-based approach is that day-to-day changes in money supply and demand translate into high-frequency interest rate volatility. As a result, realised interest rate volatility in the interbank market is typically higher in China than in countries with an implementation framework based around an overnight policy interest rate (Figure 7). While the SHIBOR benchmark yield curve was introduced partly to reduce short-term interest rate volatility, it

8 . In the second quarter of 2009, however, reflecting high market liquidity, medium- and long-term enterprise deposit rates exceptionally floated below the PBoC benchmark deposit rates.

has had only limited success to date. This reflects a number of institutional and policy factors including the fact that the 16 participating banks are not obliged to trade at their offered rates.[9] Moving to a policy interest rate framework would help reduce high-frequency interest rate volatility given that it addresses its root cause. This approach would also enable the system to handle shocks better and allow changes in policy settings to be communicated to the public more effectively.

Figure 7. Realised volatility in selected money-market interest rates[1]



1: Realised volatility is calculated as the log of squared changes in the relevant interest rate at the daily frequency:

$$RVol_t = \ln(i_t - i_{t-1})^2$$

where $RVol_t$ is realised volatility and i_t is the relevant interest rate at time t. Unlike measures of implied volatility derived from options pricing, realised volatility does not impose restrictive assumptions on the distribution of volatility. In addition, unlike other possible volatility measures, realised volatility is independent of the mean level of interest rates (ECB, 2005).

Source: OECD.

Making more use of policy interest rates would also reduce the PBoC's reliance on changes in required reserves as a means of controlling liquidity, which have been found to hamper financial market development (IMF, 2004). In addition, changes in required reserves and quantitative monetary tools in general risk becoming less effective as other forms of financial intermediation outside the banking system come to prominence. Moving to a policy interest rate would also lessen the PBoC's

9 . The PBoC attributes high-frequency interest rate volatility to announced increases in required reserves and large IPOs that are often heavily oversubscribed. Using a model of China's interbank money market, Porter and Xu (2009) find empirical support for this observation.

reliance on "window guidance" to commercial banks, which weakens competition and undermines the market determination of interest rates. The impact of window guidance on bank behaviour is also unpredictable and asymmetric, with banks following the wishes of the PBoC in times of tightening suffering commercial disadvantage.

This highlights another important difficulty with using quantity-based tools to implement monetary policy. Because SOEs still have preferential access to bank finance, a reduction in credit growth, for example, typically falls disproportionately on private-sector firms which, as a group, have been the most productive in China (OECD, 2010). In contrast, an interest rate hike in a price-based framework is more likely to induce firms to suspend investment projects for which the expected stream of future profits is marginal or highly uncertain, without the need for bank officials to make such judgements. Conversely, an interest rate cut will tend to stimulate investment projects with the highest expected rates of return, whereas mandated increases in bank credit, which have played a large role in the PBoC's response to the global recession, imply a greater risk of non-performing loans impairing bank balance sheets in the future.

As well as moving to a price-based implementation framework, interest rate reform in other areas of China's financial markets also needs to proceed. To continue reducing excess reserves in the banking system and improving the degree of central bank control over money market conditions, the interest rate on excess reserves deposited at the central bank needs to be set significantly below the other central bank rates. This would also eliminate the *de facto* interest rate floor in the money market and allow interest rates greater flexibility to respond to market conditions as well as lower the risk of the money market ceasing to function.[10] On the other hand, the interest rate paid on required reserves should be set more in line with market rates. As discussed below, this would lower the share of foreign reserve sterilisation costs that is currently borne by the commercial banks.

Some aspects of China's current interest rate framework also hinder competition in the banking sector. With commercial bank interest rates increasingly linked to money market conditions, the primary purpose of the PBoC's lending rate floor and deposit rate ceiling is to safeguard the profitability of the predominantly state-owned banking sector. By progressively widening the margin between benchmark lending and deposit rates, the PBoC has effectively pushed some of the cost of bank restructuring onto Chinese borrowers and savers, though it narrowed that gap in 2008-09. However, the benchmark rates weaken the incentive for commercial banks to price risk appropriately and stifle competition in the banking sector. They also weaken the pass-through of changes in monetary policy instruments on effective bank interest rates (Feyzioglu *et al.*, 2009). Finally, the deposit rate ceiling results in Chinese savers not being sufficiently compensated, and consequently their financial income, as a share of total income, is among the lowest in the world (Feyzioglu *et al*., 2009). As the money market now provides banks with an interest rate benchmark, there is no longer a need for the PBoC to do so. Accordingly, the benchmark lending and deposit rates ought to be progressively phased out. Concerns about bank profitability should be addressed by fiscal and prudential policy, rather than interest rate regulation.

As underlined in OECD (2010), corporate bond market regulation is also in urgent need of reform. Restrictions in this market protect banks' large corporate lending business. If this market were better developed so that the issuing rates of corporate bonds were market-determined, competitive pressures on banks would intensify. As a result, bank borrowing costs for firms would better reflect market conditions, which, in turn, are affected by the PBoC. In essence, greater reliance on market prices in the valuation of corporate assets would work to reinforce the balance sheet channel of monetary policy.

10 . On occasion, including during the first half of 2009 when the Chinese banking system was awash with liquidity, repo rates in the money market have fallen to within a few basis points of the PBoC interest rate on excess reserves, inducing the commercial banks to stop lending and deposit excess cash with the central bank (Figure 2 above).

A key issue for China in moving to a price-based implementation framework is the resilience of the banking sector to interest rates changes. As discussed in OECD (2010), reform in this area has moved a long way over recent years and the banking sector is now in significantly better health than in the recent past. With non-performing loans having been successfully reduced to low levels, the risk of financial stress in the banking sector in response to increased movements in PBoC policy interest rates has lessened. The key to further improving the robustness of the banking sector is to transform it into a well-supervised system that effectively allocates credit to its most efficient use given prevailing market interest rates. Ultimately, in conjunction with the framework changes discussed below, moving to a policy interest rate would facilitate the modernisation of the financial system.

Given the strains placed on China's financial system by the current exchange rate regime, further interest rate reform needs to be carried out as part of a package that includes changes in currency market arrangements, as outlined below.

4. The impact of interest rate changes on the real economy

The transmission of monetary policy to the real side of the economy requires that components of aggregate demand be sensitive to changes in financial conditions. A great deal of research in this area has focused on understanding the impact of interest rate changes on investment, which accounts for a particularly large share of GDP and growth in China and is an important driver of business cycle volatility.[11] In principle, firms adjust their capital stock so that its marginal productivity equals its user cost. As interest rates increase, for example, firms scale back projects for which the expected return is insufficient to cover the higher financing costs, and investment slows. In addition to this direct interest rate channel, higher interest rates may also reduce firm cash-flow which, in the absence of perfect capital markets, will reduce their spending (credit channel).

4.1 Monetary policy transmission is difficult to see at the macro level

The macro-based evidence of a significant negative relationship between interest rate changes and capital formation in China is not particularly compelling. For example, Geiger (2006) argues that changes in interest rates have had a limited impact on aggregate macroeconomic variables and that the transmission of monetary policy via the interest rate channel is distorted. In a VAR-based analysis, Laurens and Maino (2007) also find that changes in short-term interest rates have had a minimal and statistically insignificant impact on GDP. In another VAR study, Koivu (2008) reports that the transmission of interest rate changes to the real economy is weak over the sample period 1998 to mid-2007. Qin *et al.* (2005) paradoxically find that a rise in interest rates leads to an increase in investment, with a lag of about one year.

In contrast, other authors have found evidence of a link between interest rates and macro aggregates. For example, Girardin and Liu (2006), using a VAR model estimated on monthly data over 1997-2005, find that short-term interest rates do have a significant impact on output and inflation, particularly in the latter part of the sample period. He *et al.* (2005) finds that business investment in China is responsive to price signals in both the short and the long run.

Estimating a simple IS equation confirms that the impact of interest rate changes on the macro economy in China is far from obvious. Specifically, the following equation is estimated:

$$\Delta Y_t = const^{\Delta Y} + \sum_{i=1}^{4} \gamma_i^{\Delta Y} \Delta Y_{t-i} + \sum_{i=0}^{4} \gamma_i^{r} \Delta r_{t-i} + \sum_{i=0}^{4} \gamma_i^{z} \Delta z_{t-i} + \varepsilon_t^{\Delta Y} \qquad [2]$$

11. In China, gross fixed capital formation has grown by almost 20% per annum over recent years and currently accounts for around 40% of GDP. Accordingly, understanding the linkages between financial conditions and investment is of key importance when assessing monetary policy's macroeconomic stabilisation role.

where Y is real output, r the real benchmark PBoC lending rate, z the real effective exchange rate and ε an i.i.d. error term. The variable z is defined as RMB per foreign currency unit, so an increase in z denotes an appreciation of the Chinese currency. The equation is estimated on quarterly data over the period 2000-2007. It is initially estimated with the full complement of right-hand-side variables and then without the insignificant lags. The results are reported in Table 2. Changes in the real interest rate have had a statistically significant impact on GDP growth since 2000. However, this result is not particularly robust to alternative model specifications or changes in sample period. Changes in the real effective exchange rate also have the expected sign and are statistically significant to varying degrees.

