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THE COST OF STERILIZATION IN CHINA***

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Central Bank Financial Strength and the Cost of Sterilization in China

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Abstract: This paper investigates the current monetary policy regime of China's Central Bank, the People's Bank of China (PBoC). This is done from the specific viewpoint of PBoC financial strength and the cost of its monetary policy instruments. The result shows that PBoC is constrained by the costs of its monetary policy instruments. PBoC tend to use less costly but market-distorting instruments such as deposit interest rate cap and reserve-ratio requirements, rather than more market-oriented but more costly instruments such as central bank note issuance. These costs remain under control today, but may rise in the future as PBoC accumulates more foreign assets. This, in turn, will jeopardize the Chinese monetary authority's capability to maintain price stability.

Key Words: Central banking, Monetary policy, China

JEL Classification: E51, E52, E58, E63, O53

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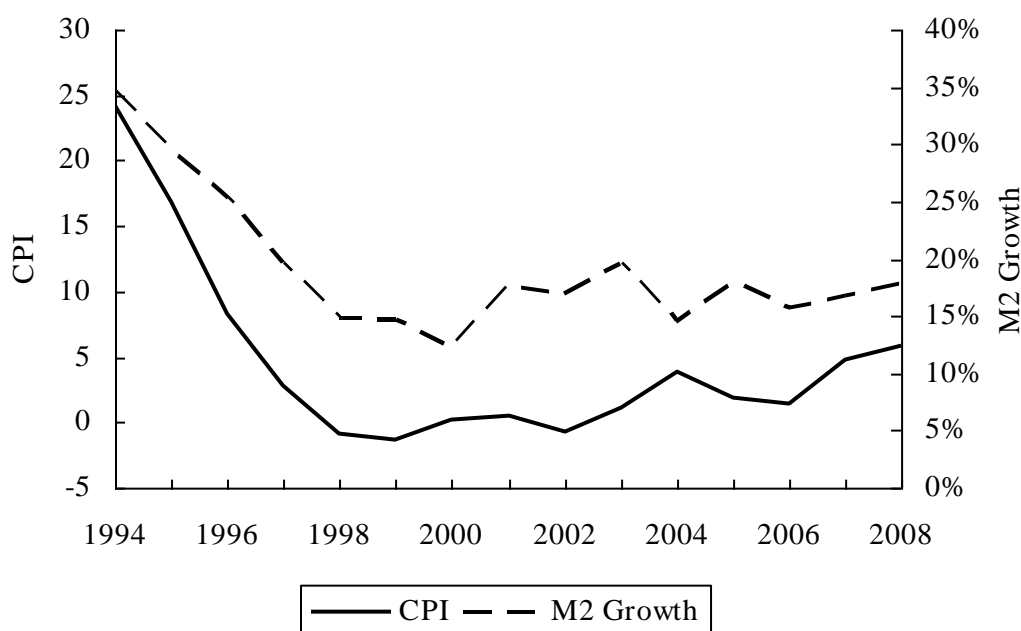
1 Introduction

It was first formally stated by Robert Mundell and Marcus Fleming, as a corollary of their Keynesian model of an open economy, that an economy cannot simultaneously maintain a fixed exchange rate, free capital movement, and an independent monetary policy (Mundell, 1960; Fleming, 1962), known as the “Incompatible Trinity” (Rose, 2000). It's been more than four decades since their works were published, yet the predictive power of their pure-theoretical assertion is still becoming more and more widely recognized as one pillar of the Trinity - free capital movement - is strengthened by the more and more integrated global financial market. Central banks of countries with a liberalized capital account usually found it extremely hard to maintain a fixed or less fluctuating exchange rate while keeping track of domestic money supply at the same time. Their central banks tried to use open market operations to offset impacts of foreign capital inflows and outflows on domestic credit, but these attempts are often costly and unsustainable in the long run. Such attempts could even eventually lead to financial turmoils: interventions on exchange rate are widely considered as one of the causes of financial crises of Latin American countries during 1980s and that of East Asian countries during late 1990s. In the end there aren't much choices left for the central banks, but either to let the exchange rate to free float and bear the fluctuations, or to give up monetary sovereignty by adopting a currency-board-alike regime, join a currency union, or even go dollarization.

China appears to be an outlier who hasn't suffered much from the pain of financial globalization. The US Dollar / Chinese Yuan exchange rate remained fixed for over a decade since 1994. In 2005 People's Bank of China, the Chinese central bank, announced to abandon fixed exchange rate to adopt a managed float peg against a basket of currencies, but the fluctuation of USD/CNY exchange rate since then is still minor by international standards. During the same period, PBoC actively employed monetary policy instruments to manage domestic credit supply and retain a stable price level. Figure 1 presents China's broad money supply and consumer

price index since 1994. It can be seen that PBoC had successfully ended the hyperinflation caused by Chinese government abandoning economic planning during 1994-1995 and had sustained a relatively stable inflation level afterward, despite a minor deflation during the Asian financial crisis.

Figure 1: China M2 Growth and CPI,



Why, then, is China capable of carrying out effective monetary policy while keeping the exchange rate fixed at the same time? As will be shown in the following parts of this paper, such ability to a large extent owes to the relatively low cost of PBoC's sterilization operations. Based on estimations from the public-reported balance sheet of PBoC, we show that PBoC retained positive gains for every single year since 2000¹, despite explosive international reserve accumulation during the same period.

However, the sterilization capability was by no means achieved without cost. We will further argue that the low cost of sterilization was due to the domestic financial repression environment. Interest rate on CNY nominated assets was kept lower than the return on capital the market otherwise would demand. PBoC had to employ other market-distorting policy instruments, such as raising deposit

¹ First year the data became publically available.

requirements or even directly setting lending quotas on banks, so that it could reduce the volume of excess liquidity that needed to be sterilized by central bank note issuance, and thus lower the total cost of sterilization. These measures hindered the financial market from working efficiently. Nevertheless, the pressure for PBoC becomes more and more intense as current account imbalance persists and foreign capital inflow continues. Losses of international reserve due to appreciation on CNY also become another concern. These issues stated above, if not properly resolved, will undermine China's financial stability in the long run.

