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The persistence of strong money supply growth in China: the forces of endogenous determinants

Abstract

The money supply in China has experienced a persistent strong growth in recent decade. This persistent strong long-term money supply growth has been determined by economic fundamentals through their impacts on the changing money multiplier and money base. The long-term money supply growth in China has thus been endogenous. Monetary authority through using conventional monetary policy instruments could hardly alter its growth path. Various monetary policy such as adjusting reserve requirement ratio and issuing central bank bill and notes have been short-term measures instead of long-term monetary targeting. The ability of using monetary policies by the Chinese monetary authority in achieving macroeconomic goals such as inflation targeting is limited.

Keywords: endogenous money supply, money multiplier, money base, reserve requirement ratio, k-ratio, excess reserve ratio, foreign exchange reserve, PBC's bill and note.
JEL Classification: E40.

Introduction

The Chinese economy achieved an average GDP growth rate of about 9.5% over the period of 1999-2010. The average inflation rate measured by CPI was merely about 1% over this period. The average growth rate of broad money measured by M2 was close to 17%. The much higher growth rate of money supply over the GDP growth rate and the moderate inflation imply the persistent pressure for higher expected inflation and thus economic overheating. The Chinese monetary authority has been quite cautious on the potential economic overheating since as early as 2002. Various measures have been taken from then in containing the strong economic growth, particularly the investment in industries such as real estate development, iron and steel, cement, coal and electricity. Among these measures, the conventional monetary policy instruments such as open market operation and change of required reserve ratios and unconventional monetary policy measures such as the issue of central bank bill and note and administrative window operation have been frequently and intensively used. For example, the People's Bank of China (PBC), the central bank in China, took the very tough measurement by raising the required reserve ratio more than 20 times from 8.5% in the beginning of 2007 to 21% in the middle of 2010, aiming at reducing the money multiplier and hence slowing down the money supply generation. However, the momentum of strong money supply growth still remains. Such failure in controlling the money supply growth seems to suggest that the determinants of money supply have become variables, which are increasingly beyond the control of the China's monetary authority in the evolving China's financial system.

Having faced the impact of global financial crisis in the late 2008, the Chinese government initiated an aggressive stimulus of 4 trillion RMB yuan investment package, aiming at achieving a target 8% of GDP growth rate by providing more investment funds to strategic industries such as automobile industry and urban infrastructure. The monetary tightening policy implemented in the early 2008 by the central monetary authority had thus been slightly reversed. The reserve requirement ratio was reduced from 17.5% to 15% and banks were allowed to provide loans to real estate developers that were basically frozen in the early 2008. The response of the China's financial system to the government initiative was surprisingly dramatic and eventually overreacted in a very short period. In the first half of 2009, the newly increased bank loans amounted to 7.36 trillion RMB yuan almost doubled the total projected rescue investment package of 4 trillion RMB yuan! While the China's financial system demonstrated again its dramatic endogenous capacity of money supply generation, the central monetary authority has to shoot up the reserve requirement ratios in 2010 after the monetary easing policy only implemented for less than two years. But this recent monetary policy adjustment hasn't fundamentally changed China's long-term strong monetary growth path and moreover has almost quickly lead to growing pressures from business society crying for the monetary easing policy.

This paper aims at verifying the behavior of money supply in China in the recent decade and explaining why the money supply in China has become endogenous through examining the features of various economic determinants of both money multiplier and money base. Through this analysis, this paper intends to establish and prove the assertion that the China's money supply has followed a persistent strong long-term growth path which has been decided by the China's economic growth model featured from strong growth in GDP, net export, for-

eign exchange earnings and savings and the increasing modernization of financial and banking systems. The Chinese monetary authority could hardly take consistent monetary policy initiatives in containing the persistent strong money supply growth but instead has been seemly forced to follow such trend from time to time through adjusting its monetary policies.

There have been considerable studies on money demand in China (Anne-Laure Delatte and et al., 2011; Mohsen Bahmani-Oskooee and Yongqing Wang, 2007; Tuuli Koivu and et al., 2008). But the studies focused on money supply and money supply mechanism in China have been quite limited although some studies have related the money supply in China to other economic issues such as inflation (Chang, Chih-Hsiang and et al., 2009). Hence, this paper also aims at providing a systematic analysis on money supply and money supply mechanism in China. It is fundamentally important to understand the development of China's

banking and financial system and the monetary policy from both money demand and money supply.