Table 2. Estimating an IS model of aggregate demand

Dependent variable: annual GDP growth Explanatory variables:	Coefficient estimate
GDP growth, 3rd lag, $\gamma_{t-3}^{\Delta Y}$	0.382***
GDP growth, 4th lag, $\gamma_{t-4}^{\Delta Y}$	0.865***
Change in the real effective exchange rate, γ_t^z	-0.074**
Change in the real effective exchange rate, 4th lag, γ_{t-4}^z	-0.081*
Change in real benchmark PBoC lending rate, γ_t^r	-0.081***
R^2	0.86
Number of observations	29

Note: *, ** and *** denote statistical significance at the 10, 5 and 1% level respectively.

The most common and obvious explanation for the limited impact of interest rate changes on the Chinese macro economy is that state-owned commercial banks are obliged to lend to SOEs that enjoy soft budget constraints, often have their debts forgiven and are therefore insensitive to changes in the price of credit. However, studies of monetary policy transmission in OECD countries also generally have difficulty finding clear evidence of a significant link between interest rate changes and investment at the macroeconomic level. This difficulty is often ascribed to simultaneity biases – investment moves pro-cyclically with the business cycle, which, in turn, is positively correlated with interest rates.[12]

4.2 Micro-level studies are more revealing

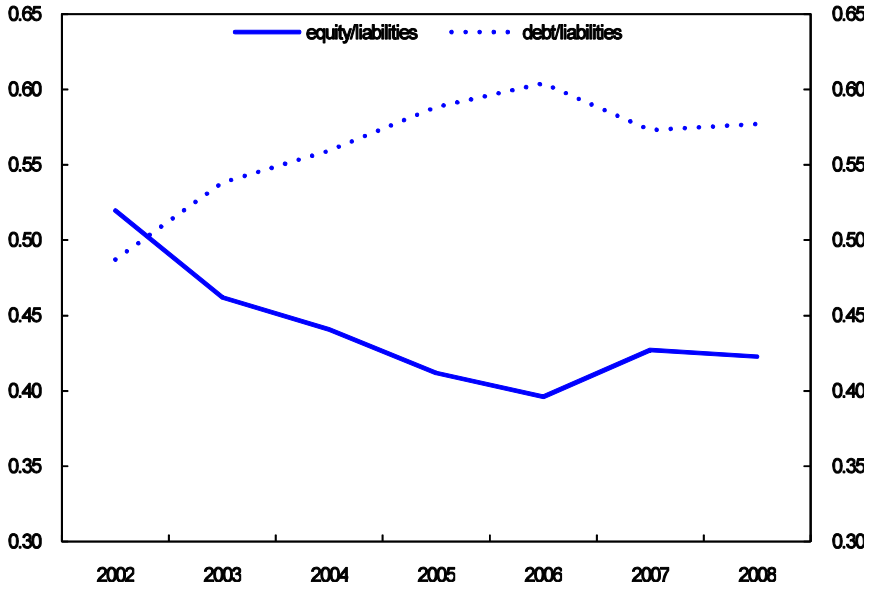
In contrast to studies conducted at the aggregate level, micro-level approaches aimed at understanding the linkages between capital formation and its user cost have been more fruitful in OECD countries. For example, the impact of changes in monetary policy on investment at the firm level has been investigated using micro data in France, Germany, Italy and Spain. This work provides compelling evidence of an interest rate channel operating through the user cost of capital. In addition, it also

12. See, for example, Bernanke and Gertler (1995), Chirinko (1993) and Gilchrist and Zakrajsek (2007). Other potential sources of biases include misspecification of dynamics in investment equations, transitory time-series variation in the data and positively-sloped supply schedules which bias the estimated user cost elasticity towards zero (Chirinko *et al.*, 2004).

uncovers a significant credit channel whereby firms with weaker balance sheets display a higher sensitivity of investment spending to cash flow.[13]

In the case of China, there are reasons to think that economic reforms over recent years would have increased the elasticity of capital formation to its user cost. Since the 1980s, the Chinese Government has been progressively separating government functions from business operations across sectors, including banking. SOEs are now held more accountable for their successes and failures and access to finance at interest rates that are (implicitly or explicitly) below market levels has become much more limited. At the same time, the rapid development of the private sector should also increase the sensitivity of aggregate investment to the user cost of capital. Listed Chinese firms have been relying more on debt funding over recent years, which should also heighten their sensitivity to interest rate changes (Figure 8).

Figure 8. Equity and debt to total liability ratios in listed Chinese firms



Note: The data show the weighted average of the debt and equity share of total liabilities across listed Chinese firms.

Source: TEJ, OECD.

To assess the impact of interest rate changes at the micro level, a model of investment by Chinese firms is estimated. To the authors' knowledge, this is the first model of investment at the firm level in China to include the impact of the user cost of capital on firms' investment decisions.[14] The model follows Chatelain *et al.* (2003) and estimates the following equation at the micro level:

$$\frac{I_{s,t}}{K_{s,t-1}} = \sum_{i=1}^{2} \gamma_i^{I/K} \frac{I_{s,t-i}}{K_{s,t-1-i}} + \sum_{i=0}^{2} \gamma_i^{\Delta Y} \Delta Y_{s,t-i} + \sum_{i=0}^{2} \gamma_i^{uc} \Delta uc_{s,t-i} + \sum_{i=0}^{2} \gamma_i^{cf} \frac{cf_{s,t-i}}{K_{s,t-1-i}} + d_t + \eta_s + \varepsilon_t \qquad [3]$$

In this model, I_s and K_s are, respectively, real investment and the capital stock, measured at replacement cost, in firm *s*. The model also includes firm output, which is proxied by (log) changes in real sales at the firm level (ΔY_s). To investigate the impact of credit constraints on capital formation,

13. See the overview by Chatelin *et al.* (2004) and the country-specific papers referenced therein. Other studies based on micro data that reach similar conclusions for other countries include Gilchrist and Zakrajsek (2007) for the United States and Nagahata and Sekine (2005) for Japan.

14. Chen (2007) assesses the impact of cash flow on investment at the firm level in China but does not include a measure of the user cost of capital in the regression.

firm cash flow as a share of the capital stock ($\frac{cf_{st}}{K_{s,t-1}}$), is also included in the regression. The regression further includes time dummies (d_t) and fixed effects at the firm level (η_s) to account for firm-specific variation in capital formation not captured by the other variables in the model.

In this model, the user cost of capital is the key price term. The benchmark measure of the user cost is calculated as follows:

$$uc_{s,t} = \frac{P_t^I}{P_t}\left[i_{s,t}\left(\frac{D_{s,t}}{D_{s,t}+E_{s,t}} \right)(1-\tau) + LD_t\left(\frac{E_{s,t}}{D_{s,t}+E_{s,t}} \right) - (1-\delta)\left(\frac{\Delta P_{t+1}^I}{P_t^I} \right) + \delta \right] \qquad [4]$$

In this equation, the user cost of capital ($uc_{s.t}$) reflects a number of factors including the expected price of investment goods relative to final goods prices ($\frac{P_{t+1}^I}{P_t}$), the corporate tax rate (τ) and the rate of depreciation (δ). It also includes a weighted average of debt and equity financing costs at the firm level, which are the components of user cost through which the interest rate channel of monetary policy operates. The opportunity cost of equity financing (LD_t) is proxied by the 10-year bond rate in China. As a robustness check, the cost of debt financing ($i_{s,t}$) is measured in three different ways in three alternative user cost measures:

- UC1: In the benchmark version of the model debt financing costs are measured as an "apparent interest rate", calculated as finance expenses over total firm debt. Reflecting data availability, finance expenses are calculated using net finance costs less cash received from investment income at the firm level. This variable is highly correlated with total firm debt, implying that it predominantly reflects debt servicing costs. This is firm-level data and introduces firm-specific variation into this measure of debt financing costs.

- UC2: Debt financing costs are measured at the macro level as the 1-year benchmark interest rate for commercial bank lending, set by the PBoC.

- UC3: Debt financing costs are measured as the 1-year effective bank lending interest rate, which is an average of interest rates actually paid on commercial banks loans as surveyed by the PBoC (see Figure 6 above).

Reflecting the long-run marginal financing decisions of the firm, the relative shares of debt $\left(\frac{D_{s,t}}{D_{s,t}+E_{s,t}} \right)$ and equity $\left(\frac{E_{s,t}}{D_{s,t}+E_{s,t}} \right)$ financing in the total liabilities of the firm are used to weight together debt and equity financing costs in all three of these user-cost measures. In addition, a fourth measure of the user cost (UC4), based on the "apparent interest rate" as in UC1, is calculated in which *changes* in the debt and equity share of total liabilities are used to weight debt and equity financing costs for each firm in each year. The advantage of these "flow" weights is that they reflect the ongoing financial decisions of the firm. The disadvantage is that they are not directly linked to a well-defined marginal decision (von Kalckreuth, 2001).