The remainder of the paper is organized as follows. Section 2 introduces the Chinese monetary authority: how it comes thus far, what is the current situation, and how it operates in this environment. In Section 3 we estimate the profitability of PBoC's operations from its assets and liabilities, and then estimate the different costs PBoC incurred when applying different policy instruments. We employ a model of central bank financial strength to illustrate PBoC's current situation and possible consequences in Section 4. Conclusions and some oversights are given in the last section.

2 Central banking in China

2.1 Starting from PBoC's balance sheet

A Central bank is the monetary authority of a country. Usually a central bank acts as the primary provider of money and credit, the monitor and stabilizer of price and economic growth, and the lender of last resort in harsh situations, although the actual functions of them may differ from country to country. All these functions are reflected in the asset and liability holdings on its balance sheet. The balance sheet of a typical central bank is presented in Table 1. On the assets side, the central bank holds real asset (gold reserve), international reserves, and domestic assets. Domestic assets are either loans to financial corporations, or all kinds of debts (mostly

government bonds). On the liabilities side, central bank issues currency and owes deposit reserves from domestic financial institutions. Some central banks also issue their own debts other than currency.

Table 1: Typical central bank's balance sheet

Assets	Liabilities
Foreign assets	Currency issue
Loans to financial corporations	Deposit reserve
Debt holding	Debt issue
Other assets	Other liabilities

The balance sheet of People's Bank of China follows the same structure, although it looks to be somewhat less 'typical' in detail. Table 2 presents a simplified version of PBoC's balance sheet as of December 2008 (compared to 1999):

Table 2: PBoC's balance sheet (RMB trillion)

Assets	2008	1999	Liabilities	2008	1999
Foreign assets	16.3	1.4	Currency issue	3.7	1.5
Claims on financial entities	2.0	1.9	Deposit reserves	9.2	1.4
Claims on government	1.6	0.2	Bond issue	4.6	0.0
Other assets	0.8	0.0	Other liabilities	3.1	0.6
Total Assets	20.7	3.5	Total Liabilities	20.7	3.5

Data source: People's Bank of China statistics release.

We can see that the composition of PBoC's assets and liabilities changed quite a lot in the 10 year period. The worth-noting characteristics of PBoC's balance sheet in 2008 are as follows:

- Huge amount of foreign assets. Foreign assets accounted for approximately four fifths of PBoC's all assets in book value. The ratio of foreign assets over currency issue is about 4.4:1.
- Little government debts and even less other market debts.
- Large deposit reserve. On Dec 2008 PBoC was holding RMB 9.2 trillion of deposit reserve from depository institutions, approaching half of its total

liabilities. The large amount of deposit reserve is primarily because PBoC raised deposit reserve requirement ratio intensively since 2006 to slow down the growth of money supply.

- Bond issuance. The volume of PBoC-issued note outstanding was RMB 4.6 trillion by the end of 2008, exceeded the volume of currency issue, compared to none in 1999. PBoC pays market interest rate on these central bank notes. They are traded on the inter-bank bond market, and are usually held by financial institutions such as commercial banks and money funds.

Why, then, is there such a huge difference between now and ten years ago? The driving force was the mass trade surplus and capital inflows during the period. In response, PBoC had taken all kinds of measures to sterilize the foreign capital and maintain a stable money supply growth.

2.2 Explosive international reserve accumulation

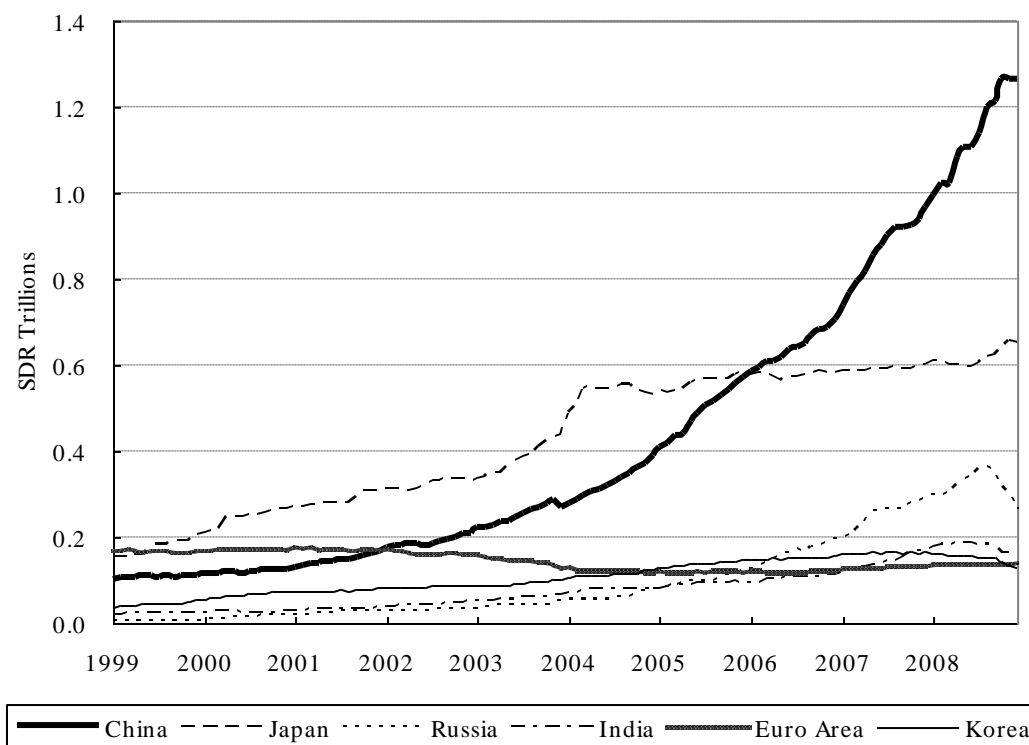
Without any doubt, China now holds the largest international reserve among all countries. The State Administration of Foreign Exchange (SAFE) reported its international reserves a total value of USD 1.95 trillion by 2008, about one fourth of world's total international reserves reported by IMF. Figure 2 compares China to other top international reserves holders.