The micro data used in the model covers listed Chinese firms at the annual frequency over the period 2002 to 2007. Descriptive statistics of the variables are given in Table 3. With the exception of changes in user cost, the distributions of all the other variables are positively skewed. The within-firm standard deviation, which measures the variability of each variable across time abstracting from

variation across firms, is relatively high for cash flow over capital ($\frac{cf_{s,t}}{K_{s,t-1}}$), whereas the investment to capital ratio ($\frac{I_{s,t}}{K_{s,t-1}}$) has been relatively less volatile. Finally, a comparatively large share of the volatility in all of the changes in user cost variables (*UC1* to *UC4*) can be explained by aggregate time effects and is therefore common across firms, particularly user cost estimated using commercial bank lending rates at the macro level. In contrast, most of the variability in the other variables in the model is firm-specific.

Table 3. Descriptive statistics of regression variables

Variable	Mean	Median	Within firm standard deviation	Firm-specific time variation
Investment over (lagged) capital $\frac{I_{it}}{K_{i,t-1}}$	0.202	0.117	0.171	0.970
Change in (logged) sales ΔY_i	0.168	0.145	0.291	0.958
Cash flow over (lagged) capital $\frac{cf_{t-i}}{K_{i,t-1-i}}$	0.582	0.299	0.381	0.946
Change in (logged) user cost - *UC1*	-0.055	-0.143	0.444	0.181
Change in (logged) user cost - *UC2*	-0.051	-0.148	0.344	0.035
Change in (logged) user cost - *UC3*	-0.083	-0.231	0.407	0.022
Change in (logged) user cost – *UC4*	-0.011	-0.079	0.634	0.490

Note: The within-firm standard deviation measuring variation over time is calculated after subtracting the means of each variable from each observation at the firm level. The firm-specific time-variation is calculated as 1-R^2 where the R^2 is from a regression of each mean-differenced variable on time dummies.

Source: TEJ database and OECD.

The results of estimating equation 2 with the four alternative measures of the user cost of capital are given in Table 4. As well as the coefficient estimates, the table also reports the long-run elasticities, which are calculated using equation 5:

$$LRE = \frac{\sum_{h=0}^{L} \gamma_h^x}{\left(1-\sum_{h=0}^{L} \gamma_h^{I/K}\right)} \qquad [5]$$

Table 4. Investment regression results

Dependent variable: $I_{i,t}/K_{i,t-1}$ Explanatory variable:	UC1	UC2	UC3	UC4
Investment over (lagged) capital 1st lag	0.199***	0.202***	0.201***	0.178***
Investment over (lagged) capital 2nd lag	0.015	0.013	0.023**	0.033*
Change in (logged) sales	0.077***	0.079***	0.074***	0.083***
Change in (logged) sales 1st lag	0.037***	0.033***	0.039***	0.061***
Change in (logged) sales 2nd lag	0.039***	0.041***	0.042***	0.044**
Long-run sales elasticity	**0.191**	**0.193**	**0.201**	**0.239**

Change in (logged) user cost	-0.025**	-0.088	0.256***	-0.026**
Change in (logged) user cost 1st lag	-0.041***	-0.119	-0.148*	-0.016
Change in (logged) user cost 2nd lag	-0.015*	-0.078	-0.312***	-0.001
Long-run user cost elasticity	**-0.102**	**0.000**	**-0.263**	**-0.033**
Cash flow over (lagged) capital	0.096***	0.086***	0.089***	0.058***
Cash flow over (lagged) capital 1st lag	-0.073***	-0.067***	-0.067***	0.015
Cash flow over (lagged) capital 2nd lag	0.013***	0.014***	0.009**	-0.032***
Long-run cash flow elasticity	**0.045**	**0.042**	**0.040**	**0.033**
Number of observations	2490	2905	2911	880
R^2	0.26	0.26	0.26	0.24

Note: *, ** and *** denote statistical significance at the 10, 5 and 1% level respectively.

In all versions of the model, the long-run impact of sales growth on changes in the capital stock is broadly similar at around 0.2, indicating that investment responds positively to increases in firm output, as proxied by real sales growth.

The estimated impact of changes in the user cost of capital on investment varies across models. In the benchmark model, the user cost, which is calculated using the apparent interest rate at the firm level (UC1), has a negative impact on investment that is statistically significant – all of the contemporaneous and lagged values are negative and significant with a peak impact occurring after one year. This indicates that by influencing the cost of debt financing and the opportunity cost of equity financing, interest rate changes alter the user cost of capital for Chinese firms and thereby affect investment.

The long-run impact of changes in the user cost of capital on investment at the firm level is negative and statistically significant in all version of the model, except the one estimated using UC2, in which debt financing costs are measured using the PBoC benchmark commercial bank lending rate. When the effective lending rate is used in the user cost calculation (UC3) the first and second lags are both negative and significant to varying degrees, although the contemporaneous coefficient is significantly positive. Finally, when the user cost if calculated using the "flow" weights (UC4), all the coefficients are negative although only the contemporaneous value is significant at the 5% level.[15] The finding that UC3 – the user cost of capital estimated using the benchmark commercial bank lending rate – has no significant impact on capital formation implies that this policy interest rate is becoming increasingly irrelevant for macroeconomic control and strengthens the case for it to be abolished.

In all versions of the model, the cash flow variable is typically highly significant. This may reflect the effect of monetary policy operating through the firm's balance sheet – that is, a change in monetary policy translates into a change in the amount of funds available to the firm, and thus affects firm investment. In most cases, the coefficient on the first lag is negatively signed, although the long-run elasticity is still positive, indicative of binding credit constraints in China's listed companies sector. Note, however, that interpreting the implication of the coefficients on the cash flow variable can be problematic given that current investment depends on expected future profits, which may be correlated with current cash flow.

To assess whether the impact of the user cost of capital and cash flow on investment differs across firm size, Table 5 reports the results of estimating the investment equation with firms split into three equal-sized groups based on the number of employees. The results are essentially unchanged from those reported in Table 4. Changes in firm sales have a significant positive effect on investment. There is some evidence that investment by large firms is less sensitive to the cost of capital with the

[15] As a result of the additional lag used to calculate the flow weights and the exclusion of negative weights, the number of observations in this regression is significantly reduced relative to the benchmark model.

long-run elasticity much lower than in the case of small and medium-sized firms, perhaps indicating that SOEs are still somewhat less sensitive to the user cost of capital than the private sector. There does not, however, appear to be any differences in the impact of cash flow on investment across different-sized firms.

Table 5. Investment regression results split by firm size

Explanatory variable	UC1	Explanatory variable	UC1
Investment over (lagged) capital 1st lag	0.199***	Investment over (lagged) capital 1st lag	0.196***
Investment over (lagged) capital 2nd lag	0.015	Investment over (lagged) capital 2nd lag	0.015
Change in (logged) sales	0.075***	Change in (logged) sales	0.080***
Change in (logged) sales 1st lag	0.036***	Change in (logged) sales 1st lag	0.038***
Change in (logged) sales 2nd lag	0.040***	Change in (logged) sales 2nd lag	0.043***
Long-run sales elasticity	**0.188**	**Long-run sales elasticity**	**0.201**
Small firms: change in (logged) user cost	-0.059***	Change in (logged) user cost	-0.030***
Small firms: change in (logged) user cost 1st lag	-0.050***	Change in (logged) user cost 1st lag	-0.044***
Small firms: change in (logged) user cost 2nd lag	-0.017	Change in (logged) user cost 2nd lag	-0.014
Small firms: long-run user cost elasticity	**-0.136**	**Long-run user cost elasticity**	**-0.093**
Mid-size firms: change in (logged) user cost	-0.043***	Small firms: cash flow over (lagged) capital	0.069***
Mid-size firms: change in (logged) user cost 1st lag	-0.041***	Small firms: cash flow over (lagged) capital 1st lag	-0.063***
Mid-size firms: change in (logged) user cost 2nd lag	-0.020*	Small firms: cash flow over (lagged) capital 2nd lag	0.014***
Mid-sized firms: long-run user cost elasticity	**-0.129**	**Small firms: long-run cash flow elasticity**	**0.026**
Large firms: change in (logged) user cost	-0.020	Mid-size firms: cash flow over (lagged) capital	0.085***
Large firms: change in (logged) user cost 1st lag	-0.035***	Mid-size firms: cash flow over (lagged) capital 1st lag	-0.035***
Large firms: change in (logged) user cost 2nd lag	-0.009	Mid-size firms: cash flow over (lagged) capital 2nd lag	0.019**
Large firms: long-run user cost elasticity	**-0.044**	**Mid-sized firms: long-run cash flow elasticity**	**0.086**
cash flow over (lagged) capital	0.095***	Large firms: cash flow over (lagged) capital	0.052***
cash flow over (lagged) capital 1st lag	-0.072***	Large firms: cash flow over (lagged) capital 1st lag	-0.051***
cash flow over (lagged) capital 2nd lag	0.013***	Large firms: cash flow over (lagged) capital 2nd lag	0.049***
long-run cash flow elasticity	**0.046**	**Large firms: long-run cash flow elasticity**	**0.062**
Number of observations		Number of observations	2490
R2		R2	0.260

Note: *, ** and *** denote statistical significance at the 10, 5 and 1% level respectively.

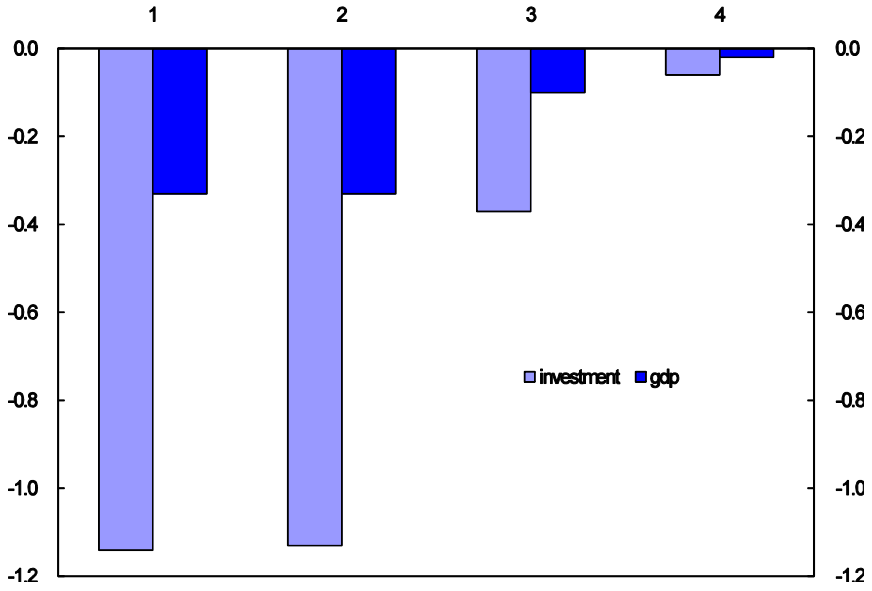
Dynamic simulation of the benchmark model (UC1) indicates that the impact of interest rate changes on business investment is not only statistically significant but also of a scale that is useful for macroeconomic stabilisation. In this simulation, the policy interest rate is raised by one percentage point while inflation is held constant. This policy rate shock is then reversed linearly over five years. Changes in the policy interest rate are assumed to gradually feed into the interest rate faced by firms according to the maturity structure of their debt and the extent of equity financing.[16] The cost of

16 . This average interest rate is not the rate that enterprises should use in making their investment decision; rather the interest rate on new borrowing should be used. However, almost all firm debt is short term, so reducing this bias. For the average firm, 80.9% of debt has an original maturity of less than one year.

equity financing is driven by the cost of long-term debt, which, based on the observed behaviour of Chinese 10-year bond rates, increases by 0.2 percentage point for every percentage point rise in short rates. In total, reflecting the gradual impact of the policy rate on interest rates faced by firms, the user cost of capital increases by only one third of a percentage point in the first year in response to a one percentage point increase in the policy rate. Even so, this relatively mild policy interest rate shock is estimated to lead to a cumulative slowdown in investment and GDP relative to baseline of 2.5% and 0.9% respectively over the next four years (Figure 9).

Figure 9. Impact of a one percentage point increase in real policy rates on investment

The increase in the policy rate is tapered to zero over five years
% change from baseline



Source: OECD calculations.

4.3 The impact of monetary policy on consumption is probably small but growing

China's consumer credit market is still relatively small compared with enterprise credit but is developing quickly. At the end of the 1990s, there was scarcely a housing market at all. However, as a result of housing market reforms that concluded in 1998, the sale of state-owned housing to occupants at less than market value resulted in a large number of owner-occupiers with little debt and created the potential for a buoyant market. Since then, a re-orientation of the banking system towards more commercial lending practices has significantly increased the dynamism of the residential mortgage market. Banks have rapidly expanded mortgage lending, which has increased by over 20% annually since 2006. By mid-2009, the value of total residential mortgages had risen to around CNY 3.9 trillion or 10% of total bank lending.

The housing market is therefore becoming a significant additional channel through which interest rate changes affect the real economy. At the current level of interest rates and assuming a 15-year mortgage, a two percentage point increase in interest rates would increase mortgage payments by an amount equivalent to 3.5% of consumer spending or 1% of GDP.[17] The effect of interest rates on house prices is another potential transmission channel through which monetary policy could affect

Of the remaining long-term debt, 17% had a maturity of less than one year, suggesting an average initial maturity of 6 years.

17 . Mortgage lending is regulated by the PBoC. Until recently, the mortgage interest rate had to be adjustable and linked to the regulated commercial lending rate of the banks. Rates are changed at the beginning of each year. Mortgages must be less than 80% of the assessed value of the property and payments must be less than 50% of income.

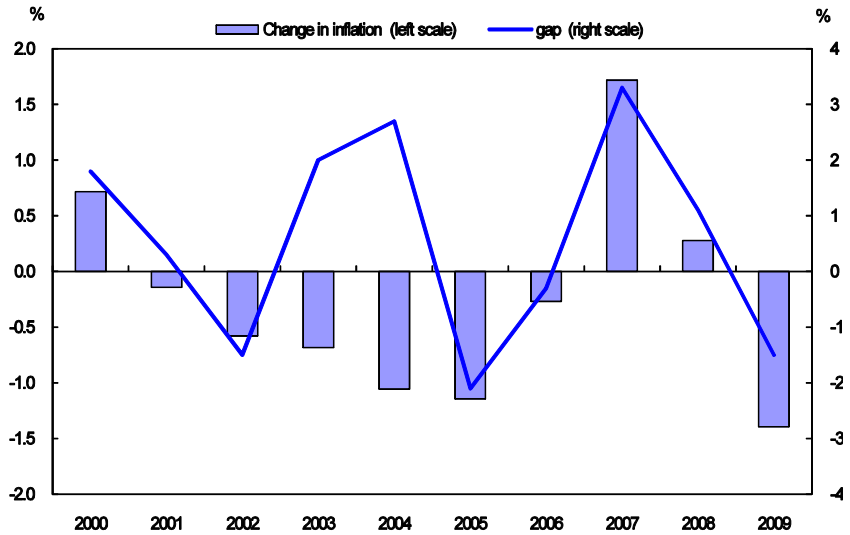
economic activity. Over 1998-2005, however, there was no evidence for such an effect in China, although credit availability did appear to influence house prices (Zhu, 2006).

5. The determinants of Chinese inflation

In market economies, the difference between aggregate demand and potential output is a key source of changes in inflation pressure: the output gap, as a summary measure of the extent of excess demand, is an important link between the real side of the economy and inflation. Given that the investment decisions of Chinese firms are sensitive to interest rate changes and the rapid growth of consumer credit, a significant relationship between aggregate demand and inflation would provide important evidence of an operative monetary policy transmission channel. Of course, for this link to work, prices need to be largely determined by market forces, which is generally now the case in China.[18]

From the mid-1980s to the mid-1990s the Chinese economy was very volatile with wide swings in the output gap and inflation. Subsequently, the adoption of a fixed exchange rate peg against the dollar, following a period of large devaluations, helped reduce inflation volatility. At the same time, with greater experience in managing an increasingly market-oriented economy, the gaps between aggregate supply and demand have moderated. In addition, the adoption of a more flexible exchange rate policy in 2005 increased the ability of monetary policy to focus on domestic objectives and stabilise inflation. However, in part reflecting the global commodity cycle, inflation began to increase again prior to the global financial crisis, with CPI inflation peaking at 8.1% in February 2008. From the beginning of 2009, reflecting a marked tightening in monetary policy one year earlier and the global economic recession, Chinese inflation declined markedly, turning into deflation. Consistent with China's recent inflation experience, the OECD's estimate of the output gap indicates significant excess demand in 2007 that subsequently turned into excess capacity with the tightening of monetary policy and the global recession (Figure 10).

Figure 10. Changes in inflation and the output gap



Source: OECD and CEIC.

Empirical assessments of the link between aggregate demand and inflation in China have produced mixed results. Using a basic specification of the Phillips curve, Coe and McDermott (1996) find no

18 . Price reform in China began in agricultural markets in the late 1970s and gathered pace in the mid-1980s. By the early 1990s, almost half of industrial prices had been deregulated. By 2003, this figure had increased to almost 90% (OECD, 2005).

support for a link between aggregate demand and Chinese inflation over the 1970s and 1980s. Ha *et al.* (2003) measure potential output using a simple linear trend and also find that the Phillips curve fails to explain inflation dynamics in China, which they attribute to the difficulties of estimating potential output. In contrast, papers using data from the more recent period and output gaps estimated using more appropriate techniques do find support for the Phillips curve in Chinese data. For example, Oppers (1997) finds that China's inflation experience does, to a large extent, reflect surges in the main components of aggregate demand. Gerlach and Peng (2004) also find that the Phillips curve fits the Chinese data provided adequate care is taken to account for the effect of structural change on price formation in the economy. Finally, in a careful analysis that uses time dummies to account for structural change, Scheibe and Vines (2005) find that the output gap, the exchange rate, and inflation expectations all play important roles in explaining Chinese inflation.