China hasn't been the largest international reserves holding country for long. It was only in late 2005 that China's total international reserves exceeded Japan. Dated back to 1980s and early 1990s, foreign currencies were so scarce to the economy that the government had to allocate foreign exchange to importing firms by quotas². It is only since China adopted a fixed exchange rate regime in 1994 that international

² China adopted a so-called "dual-track" foreign exchange rate regime before 1994. There were two different exchange rates, an official rate and a market rate. The government allocated foreign exchange quotas to state-owned enterprises which gave them the right to import foreign products at the price of official rate. All other imports went to the market track, in which firms had to pay the market rate for foreign exchange, which was determined by a foreign exchange market and is significantly higher than the official rate.

reserves began to rise sharply. In particular, the speed of international reserves accumulation has accelerated since China joined WTO in 2001.

Figure 2: Top international reserves holding countries/regions, 1999-2008



Although China's international reserve is huge in absolute term, it's not that extraordinary if compared to the size of Chinese economy. Total value of international reserves in 2008 is about 44 percent of China annual GDP, or 76 percent of trade volume (import plus export), quite large but not outstanding by East Asian countries standards³. It is the magnitude of its growth rate that is astonishing. Annual growth rate averaged 34 percent for the last eight years, far exceeded the 16 percent average nominal GDP growth rate for the same period.

Why would China have hoarded so much international reserves? We have several candidate explanations. First, it is widely believed that East Asian countries

³ See Hawkins (2004) for a cross-country comparison.

increased their international reserves after the Asian financial crisis to pursuit more stability in their currency and to prevent future financial crises. Holding more international reserves “can be viewed as a precautionary adjustment, reflecting the desire for self-insurance against exposure to future sudden stops” (Aizenman and Marion, 2003;Aizenman and Lee, 2007). This explanation works for most East Asian countries but China seems to be different: China was one of the East Asian countries that suffered the least contraction during the crisis, yet it increased international reserves the most after the crisis. An alternative explanation puts it in the context of global imbalance.

Second, in their view, mass international reserves is a by-product of the so-called “Bretton Woods II” system (Dooley et al., 2003): “periphery countries” takes export-led growth strategy to maintain fast growth so that they can catch up with US, the “center country”. Neither does this modern mercantilist theory seem to fully explain China since foreign capital inflows far exceeded the amount of money supply China needed.

A third point of view associates accumulation of international reserves with unbalances within the Chinese economy, that Chinese people tend to consume less and save more, naturally lead to trade surplus and growing international reserves.

None of the views above seems to be outstandingly convincing. Perhaps each explanation reveals part of the truth, but it's not the purpose of this paper to find out. Rather, we are more interested in how the Chinese central bank deals with increasing international reserves, given that it has limited power to influence the amount of capital inflows.

2.3 Money supply and policy instruments

Sterilizing foreign capital inflows is a common issue for countries with large international reserves. This can be viewed from central bank's balance sheet. An increase in international reserves is an increase in assets of the central bank and will

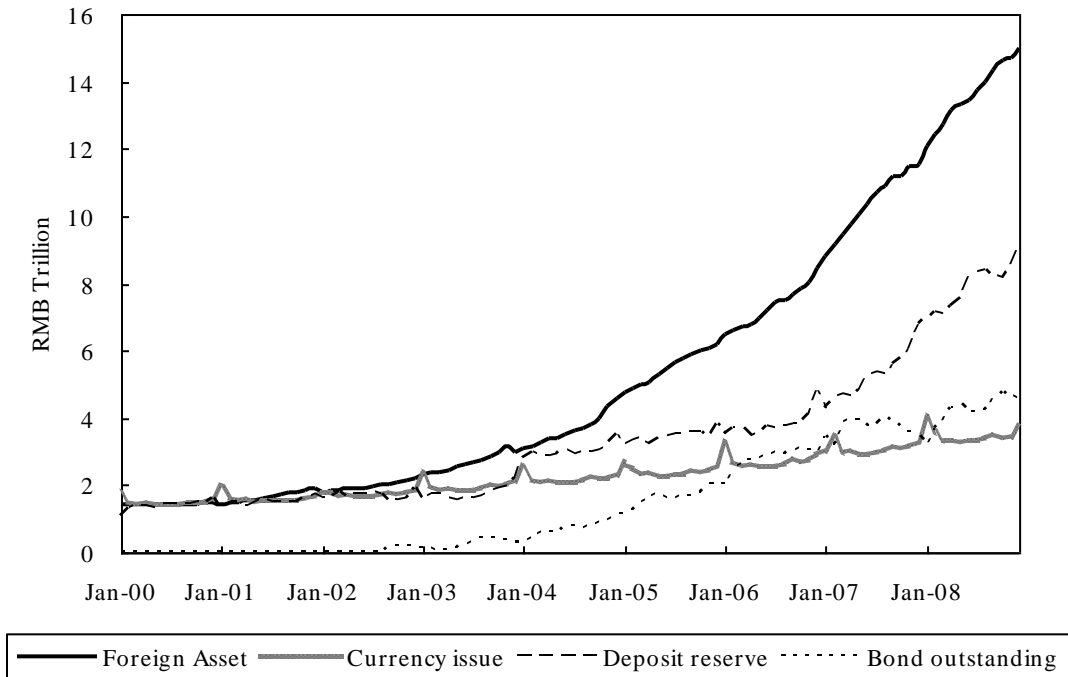
correspond to an increase in liabilities for the same amount, therefore high-power money supply will increase, unless sterilizing operations are undertaken, i.e., the central bank sells its other assets or rises certain kind of its liability other than currency to absorb the impact.

The two major instruments intensively used by PBoC to sterilize capital inflows are open market operations and deposit reserve requirement.

- Open market operations: Since 2002 PBoC issues and trades short-term and mid-term notes to absorb capital inflows into the economy. Interest rates on these notes largely depend on the short-term market interest rate. Maturity is usually less than a year, but when the need for sterilization is urgent PBoC will issue 3-year mid-term notes.
- Deposit reserve requirement: Starting in 2006, PBoC began to use deposit reserve requirement ratio (RRR) as a policy instrument. It raises RRR in small steps (usually by 0.5 percent each time) to slow down broad money expansion. Reserve requirement ratio was initially 6 percent in 2006 and peaked 17.5 percent in July 2008. In the following months PBoC began to lower the rate due to the economic downturn. By December the reserve requirement ratio was 16 percent, still well above international standards.