To assess the impact of changes in aggregate demand on inflation in China, the following Phillips curve is estimated, based on Scheibe and Vines' approach but updated to include five additional years of data at the quarterly frequency to end-2007:

$$\pi_t = const^{\pi} + \gamma^{E\pi} E\pi_{t+1} + \sum_{i=1}^{4} \gamma^{\pi} \pi_{t-1} + \sum_{i=0}^{4} \gamma^{gap} y_{t-i}^{gap} + \sum_{i=0}^{4} \gamma^{\Delta e} \Delta e_{t-i} + \varepsilon_t^{\pi} \qquad [6]$$

where π is the four-quarter percentage change in the consumer price index, $E\,\pi$ is expected inflation, y^{gap} is the OECD's estimate of the Chinese output gap derived using a production function methodology and e is the nominal effective exchange rate expressed so that an increase is a depreciation.

The results of estimating this equation are given in Table 6. In the backward-looking version of the model, in which expected inflation is assumed to equal inflation in the previous quarter, the coefficient on the output gap is positive and significant, indicating that Chinese inflation does react to the level of excess demand in the economy. When aggregate demand is greater than the economy's supply capacity, inflation begins to move upwards in response to shortages in key markets. The converse applies when the output gap is negative. In addition, the coefficients on changes in the nominal effective exchange rate are also highly statistically significant, implying that changes in the (trade-weighted) nominal exchange rate also drive inflation, with currency appreciation working to bring down inflation.

Table 6. Phillips curve estimates for China

Dependent variable: annual CPI inflation explanatory variable:	Backward-looking inflation expectations	Hybrid inflation expectations
CPI inflation, 1st lag	1.369***	1.161***
CPI inflation, 2nd lag	-0.486***	
CPI inflation, 3rd lag		-0.346***
Expected inflation		0.213***
Output gap, 3rd lag	0.144**	0.156*
Effective nominal exchange rate	0.127***	0.053***
Effective nominal exchange rate, 5th lag	0.040***	0.036
Number of observations	78	65
Sum of coefficients on lagged and target CPI and exchange rate	1.049	0.904

Note: *, ** and *** denote statistical significance at the 10, 5 and 1% level respectively.

In the "hybrid" version of the model, expected inflation is modelled as a weighted average of lagged inflation and a survey measure of forward-looking inflation expectations. The coefficient on the surveyed inflation measure has the expected positive sign and is highly significant indicating that current inflation is influenced by expected inflation one year in the future. This has important implications for monetary policy, which will be more effective than would otherwise be the case provided the PBoC's pursuit of low and stable inflation is credible. If it is believed that the PBoC will adjust policy settings to keep inflation low, this will, to some extent, become self-fulfilling through the impact of expected inflation. As a result, a given reduction in inflation can be brought about by smaller changes in the output gap than if expectations were based purely on past inflation. Furthermore, the sum of the coefficients on lagged and forward-looking inflation and changes in the nominal exchange rate is not statistically different from one, implying that the long-run Phillips curve is vertical and there is no long run trade-off between excess demand and inflation. As a result, any sustained increase in output above potential would lead to ever-higher inflation.

Not surprisingly, given price and other reforms in China, Phillips curve estimates are sensitive to the sample period and to how structural change is accounted for in the model. However, with a larger share of economic activity being conducted by the private sector and subject to market conditions, the relationship between excess demand and inflation is likely to become increasingly robust over time.

6. The role of the exchange rate regime in Chinese monetary policy

Since a system of dual exchange rates was abolished in 1994, China's exchange rate regime has officially been described as a managed float. During the first half of the 2000s, however, the renminbi was effectively pegged to the US dollar. In July 2005, the renminbi was revalued by 2.1% against the US dollar and the bands of permissible daily movements increased to ± 0.3%. The authorities also announced that, going forward, the value of the renminbi would be set relative to a currency basket. In practice, the authorities did permit the rate of renminbi appreciation *vis-à-vis* the US dollar to increase after the July 2005 announcement but daily changes typically did not test the ± 0.3% bound.[19] Since August 2008, the pace of appreciation has stalled and the value of the renminbi has been broadly stable against the US dollar.

6.1 The weights in the renminbi currency basket

The official weights in the renminbi currency basket have not been disclosed. However, these weights can be estimated using a modified version of a model devised by Frankel and Wei (2007). Specifically, the following equation is estimated:

$$\Delta e^{SDR}_{RMB,t} = const^{\Delta e} + \sum_{C=1}^{N} \gamma^{\pi} \Delta e^{SDR}_{C,t} + \varepsilon^{\Delta e}_{t} \qquad [7]$$

In this model, daily changes in the renminbi exchange rate ($\Delta e^{SDR}_{RMB,t}$) are regressed against daily changes in the 11 currencies ($\Delta e^{SDR}_{C,t}$) that have been disclosed by the PBoC as being in the renminbi currency basket (US dollar, euro, Japanese yen, Korean won, Singapore dollar, UK pound, Malaysian ringgit, Russian ruble, Australian dollar, Thai baht and Canadian dollar). To reduce the potential for multi-collinearity, all of the Asian currencies, except the Japanese yen, are combined into a weighted average using their share of Chinese trade as weights. All currencies used in the regression are

19 . From end-July 2005 to August 2008, the absolute value of daily changes in the renminbi spot rate *vis-à-vis* the US dollar averaged 0.06%, only a small fraction of the permissible maximum. The limit of ± 0.3% was reached or exceeded on only three days.

expressed *vis-à-vis* the IMF's Special Drawing Rights (SDR). The equation also contains a constant term ($const^{\Delta e}$) and error term ($\varepsilon_t^{\Delta e}$).

The estimation period runs from July 2005, when the Chinese authorities announced that the value of the renminbi would be managed relative to a currency basket, until July 2008. The sum of the coefficients in the model is constrained to equal one, though this has little impact on the estimation results. As well as estimating the model over the full sample period, it is also estimated over 50-day windows to assess the extent of change in the weights over time. The same model is also estimated over the entire sample period using the time-varying coefficients methodology outlined in Box 1.

The results of estimating equation [7] are given in Table 7. The US dollar is the only currency that is significant across all of the sub-periods and Asian currencies are the only other currencies that are significant over the full sample period. These results imply that the weight of the US dollar may have fallen somewhat in 2008 but has still averaged over 0.9 since the 2005 announcement. The coefficient on the US dollar derived from the version of the model with time-variant coefficients also indicates a large weight that has been reasonably constant over time (Figure 11). As a result, movements in the renminbi against the US dollar have been dwarfed by movements in the dollar against the euro, yen and other currencies and the renminbi has moved substantially in effective terms over recent years (Figures 12).

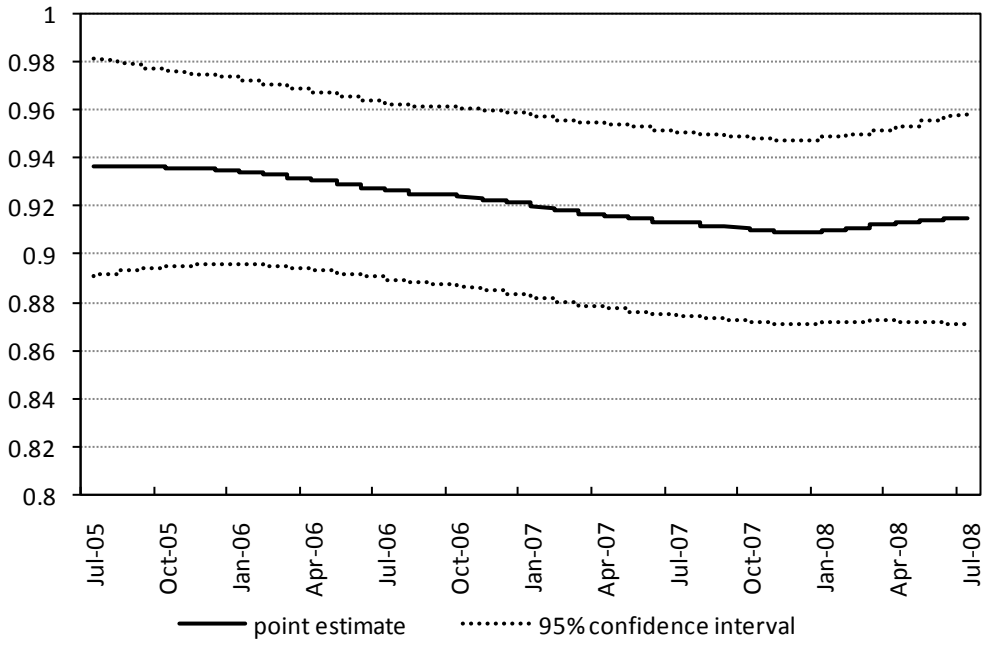
Table 7. Estimated currency weights in the renminbi currency basket