Figure 3 shows how these two policies are used to absorb capital inflows. Volume of PBoC-issued notes keeps increasing since 2002 but the speed did not catch up with that of international reserves after 2007. Instead, deposit reserves rose dramatically for the recent two years to match the accelerating capital inflows. As a result of these operations, currency issue remained to grow quite stable.

Figure 3: Sterilizing capital inflows



Besides sterilization operations, PBoC also needs to deal with internal credit markets in order to adjust broad money supply and to fight inflation. This is achieved by adjusting interest rates and sometimes setting loan caps to commercial banks.

- Interest rate: PBoC maintains strong control over interest rates in China. It sets price caps on deposit interest rates, and price floors on loan rates. Commercial banks in China always set their deposit rates at the price cap to compete for depositors. The situation of loan rates is more complicated. Usually large enterprises can acquire loans at the floor interest rate, but it may not be the case for small business or individual borrowers.
- Loan volume caps: when the threat of inflation became harsh, PBoC might directly intervene on commercial bank's loan making. For instance, it was widely reported in 2008 that PBoC set caps for each individual bank on how much new loans they could make for that year. PBoC does not publicly announce these numbers, nor do we have sufficient evidence to indicate that PBoC implemented this policy every year (or at least the restriction is not

binding for every year).

Most of these policy instruments implemented by PBoC creates distortions that may lower efficiency of the financial market. High deposit reserve requirement ratio hurts the profitability of commercial banks by freezing a portion of their assets. Frequent adjustment to deposit reserve requirement ratio may lead to extra costs as commercial banks may have to keep extra cash in hand to respond to ratio adjustments. Deposit and loan interest rate controls prevents the market price to adjust according to supply and demands. The only exception is notes issuing and trading. The question is: why would PBoC prefer to use all these market-distorting instruments, rather than sticking to open market operations?

Historically, PBoC kept deposit and loan rates low so that state-owned enterprises are subsidized by receiving loans from banks, which are also state-owned (Gordon and Li, 2003). But now the number of state-owned enterprises has significantly reduced, and most banks have become publicly listed companies that seek to maximize its stock value rather than providing cheap credit to state-owned enterprises. What's the motivation now for PBoC to maintain all these interventions? We will show in the next section that one possible reason may be that PBoC have to do so to keep the cost of its monetary operations low.

3 Financial strength of PBoC and the cost of monetary policy instruments

We estimate the cost of PBoC monetary policy instruments by two steps. The first step is to find out PBoC's periodical gains/losses from its all operations. However, PBoC do not report its income statement to the public. Alternatively, we back out the monthly profit of PBoC from its balance sheet, which is updated every month by PBoC in its statistics release. In the second step we estimate the costs of the three major instruments - deposit reserve requirement ratio, central bank note issue and

deposit interest rate - through linear regressions.

Before going into the estimation method and results, it's important first to clarify the reasons for using such a two-step estimation procedure. A simple yet widely accepted method to obtain sterilization cost is simply to estimate the interest rate premium of domestic assets over foreign assets (see, Kletzer and Spiegel (2004), for example). However, whether this method is applicable to China remains in question, because yield on domestic assets in China largely depends on the deposit interest rate which is also set by PBoC. The two-step method allows us to endogenize deposit interest rate as a policy variable and estimate the cost associated with it. Moreover, the profit itself provides extra information: we are interested in whether PBoC is able to cover the sterilization costs by its own seignorage income. The closer PBoC approaches zero or negative profit, the less power it has on further sterilization operations.

3.1 Estimating profit of PBoC

The estimation of PBoC's profit is based on its balance sheet. PBoC began to publicly report its balance sheet monthly in December 1999. International reserve became a concern only after China joined WTO in 2001, so the available data perfectly covers this period.

On its balance sheet, PBoC presented its assets and liabilities in categories. Profit is obtained by summing up the estimated gains/losses on each category of assets then subtracting holding costs of each category of liabilities. Details of the estimation procedure are presented in Appendix. Several treatments in estimating the gains/losses are non-trivial thus are worth mentioning here:

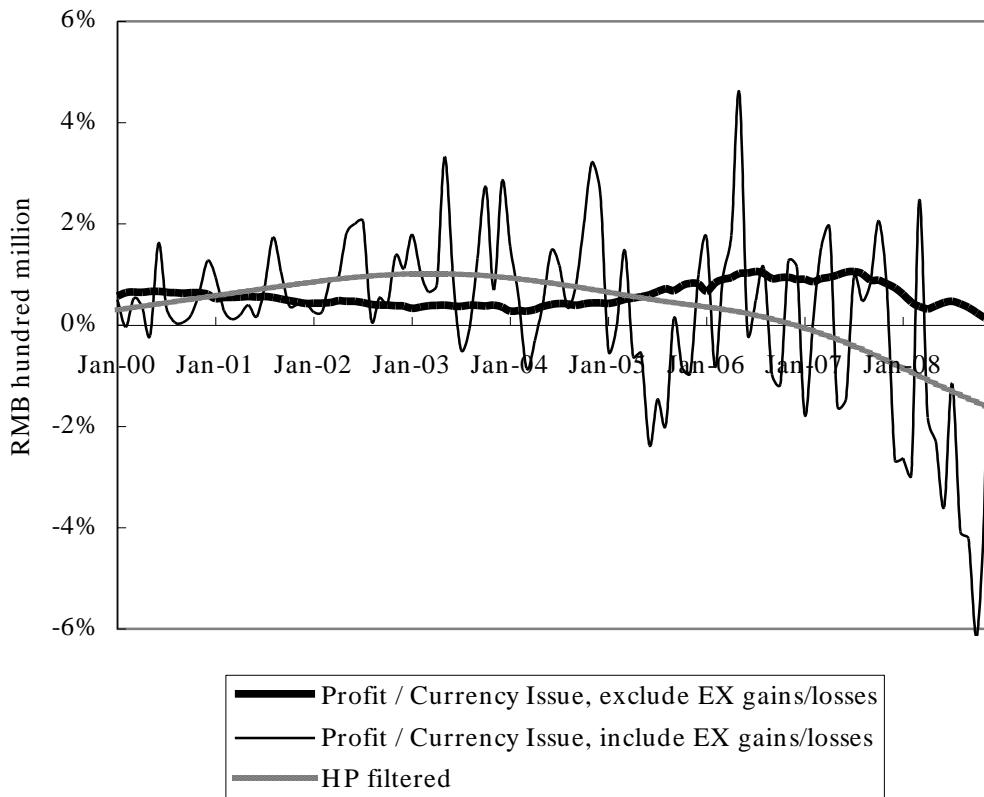
- No public information is available about the composition of international reserves. Instead, we use quarterly international reserves composition of all countries from IMF Currency Composition of Official Foreign Exchange

Reserves (COFER) database as an approximation. We only take into account assets nominated in US dollars, Euros and Japanese Yens. This approximation is consistent with other direct estimations of China's international reserve compositions by Zhao (2005) and Liu (2008). Yield on these assets is approximated by ten-year government bonds issued by the corresponding national government (for Euro asset, it's an average of bond of several national governments in Euro area).