	Full sample	22-Jul-05 to 3 Nov 05	4 Nov 05 to 9-Feb-06	10-Feb-06 to 10-May-06	11-May-06 to 16-Aug-06	17-Aug-06 to 22-Nov-06	23-Nov-06 to 2-Feb-07
US	0.923***	0.901***	1.031***	0.856***	0.917***	0.801***	0.974***
Euro	-0.001	-0.064**	0.041	-0.056*	0.004	-0.093	-0.072
Japan	0.021***	0.023	-0.006	0.006	0.064**	-0.003	-0.017
UK	-0.004	0.02	-0.011	-0.019	-0.025	0.025	0.05
Russia	0.017	0.12**	-0.045	0.166***	-0.068	0.169	0.066
Canada	-0.001	-0.015	-0.053**	0.009	-0.007	-0.011	0.021
Asia	0.045***	0.015	0.041	0.039	0.115***	0.112*	-0.023
Constant	0	0	0	0	0	0	0
Observations	757	72	66	63	66	66	49

	5-Feb-07 to 17-Apr-07	18-Apr-07 to 28-Jun-07	29-Jun-07 to 12-Sept-07	13-Sept-07 to 26-Nov-07	27-Nov-07 to 8-Feb 08	11-Feb 08 to 22-Apr 08	23-Apr 08 to 30-Jul-08
US	0.838***	1.015***	0.875***	0.808***	0.912***	0.922***	0.977***
Euro	0.133	-0.077	0.064	-0.104	0.105	-0.036	0.053
Japan	0.009	0.044	0.01	0.018	0.051	0.017	0.055*
UK	-0.02	0.141**	-0.011	0.045	-0.024	-0.006	-0.035
Russia	-0.044	-0.08	-0.055	0.138	-0.149	0.113	-0.14
Canada	-0.032	0.031	-0.029	-0.008	0.04	-0.036	0.056
Asia	0.116**	-0.074	0.145**	0.102	0.065	0.027	0.033
Constant	0	0	0	0	-0.001	0	0
Observations	51	51	51	51	51	51	69

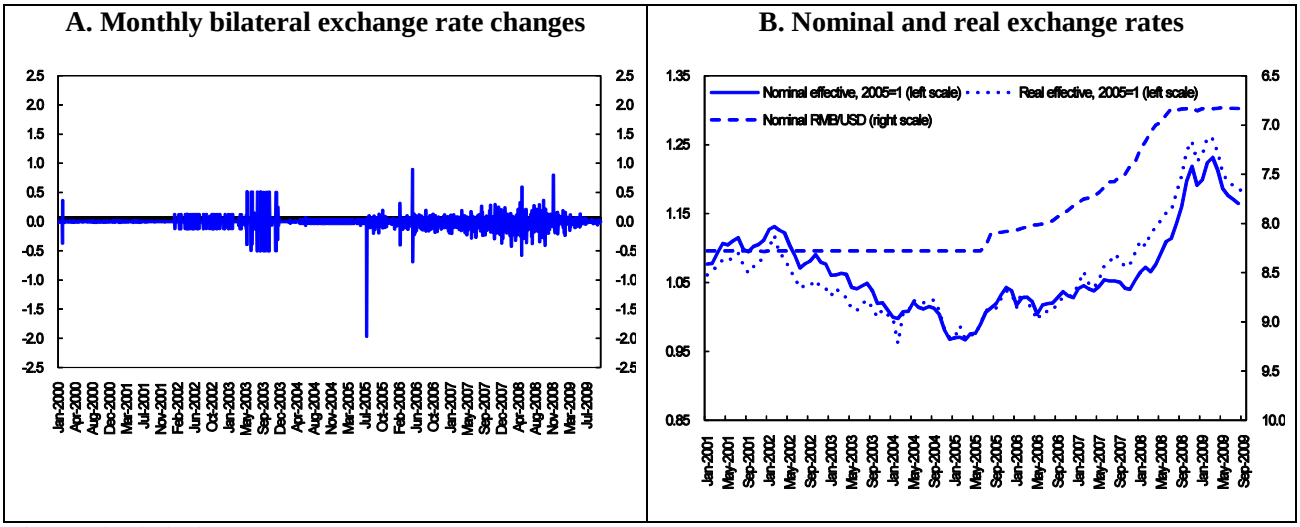
Note: *, ** and *** denote statistical significance at the 10, 5 and 1% level respectively.

Figure 11. Estimated weight of the US dollar in the renminbi currency basket



Source: OECD.

Figure 12. Bilateral and effective exchange rates

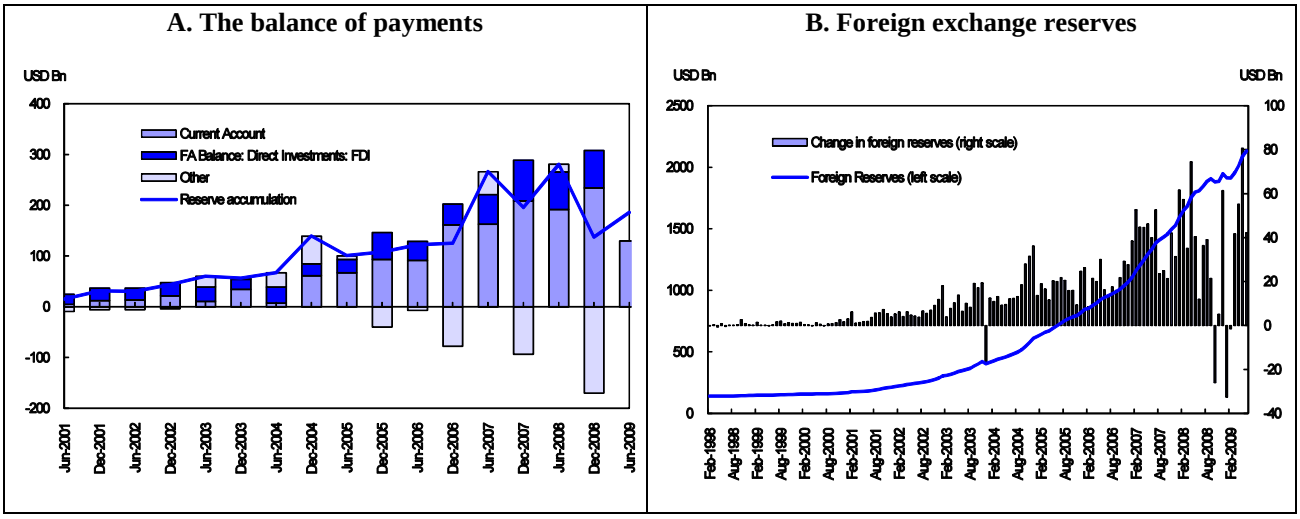


Source: CEIC, OECD.

6.2 The sterilisation of foreign reserve inflows

Over recent years, China's exchange rate regime has been coming under increasing pressure. Since 2005, large current account surpluses and rising capital inflows, particularly of foreign direct investment, have resulted in appreciation pressure on the renminbi (Figure 13 Panel A). In response, the State Administration of Foreign Exchange has sold renminbi, leading to a large and sustained increase in foreign reserves to unprecedented levels. In late 2008 and early 2009, sizeable capital outflows slowed the pace of foreign reserve accumulation (Figure 13 Panel B). However, this proved to be temporary and since March 2009 reserve accumulation has averaged around $55 billion per month. By mid-2009, total reserves stood at $2.1 trillion, making China by far the world's largest holder of foreign exchange reserves, ahead of Japan.

Figure 13. The balance of payments and foreign exchange reserves



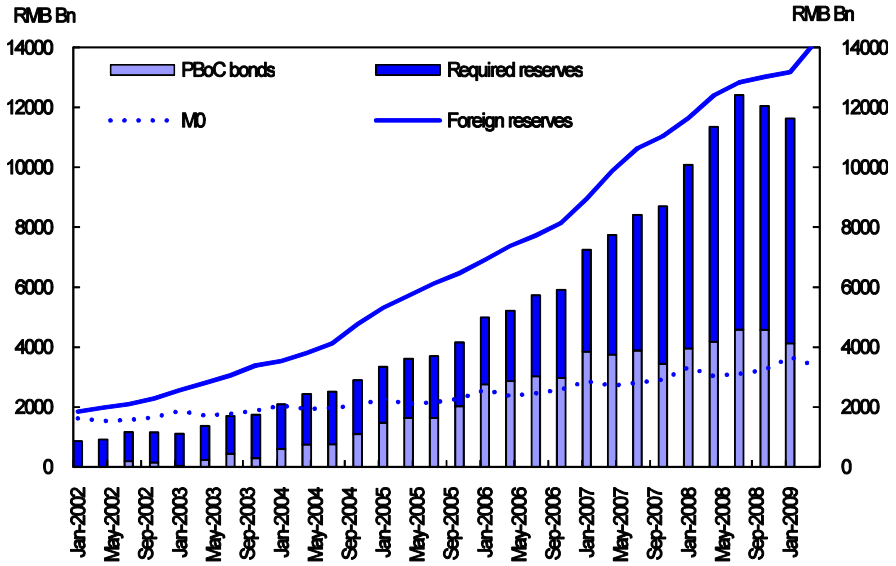
The rapid accumulation of foreign exchange reserves arising from currency intervention has the potential to spill over into China's domestic money market by affecting reserve money growth and wider monetary conditions. This has been an important consideration underpinning the policy actions of the PBoC over recent years. To limit such effects, the PBoC uses OMOs of PBoC bills and changes in commercial bank reserve requirements to drain liquidity from the banking system and sterilise the domestic monetary consequences of foreign reserve inflows.