- PBoC does not book the gains/losses of international reserves caused by exchange rates fluctuations, so we use international reserve data published by SAFE to calculate yields. Since PBoC takes such an accounting method on balance sheets, it is not likely to book exchange rate gains/losses on their income statement either. For this reason we consider exchange rate gains/losses separately from interest gains/losses. Two estimations are given, one takes exchange rate gains/losses into account while the other don't.
- Administrative and operational costs of PBoC is not available and thus is not subtracted from estimated profit. these costs are usually quite stable and unlikely to vary with monetary policy changes. Since our purpose is to see how PBoC's monetary policy will affect its profit, ignoring these costs will only bring minimal distortion to our results.

Figure 4 shows the result of our estimation, one line is PBoC monthly profit without exchange rate effect and the other is with it. Both series have been normalized by currency issue. If we do not take into account exchange rate gains/losses, PBoC have achieved positive profit in every month of the eight years. On average PBoC obtained about 0.55 percent of monthly profit over currency issue, or 6.6 percent per year. Profitability varies from time to time: in the most profitable year 2006 it was 11 percent of currency issue, while in 2008 the number falls down to 4 percent.

Figure 4: Estimated monthly profit of PBoC



Including exchange rate gains/losses completely alter the pattern. Before 2005 Chinese Yuan hard-pegged US Dollars at an exchange rate of 8.28. In August 2005 PBoC announced an instant 3 percent appreciation against US Dollars and adopted a crawling peg regime since then. Profit presents greater fluctuations when exchange rate gains/losses are included. The trend component of it, obtained through an HP filter, is continuously declining since 2003. The trend reveals that on average PBoC has been running with negative profit since 2007.

3.2 Estimating the cost of PBoC's monetary policy

3.2.1 Equation and Variables

We estimate the following equation:

$$Profit_t = \alpha_1 depr_t + \alpha_2 rrr_t + \alpha_3 note_t + \gamma_1 depr_t \cdot note_t + \beta \mathbf{X}_t + \delta_t$$

On the left hand side is PBC's monthly net profit over currency issue. On the left hand side are PBC's three major monetary policy instruments: $depr_t$, benchmark one-year deposit rate; rrr_t , reserve requirement ratio; and $note_t$, the volume of outstanding PBC issued notes divided by reserve money. We are also interested in the cross term of deposit rate and note outstanding volume. Controlling variables \mathbf{X}_t are listed in Table 3. The regression is run on monthly data from January 2000 to December 2008.

Table 3: Variables

Variable name	Description	Data source
$Profit_1$	PBC's net profit / currency issue	Calculated
$Profit_2$	(PBC's net profit + exchange gains/losses) / currency issue	Calculated
$depr$	benchmark one-year deposit rate	PBC
rrr	reserve requirement ratio	PBC
$note$	outstanding PBC issued notes / currency issue	PBC
$forex$	foreign reserve asset / total asset	PBC
$usexr$	USD / CNY exchange rate	SAFE
$jpexr$	JPY / USD exchange rate	IMF
$euexr$	EUR / USD exchange rate	IMF
$usyield$	US ten-year government bond yield rate	US Treasury
$jpyield$	Japan ten-year government bond yield rate	BoJ
$euyield$	Euro ten-year government bond yield rate	ECB
d_float	Dummy variable for float exchange rate	

Table 4: Unit root tests

Variable name	Stable?	1st difference stable?
<i>Profit</i> ₁	N	Y
<i>Profit</i> ₂	Y	Y
<i>depr</i>	Y	Y
<i>rrr</i>	N	Y
<i>note</i>	N	Y
<i>forex</i>	N	Y
<i>usexr</i>	N	Y
<i>jpexr</i>	N	Y
<i>euexr</i>	N	Y
<i>usyield</i>	N	Y
<i>jpyield</i>	N	Y
<i>euyield</i>	N	Y

3.2.2 Regression Estimation

We ran OLS regressions over the whole sample period with different dependent variables: the first includes exchange rate effects and the second doesn't. Each dependent and independent variables is first-order differentiated to assure that it does not have a unit root when it enters the regression equation. The White Heteroskedasticity-consistent Estimator is used to obtain robust significance intervals. Estimation results are presented in Table 5.

Table 5: Estimation of Regression Coefficients

Variables	1. Include exchange rate gains & losses	2. no exchange rate gains & losses	3. regression 2 corrected for serial correlation
Monetary policy variables			
benchmark deposit rate	-4.981** (-2.000)	0.071 (1.058)	0.059 (1.193)
deposit reserve requirement ratio	-0.581 (-0.962)	0.004 (0.220)	0.017 (1.430)
PBoC notes / currency	-0.052 (-0.826)	0.003* (1.800)	0.004*** (2.794)
cross term of <i>depr</i> and <i>note</i>	0.955 (0.185)	-0.294* (-1.841)	-0.269** (-2.455)
Controlling Variables			
US 10-year bond yield	0.435 (0.793)	0.052** (3.532)	0.055*** (4.289)
Japan 10-year bond yield	-0.037 (-0.030)	0.000 (-0.017)	-0.026 (-0.961)
EU 10-year bond yield	-0.090 (-0.099)	0.080** (2.904)	0.056** (2.336)
USD / CNY exchange rate	0.155* (1.936)		
JPY / USD exchange rate	20.880** (2.493)		
EUR / USD exchange rate	0.301*** (5.410)		
foreign reserve / currency	0.015 (0.778)	0.001 (1.157)	2.22e-4 (0.383)
dummy: float exchange rate	0.008** (2.234)	0.000** (-2.089)	-1.81e-4 (-1.439)
Intercept	-0.001 (-0.606)	0.000 (-1.110)	2.46e-5 (0.290)
lag error term			0.454*** (4.795)
Adjusted R-squared	0.50	0.41	0.53
Durbin-Watson stat	2.01	1.14	2.11

Note: t-statistic in parentheses. *, **, *** indicates significance level at 10%, 5% and 1%, respectively.