Since 2002, the value of the PBoC's sterilisation instruments outstanding has risen roughly in line with the stock of foreign exchange reserves, indicating that the central bank has generally been successful in offsetting the domestic monetary impact of reserve inflows (Figure 14).[20] Accordingly, base money growth has been relatively stable, with little evidence of a trend pick-up in the mid-2000s when reserve inflows began to accelerate. Since then, the PBoC has primarily relied on reserve requirement hikes to offset increased inflows while the issuance of PBoC bills has slowed. In mid-2009, the total value of PBoC bills outstanding was CNY 4.1 trillion, equivalent to 8.25% of total bank deposits. With the required reserves ratio at 15% – equivalent to CNY 7.5 trillion – the PBoC is effectively removing 23.3% of bank deposits from circulation.[21]

20 . Relative to the PBoC's desired rate of reserve money growth – derived from a money supply equation – Ouyang *et al.* (2007) estimate that the central bank was able to sterilise 92 to 97% of excess reserve inflows over 1999-2005.

21 . Prior to the onset of the global financial crisis, the total value of PBoC sterilisation instruments peaked at 27.5% of bank deposits (required reserve ratio of 17.5% or CNY 7.8 trillion plus PBoC bill issuance of 10% of bank deposits or CNY 4.6 trillion). As part of its efforts to increase liquidity in late 2008 and early 2009, the PBoC used OMOs and cuts in the required reserves ratios to inject around CNY 780 billion of base money.

Figure 14. PBoC sterilisation and base money



Although the PBoC has generally managed to sterilise the effect of foreign reserve inflows on the domestic money supply, holding large reserves is not necessarily costless. Cost/benefit quantification is difficult, however, as it depends on several unknowns, including the maturity of bonds held as reserves and their currency composition.[22] One extreme case is to assume that all foreign exchange reserves are held in dollars, invested in instruments with short-term maturities and financed in local currency by the issue of liabilities with similar maturities to the assets. Then, the financing cost depends on the short-term interest rate differential between US Treasury and PBoC bills. Since 2003, when the build-up in reserves took off, Chinese rates have been, on average, 20 basis points below US rates. This small differential has occurred despite capital controls that, in theory, prevent arbitrage between domestic and foreign money markets. In total, over the period from June 2003 to October 2009, the cumulated interest cost of financing the reserves would have been close to zero on the basis of this extreme assumption. Periods when financing was expensive, such as since the beginning of 2008, have been offset by periods when there was a profit in holding reserves. This was noticeably the case in 2007, when the Chinese authorities did not follow the Federal Reserve in raising short-term interest rates.

While the interest rate cost of holding reserves has been minimal, the central bank has incurred substantial losses due to the appreciation of the currency against the dollar. If the reserves had been held entirely in dollars, the cumulative loss would have amounted to around 6% of annual GDP by October 2009 and would eventually require a recapitalisation of the central bank.

As well as exposing the central bank and indirectly the government to interest rate and exchange rate risk, the PBoC's sterilisation operations also impose considerable cost on the Chinese banking sector. In particular, the interest rate paid by the PBoC on required reserves is typically lower than interest rates prevailing in the money market, implying significant opportunity costs for the commercial banks from having to hold reserves. This has worked against the impact of regulated interest rates on bank profits, described above.

Sterilisation costs are a fiscal problem and arrangements need to be put in place to pay commercial banks a competitive rate of interest on required reserves and ensure that any losses borne by the PBoC

22 Even if these were known, there would arguably be a need to standardise the risk factors for both assets and liabilities, otherwise part of the cost (or apparent profit) would be due to unmatched risk-taking, rather than the cost of sterilisation *per se*.

are transferred to the government in a timely manner without weakening the commercial banking sector.

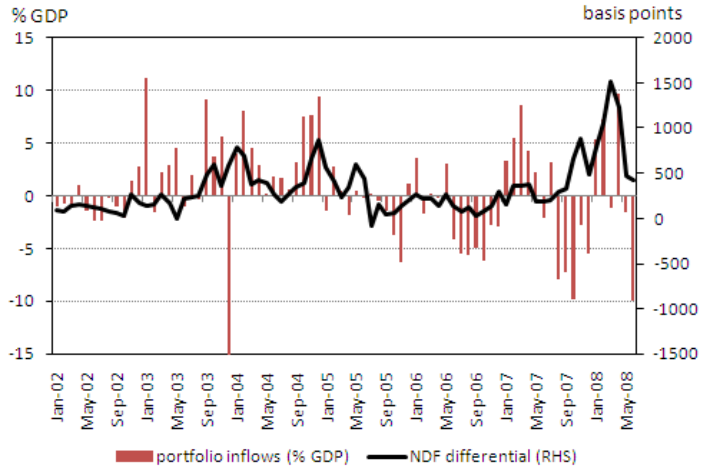
6.3 The way forward on exchange-rate reform

Perhaps the greatest cost of China's exchange rate regime is the constraint it imposes on the PBoC's ability to tailor monetary policy to domestic objectives. The essential problem stems from Robert Mundell's "inconsistent trinity" – the impossibility of running an independent monetary policy under a fixed exchange rate regime when financial capital is mobile across borders. This arises because, without exchange rate adjustment, cross-country differences in interest rates lead to capital flows that affect domestic financial conditions. Ultimately, the arbitrage opportunity closes and the central bank is prevented from running an independent monetary policy.

Intervening to sterilise changes in foreign reserves can forestall this adjustment but runs the risk of ever-increasing capital flows that could ultimately overwhelm central bank control of the money supply. For example, resisting currency appreciation and sterilising the foreign reserve inflow prevents the domestic interest rate from falling, which attracts more inflows, necessitating more sterilisation, *etc*. Eventually, as sterilisation costs become prohibitive, the central bank has no choice but to allow the currency to appreciate or interest rates to fall, sparking domestic inflation. In either case, an appreciation of the real exchange rate becomes unavoidable.

In the case of China, capital controls do provide the PBoC with some scope for independent monetary policy despite a heavily-managed exchange rate regime. Deviations from covered interest parity (CIP) *vis-à-vis* the United States have been relatively large and persistent at times (Ma and McCauley, 2007). Expectations of renminbi appreciation against the US dollar – as measured in the offshore non-deliverable forward (NDF) market – do appear to influence the direction and volume of estimated portfolio flows across China's border (Figure 15).[23] However, persistent deviations from CIP suggest that these flows are insufficient to equalise returns on broadly equivalent assets, implying that China's capital controls do still bind to some degree. In turn, this implies that the PBoC has some autonomy in its monetary policy settings, despite the exchange rate regime.

Figure 15. Portfolio inflows and the implied renminbi forward premium

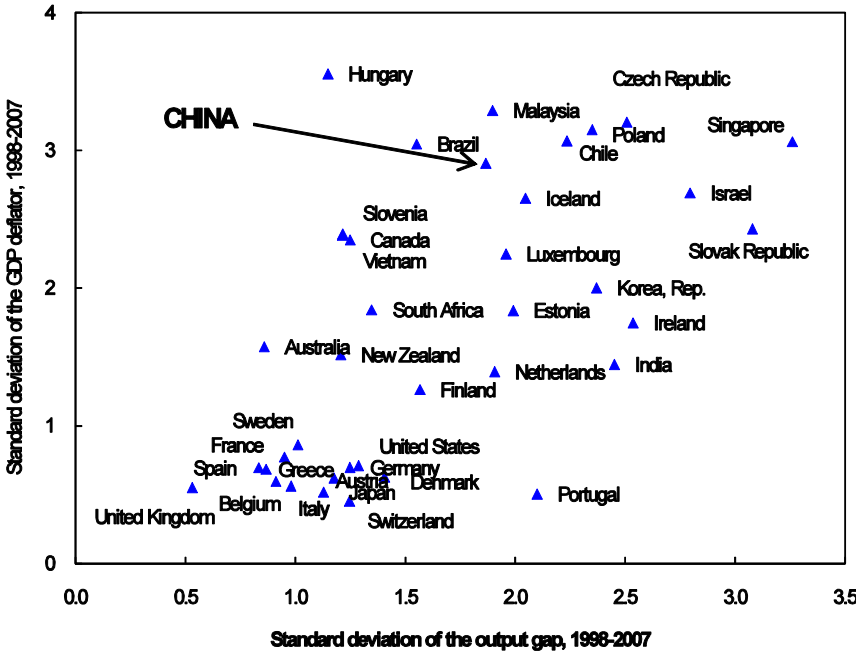


Source: OECD.