The discussion concerning the cost of PBoC's monetary policy is based on the above regression results. Benchmark 1-year deposit interest rate: deposit rate itself is not significant in the second equation, but its cross term with note issue is significant. This means raising deposit rate do brings cost to PBoC since it then have to pay higher interest rate on its central bank notes. In the first equation, however, the coefficient is negative and strongly significant. CNY will appreciate against other currencies as return on CNY assets increase. Our result shows that other variables being controlled; raising deposit interest rate by 1 percent will cause PBoC profit over currency to drop by as much as 5 percent.

Reserve requirement ratio *rrr* is not statistically significant in either of the two regressions. We can interpret that the cost to PBoC of raising reserve requirement ratio seems to be minimal. Although PBoC do pay interest to commercial banks on deposit reserves, this cost is not significant compared to other policy instruments. But commercial banks might have lost their operating efficiency as reserve requirement rises. In other words, PBoC might have shifted the cost of sterilization to commercial banks by raising reserve requirement.

It might be suspicious to see a positive coefficient on Central bank notes issue, *note*, at the first glance, but one shall align the coefficients of both *note* itself and its interaction term with deposit interest rate to get the whole picture. Estimation result shows that deposit rate of about 1 percent is the break-even point. When deposit rate is below 1 percent, issuing notes even brings profit to PBoC, but when deposit rate is above 1 percent, interest payments become a burden to PBoC. Note that 1 percent here might not be a precise estimate; nonetheless, the effect that cost of note issue rises when deposit rate is high do seem to be robust.

Implications of these results will be further developed in the next section.

4 Is China's current central banking regime sustainable?

The past one two decades saw deepening understandings over the “art and science” of central banking in the economics literature (Feldstein, 2006). Central bankers and monetary economists reached wide consensus over several key issues in conducting monetary policy: long-term goal of price stability, independent monetary authority, and credibility of policy commitments, to name a few.

However, the financial strength of a central bank - how much capital it owns, the allocation and quality of its assets, and especially how much profit it makes - is seldom mentioned in the literature. Most works in this field simply do not take into account central bank's financial strength. They do have reasons doing so. The usual arguments are as follows:

- The main function of a central bank is to ensure moderate money and credit environment for the economy. Profitability should be off the priority concern of central bankers.
- With its monopolistic power in money creation, central banks are usually making profits sufficiently large enough to cover their expenses.
- Should a central bank incur negative profit during extreme economic conditions, these losses shall nonetheless be covered by the government.

In short, financial strength of central banks did not seem to be a problem historically, and central banks should not care about their profitability when making policy decisions.

But the healthiness of central bank balance sheet does seem to be an issue in real world central banking, especially for emerging countries. Central banks of a group of Latin American countries were continuously losing money in 1987-2001 which in turn undermined their monetary and exchange rate policy (Stella, 2002). Unhealthy balance sheet of the central bank is considered to be one of the major cause why some countries have suffered more from the Asian Financial Crisis. Even

well-industrialized countries are not exempt from financial strength problems. For example, Bank of Japan has continued to express concern about potential capital losses from its large holdings of Japanese government bonds (Cargill, 2005).

Ize (2005) and Stella (2005) provided alternative perspectives on central bank financial strength. They both argued that, although a central bank never needs to default on its liabilities, it would have to print more fiat money to meet the need to pay back them should it not be able to generate sufficient gains from its assets. Therefore, a central bank cannot credibly attain a nominal policy objective without the support of its financial strength. A keep-losing-money central bank will be forced to deviate from providing planned money supply thus unable to keep a stable price level. Another choice is to turn to the government for fiscal assistance, but it largely depends on the government's fiscal strength and willingness to help out. Also, central bank loses some extent of its independence by doing so.

Excluding currency revaluation effect, so far PBoC is not losing money. At the same time PBoC have managed to control inflation, with only limited help from the government. According to Chinese law, should PBoC run under deficit, central government should undertake such losses by fiscal net transfer. Since PBoC is not losing money according to our estimation, it is not likely that such transfers had occurred in the past. In fact it is more likely the case that PBoC is transferring its profit to its owner, the central government⁴. It seems PBoC has gone a third way - with the help of a repressed domestic financial market.

PBoC's control on interest rates, especially the cap set on deposit interest rate, is the first component of PBoC's strategy against rising sterilization cost. Compared to China's 8 to 10 percent annual real GDP growth rate, average one-year nominal deposit interest rate was 2.5 percent during 2000-2008. Even in early 2008 when CPI growth rate peaked above 6 percent, deposit rate remained just above 4 percent.

⁴ It should be noted that the Chinese government have provided help recently. In 2007 It replaced 200 billion of international reserves by government bonds and used these reserves to set up the the China Investment Corp. After the transaction PBoC receives stable and relatively high yield from government bonds while government takes the risk of foreign investment.

Historically PBoC used to take interest rate as its priority policy instrument against inflation. For example, in year 1994 PBoC pushed up one-year deposit rate to above 10 percent to pull back inflation. At that time China was more of a closed economy with international reserves no more than 52 billion US Dollars. Now with 50 times more international reserves, PBoC have to hold deposit rate low so that it can pay low interest rate on central bank notes as well as deposit reserves. Sterilization thus becomes much less costly.

The second component is deposit reserve requirement ratio. Reserve requirement for commercial banks have almost fallen into the financial history in contemporary well developed financial markets after several decades of financial innovations. But in China, two important factors has made requirement ratio still a powerful tool. First, traditional deposit-loan business still constitutes a major portion of financing activities in China. Other financing channels, especially corporate bond markets, remains underdeveloped. Second, under depressed deposit rate, profit margin widens for commercial banks, and so PBoC can raise reserve requirement ratio to more than 15 percent while commercial bank business is still profitable.

There's a hidden assumption lying in all the discussions above: that PBoC cannot freely adjust the exchange rate. Surely, if PBoC could allow exchange rate to accommodate freely to the foreign exchange market, it wouldn't have accumulated so much international reserves and sterilization would never have been a problem at all. Interestingly, China do have a quite flexible foreign exchange market before 1994. That the decision making process of the authority remains unclear but China shifted to a fixed exchange rate in 1994. Exchange rate flexibility remained low since then.

After all, real exchange rate of China against other country will have to appreciate according to the Balassa-Samuelson effect. However, the more foreign asset has accumulated in the form of international reserves, the more reluctant the authority will be to let exchange rate to free flow as more losses will come with appreciation of home currency. Holding nominal exchange rate constant, the real

exchange rate appreciation will thus result in inflationary pressure, but this pressure has been successfully held back by PBoC's monetary policy through depressed interest rate and high reserve requirements. It remains in question how long PBoC can continue to provide stable money supply in this way. But, if the growth of international reserves continue to exceed growth of currency supply (which increases the need for sterilization, and if the Chinese financial markets continue to innovate) which constraints PBoC's ability to control sterilization cost, it's only a matter of time before this becomes an implausible task

5 Concluding Remarks

In this paper we have investigated the current monetary policy regime of the Chinese central bank, People's Bank of China, from the specific viewpoint of PBoC's financial strength and the cost of its monetary policy instruments.

How to maintain price stability under the circumstance of large foreign capital inflows from growing current account surpluses have become the main issue for China's monetary policy in the most recent decade. According to our findings, on the whole PBoC has successfully minimized the shock of foreign capital to money supply. However, this was achieved by holding interest rate at a relatively low level, sharply rising reserve requirement ratio, and sometimes even by direct intervention on the volume of loans made by commercial banks. Only as such was PBoC able to maintain the cost of its sterilization operations at a low level. In other words, capability of Chinese authority carrying out current monetary policy is based on the repressed domestic financial markets.

Identifying the most appropriate monetary policy in an increasingly integrated global economy is not an easy task for a developing-country central bank. It is not the purpose of this paper to answer whether China has adopted proper monetary policy for the last few years. To make such judgment one need to thoroughly

understand each of the potential policy options and its outcomes, for that purposes our findings is far from sufficient.

But, more importantly, from our results one can see more clearly the connection between China's monetary policy and its financial market structure, and the trade-off between sterilization cost and financial market efficiency faced by Chinese monetary authority. As long as China's trade surplus and foreign capital inflows persist, it is likely that this trade-off will continue to play an important role in China's future monetary policy.

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Appendix: Estimation of People's Bank of China's Profit

Estimates of PBoC profit is based on its balance sheet.

Proportional Balance sheet from Dec. 1999 to Dec.2008							
ASSETS	max	min	mean	LIABILITIES	max	min	mean
Foreign Assets	78.5%	36.9%	56.2%	Reserve money	93.7%	53.5%	73.2%
Foreign Exchange	72.2%	35.4%	53.9%	Currency issue	50.3%	16.7%	30.2%
Monetary Gold	0.7%	0.0%	0.3%	Deposit of financial institutions	47.1%	29.3%	37.0%
Other Foreign Assets	7.7%	0.4%	2.0%	Deposit money banks	46.9%	29.0%	36.5%
Claims on Government	9.6%	1.9%	4.9%	Special depositor institutions	0.7%	0.2%	0.4%
Of which: Central Government	9.6%	0.0%	3.7%	Other financial institutions	0.4%	0.0%	0.1%
Claims on Depository Money Banks	42.8%	3.8%	15.5%	Deposits of non-financial institutions	15.6%	0.1%	6.0%
Claims on specific depository institutions	5.8%	0.9%	3.1%	Demand deposits	0.2%	0.1%	0.2%
Claims on other financial institutions	23.1%	5.7%	14.1%	Saving deposits	15.4%	0.0%	9.6%
Claims on non-financial institutions	0.5%	0.0%	0.2%	Bond issue	27.8%	0.0%	14.4%
Other assets	15.1%	-0.1%	7.8%	Foreign liabilities	1.1%	0.4%	0.7%
				Deposits of government	14.8%	5.0%	10.2%
				Of which: Central government	7.7%	1.9%	4.9%
				Own capital	1.1%	0.1%	0.4%
				Other liabilities	11.1%	0.3%	5.0%
TOTAL ASSETS	100%	100%	100%	TOTAL LIABILITIES	100%	100%	100%

On the asset side, we estimated the return of 6 items, which includes “foreign exchange”, “other foreign assets”, “claims on government”, “claims on depository money banks”, “claim on other financial institutions”, and leaving out “monetary gold”, “claim on non-financial institutions”, “other assets”. We leave out the latter 3 items because all of their return rates are difficult to obtain, plus “monetary gold” and “claim on non-financial institutions” only takes a very small portion (0.5%) of total assets. On average, 91.8% of total asset is included in the 6 items.

On the liability side, we included 4 items into our estimation, which are “currency issue”, “deposit of financial institutions”, “bond issue” and “deposits of government”. The 4 items on average covers 89.1% of total liabilities. The other 4 liability items are “deposit of non-financial institutions”, “foreign liabilities”, “own capital”, and “other liabilities”. The reason why we left those 4 items is still due to lack of access to return data, and the 2 items “foreign liabilities”, “own capital” only occupy 1% of total liabilities.

Selected Proportional Balance sheet from Dec. 1999 to Dec.2008

ASSETS	max	min	mean	LIABILITIES	max	min	mean
Foreign Exchange	72.2%	35.4%	53.9%	Currency issue	50.3%	16.7%	30.2%
Other Foreign Assets	7.7%	0.4%	2.0%	Deposit of financial institutions	47.1%	29.3%	37.0%
Claims on Government	9.6%	1.9%	4.9%	Deposits of non-financial institutic	15.6%	0.1%	6.0%
Claims on Depository Money Banks	42.8%	3.8%	15.5%	Bond issue	27.8%	0.0%	14.4%
Claims on specific depository institu	5.8%	0.9%	3.1%	Deposits of government	14.8%	5.0%	10.2%
Claims on other financial institutions	23.1%	5.7%	14.1%				
TOTAL ASSETS	100%	84%	92%	TOTAL LIABILITIES	97%	75%	89%

Return on foreign exchange and other foreign assets

We should be aware of the fact that the foreign exchange on PBoC's balance sheet is recorded using the historical cost method. As a result, the value of foreign exchange will not change with the exchange rate. Instead, we use data from State Administration of Foreign Exchange (SAFE), which is recorded with its fair value in USD, to estimate the return of foreign reserve. Both foreign exchange and other foreign assets are published by SAFE .