23 . Although reserve accumulation over the past four years has in large part been driven by the current account surplus and FDI inflows, estimated portfolio flows have also become increasingly significant, exceeding 5% of GDP on occasion. A number of authors have investigated the drivers of portfolio inflows in China, finding that to some extent they are correlated with expected movements in the exchange rate, interest rate differentials and asset market returns (Anderson, 2007; Ma and McCauley, 2007). Ouyang *et al.* (2007) find that China's balance of payments is sensitive to changes in domestic money creation.

It remains an open question, however, whether the degree of autonomy afforded by China's capital controls is sufficient to allow the PBoC to conduct monetary policy in an optimal way. Assessing central bank performance in this regard is not straightforward given the difficulties of isolating the effect of monetary policy on the macroeconomy. Since the "boom/bust" cycles of the 1980s and 1990s, Chinese inflation volatility has fallen considerably. However, inflation volatility was also lower in most other countries after 2000 and Chinese inflation remains more volatile than in most OECD countries, including the United States, against whose currency the renminbi has been extremely stable (Figure 16).

Figure 16. Inflation and business cycle volatility across countries



Note: the standard deviations are calculated using the HP filter over 1998-2007 (annual data).

Source: World Bank and OECD.

Although a range of factors are at play, the PBoC's policy actions seem often to reflect balance-of-payments concerns at the expense of domestic policy objectives. For example, Burdekin and Siklos (2006) find that changes in foreign reserves play a significant role in the PBoC's monetary policy reaction function. Similarly, Ouyang *et al.* (2007) find evidence that changes in foreign reserves have a significant impact on changes in the PBoC's net domestic assets, implying that maintaining a targeted exchange rate narrows the scope for monetary policy to address domestic objectives. Laurens and Maino (2007) argue that China's tightly managed exchange rate in the face of foreign exchange inflows prevents greater reliance on interest rates to manage aggregate demand given that a tightening may result in larger capital inflows.[24]

The monetary policy constraints imposed by China's exchange rate regime are reinforced by concerns over the impact of central bank actions on sterilisation costs and the value of China's foreign reserve holdings. Given that the existing stock of PBoC bills has an average maturity of less than one year,

24 . On the other hand, Ma and McCauley (2007) note that the correlation between US and euro-area interest rates is higher than that between US and Chinese rates and argue that this implies that the PBoC has at least as much autonomy in the conduct of monetary policy as the European Central Bank. However, in making this comparison, the wider macroeconomic context needs to be taken into account. For example, if, compared to the euro area, China's business cycle is less correlated with the US cycle, then, all else equal, Chinese interest rates will need to deviate from US rates by a relatively larger margin for monetary policy to be optimal.

changes in domestic interest rates aimed at controlling inflation quickly affect sterilisation costs. Contingent losses on foreign reserves also temper the extent of renminbi appreciation permitted by the Chinese authorities. A preference to contain the increase in China's foreign reserve holdings has prompted recent efforts to promote the use of the renminbi in international trade and finance.[25] However, if the renminbi is to be used more widely internationally, China's capital controls will need to be eliminated so that foreigners can invest in renminbi-denominated assets and easily repatriate their capital and income.

China will eventually require a flexible exchange rate regime with open capital markets. The next step in this direction would be to link the Chinese currency to a basket of currencies of major trading partners and to announce the composition of the basket. This would help avoid some of the potential problems of linking the renminbi to a currency that is influenced by different factors than those affecting China. Under such a regime, in order to mitigate the potential for abrupt changes in the value of the renminbi to destabilise economic activity, the PBoC would smooth short-run exchange rate fluctuations while allowing the exchange rate to reach its market-determined level over longer horizons. Greater exchange rate flexibility would facilitate the implementation of a monetary policy geared to domestic objectives. The next step could entail a greater liberalisation of capital outflows and a degree of foreign investment in Chinese bond markets, either by allowing foreign investors access to the government bond market or allowing greater issuance of renminbi bonds by foreign issuers. The recent moves to allow certain banks to issue bonds in the Hong Kong market are a step in this direction.

Greater exchange rate flexibility would also enhance the exchange rate's role as an automatic stabiliser that helps smooth business cycle volatility, as China becomes more integrated with the global economy. The empirical modelling work discussed above indicates that changes in the real effective exchange rate are a significant determinant of changes in aggregate demand and that the nominal exchange rate influences inflation.[26]

At the moment, greater exchange rate flexibility would likely result in currency appreciation, increase the labour share of income and the purchasing power of households and help reorient investment towards the non-tradables sector. However, it would also likely entail a short-term output cost that might warrant offsetting measures to boost domestic demand. In these circumstances, the authorities may be inclined to wait until inflation becomes a problem once again before allowing an appreciation. Greater exchange rate flexibility would also reduce the pace at which China's exposure to US dollar assets is rising. Although this may entail an initial capital loss on existing reserves, as the renminbi appreciates, it would lower China's exposure to future losses.

7. The benefits of moving towards a flexible inflation target

Greater exchange rate flexibility raises the question of the most appropriate nominal anchor for Chinese monetary policy. Increasing the PBoC's reliance on the stock of money as an intermediate policy target is problematic. Although a number of studies have identified a link between money growth and inflation in the long run, short-run instabilities in the rate of money growth consistent with low and stable inflation indicate that a money target is not a good stand-alone nominal anchor (Laurens and Maino, 2007). In addition, simple quantity-based frameworks do not handle shocks very well and are susceptible to errors in forecasting money demand.

25 . From mid-2009, selected firms in five Chinese cities have been able to settle transactions in renminbi with businesses in Hong Kong and Macau. Foreign banks are able to buy or borrow renminbi from mainland lenders to finance such trade. The PBoC has also signed currency-swap agreements with Argentina, Belarus, Hong Kong, Indonesia, Malaysia and South Korea and will make renminbi available to pay for Chinese imports if these economies run short of foreign exchange. Hong Kong banks are now allowed to issue yuan-denominated bonds, a step towards building an offshore renminbi market.

26 . Shu and Yip (2006) also find that changes in the exchange rate influence aggregate demand, through the net exports channel, as well as inflation.

Instead, changes in the PBoC's policy stance should be predicated on informed judgements based on monitoring a set of indicators in the framework of a flexible inflation objective over the medium term. Because money growth and inflation are correlated in the long run, money aggregates would still have an important role to play as informational variables within this framework.[27] This would facilitate the PBoC "leaning against" excess credit creation and the build-up of related imbalances that have contributed to the recent failure of monetary policy in a number of countries to ensure macro and financial stability (White, 2009).

Incorporating an inflation objective into the PBoC's monetary policy framework would yield a number of additional benefits.[28] Specifically, an inflation objective is transparent and easily understood by the public. So when monetary policy is credible, an inflation objective can help condition inflation expectations, which can play an important role in macroeconomic stabilisation. In addition, an inflation objective has the advantage of focusing the political debate on what monetary policy is able to achieve in the long run, namely controlling inflation, and away from what monetary policy cannot do, namely permanently increasing output growth, lowering unemployment or keeping the real exchange rate at some predetermined level.

Moving China's monetary policy framework in this direction would require a range of enhancements in other areas. Incorporating an inflation objective into the policy framework would allow a rethink of NDRC policies that attempt to influence inflation by controlling individual prices. China's macroeconomic statistics would also need to continue to improve to provide the PBoC with better information to monitor the economy and communicate its policy intentions. Improved macroeconomic statistics would allow for better conditional macroeconomic forecasts to inform policy decisions. The literature on Chinese macro-modelling is still relatively sparse, but the empirical models discussed in this paper and used in other research suggest that relatively stable macroeconomic relationships are beginning to emerge.

The issue of central bank independence would also need to be addressed. Currently in China, decisions to adjust the PBoC's monetary policy instruments are made by the State Council. Modernising the framework would require granting the PBoC instrument independence so it can react promptly and decisively to changing economic circumstances without being swayed by political concerns. Operational independence would allow the PBoC to generate and sustain the credibility it needs to effectively influence inflation expectations. The State Council would still set the strategic objectives, but leave implementation to the PBoC.

As the exchange rate regime evolves towards greater flexibility, monetary policy should focus increasingly on domestic objectives, notably the goal of price stability over the medium term. The monetary policy transmission mechanism is operational and the PBoC needs to be able to move short-term interest rates in a wider range to enhance the role of monetary policy in buffering the economy from domestic and external shocks.

27 . See, for example, Gerlach and Kong (2005) and Laurens and Maino (2007).

28. The pros and cons of inflation targeting in emerging economies are discussed in Mishkin and Schmidt-Hebbel (2007).

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