The return rate of foreign exchange in China remains a mystery to the public. Neither of the return and component of foreign exchange is made publicly available by the Chinese government and, hence we can only get an estimation of foreign exchange returns. Several assumptions apply: first, we assume that the structure of China's foreign reserve is the same as IMF statistics, which mainly consists of three parts: US dollar denominated asset, Euro denominated asset, and Japanese Yen denominated asset; second, we adopted 10 year government bond yield of each country to be the yield of each country's currency denominated assets. Counting into the effect of changing exchange rate of Euro/USD and JPY/USD, the weighted average return is the total foreign exchange return.

Return on claim on government

The item "claim on government" means that central banks directly purchased the national debt. Most of the time, central banks are prohibited from buying national debt because it will increase money supply. In China's case, this only happened twice in history, which is the issue of 270 billion special national debt in 1998, and 1350 billion in 2007. Both issuances are to help state owned banks out of their

enormous non-performing loans. Both debts have only one purchaser: PBC. The interest rates are 7.2%, and 4.3% respectively. Data from PBC's balance sheet is in line with it. From December 1999 to July 2007, "claim on government" maintain a stable level of under 300 billion RMB. In August 2007, this data changed dramatically to about 880 billion; then in December 2007, it increased to 1630 billion, and never changed much hereafter.

Based on the above information, we can easily identify the interest return of "claim on government". Before July 2007, there is a constant return rate of 7.2%; then, after July 2007, in each month's "claim on government", 283 billion is receiving 7.2% interest rate, and the remaining part receives 4.3% interest rate.

Return of "claim on deposit money banks" & "Claims on specific depository institution"

"Deposit money banks" in China includes: policy banks, joint stock banks, commercial banks, credit cooperatives, foreign banks, postal saving banks, finance companies. "Specific depository institutions" includes: National Development Bank, The Export-Import Bank of China, trust and investment companies, and financial leasing companies. "Claim on deposit money banks" and "claim on specific depository institution" mean the re-lending from central bank to those financial institutions.

Interest rate of loan from PBC to financial institutions							
adjusting time	one year	six months	three months	20 days	average	max	min
1996.05.01	11.0	10.2	10.1	9.0	10.0	11.0	9.0
1996.08.23	10.6	10.2	9.7	9.0	9.8	10.6	9.0
1997.10.23	9.4	9.1	8.8	8.6	9.0	9.4	8.6
1998.03.21	7.9	7.0	6.8	6.4	7.2	7.9	6.4
1998.07.01	5.7	5.6	5.5	5.2	5.4	5.7	5.2
1998.12.07	5.1	5.0	4.9	4.6	4.9	5.1	4.6
1999.06.10	3.8	3.7	3.5	3.2	3.5	3.8	3.2
2002.02.21	3.2	3.2	3.0	2.7	3.0	3.2	2.7
2004.03.25	3.9	3.8	3.6	3.3	3.6	3.9	3.3
2008.01.01	4.7	4.6	4.4	4.1	4.4	4.7	4.1
2008.11.27	3.6	3.5	3.3	3.1	3.3	3.6	3.1
2008.12.23	3.3	3.2	3.1	2.8	3.1	3.3	2.8

From PBoC, we can find interest rates of PBoC re-lending, which have 4 different

types because of different time span. Since we can not know the exact structure of PBoC re-lending, we assume all loans have the same life span somewhere between three month and six months. So we take the average of the four interest rates. It is viable because each year, the 20 days interest rates are only 0.54% lower than one year interest rates. And since the life span and interest rate of all re-lending are the same, we can just multiply claim on both financial institutions to the average interest rate.

Claims on other financial institution

“Other financial institutions” means the financial institutions except deposit money banks, specific deposit institutions, and the central bank. It mainly includes insurance companies, security investment companies, fund management companies, pension funds, asset management companies, security companies, futures companies, stock exchange and future exchange, etc.

For this item in PBoC balance sheet, it is mainly the loan that PBoC give to the Four asset management companies to purchase commercial banks’ non-performing loan. According to Huarong Asset Management Company’s website (Huarong is one of the Four asset management companies), the interest rate they pay to PBC on this loan is only 2.25%. We confirmed that all the loan PBoC gives to Four asset management companies receive 2.25% interest rate.

Currency issue

This item will not cause any interest expenditures.

Deposit of financial institutions

This item “deposit of financial institutions” is mainly the statutory reserve and excess reserve that financial institutions have been deposited in central bank. So their returns are the interest rates PBoC pay on statutory reserve and excess reserve, both of which are available on PBoC’s website. However, there is another problem that we don’t know how much proportion each kind occupies.

Given legal reserve rate and RMB deposit, we can calculate the total statutory

reserve money. Then use “deposit of financial institutions” minus the calculated total statutory reserve money, we can get excess reserve money.

Interest rate of reserve					
adjusting time	legal reseve	excess reserve	adjusting time	legal reseve	excess reserve
1996.05.01	8.82	8.82	1999.06.10	2.07	2.07
1996.08.23	8.28	7.92	2002.02.21	1.89	1.89
1997.10.23	7.56	7.02	2003.12.21		1.62
1998.03.21	5.22	5.22	2005.03.17		0.99
1998.07.01	3.51	3.51	2008.11.27	1.62	0.72
1998.12.07	3.24	3.24			

Using the interest rate on PBoC’s website and the estimated legal reserve/excess reserve ratio, we can get the return on “deposit of financial institutions”.

Bond Issue

From Wind data base, we downloaded the detailed information on the PBoC issued bond, which included the circulation, issue day, due day, and interest rates. We assume that if a bond is issued before the middle of a month or due after the end of this month, this bond is considered circulating on the market this month. Adding up all the circulating PBoC bonds and the total annual interest payment each month, we can get each month’s weighted average interest rate on PBoC bonds.

Deposits of Government

“Deposits of government” are the fiscal income of government deposited in the central bank. Materials show that this deposit makes a current account interest rate.