The paper is organized as follows. The persistent long-term money supply growth in China will be verified, secondly, the economic determinants of money multiplier will be examined; thirdly, the economic determinants of money base will be analyzed, finally conclusion and policy implication will be made.

1. The persistent strong long-term money supply growth in China

Before going to the assessment of various determinants of money supply, it is worthwhile having a basic understanding on the persistence of strong money supply growth in China in recent decade. Figure 1 shows the monthly money supply, measured in broad money M2, and the monthly reserve requirement ratios in the period of 1999-2010. One can easily notify the key feature of the money supply growth in China: a persistent long-term growth trend.
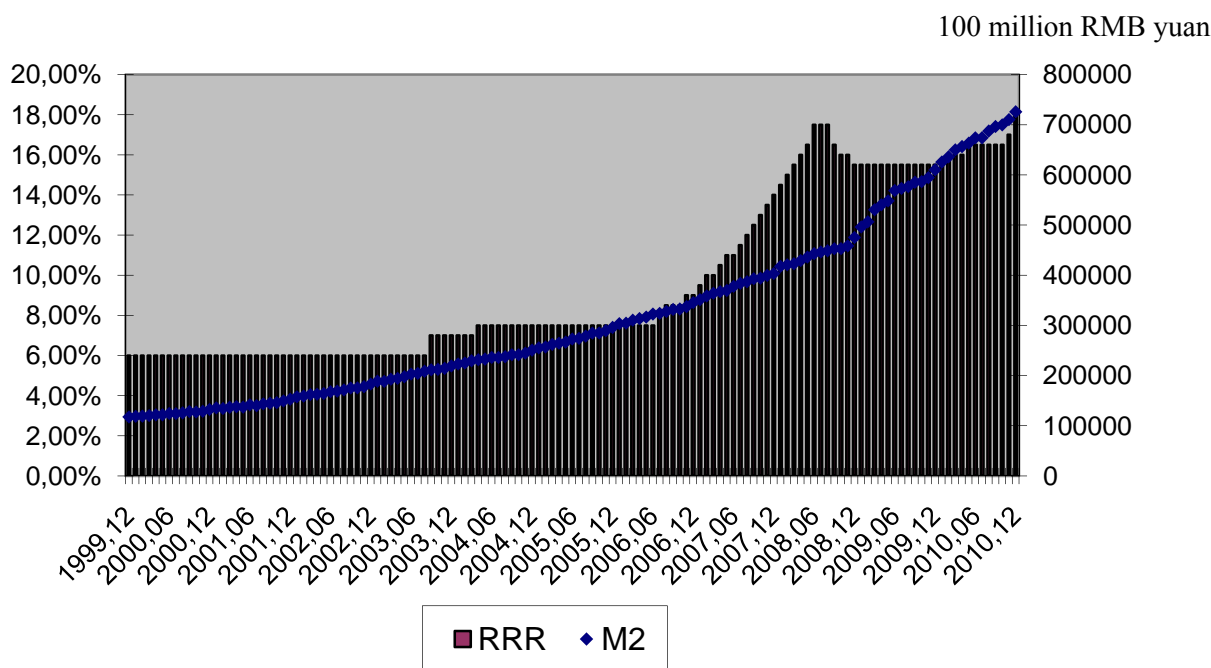
Source: Derived from data in "The People's Bank of China, Financial Statistics", various years.

Fig. 1. Monthly money supply (M2) and reserve requirement ratio (RRR) in China: December 1999-December 2010

Two simply deterministic time trend models, namely, the liner trend model and the autoregressive trend model have been done by using the monthly data from December 1999 to December 2010 to confirm such linear money supply growth trend. The estimated results, shown in equations (1) and (2), are of great relevance, as the estimated coefficients are well determined.

The log-linear trend model:

$$\text{Log}\,(M2) = 11.616 + 0.0139\,t \qquad (1)$$
$$(2317.943)\quad(211.194)$$

$$R^2 = 0.998 \qquad DW = 0.118.$$

The autoregressive trend model:

$$M2_t = -1420.476 + 1.0199\,M2_{t-1} \qquad (2)$$
$$(-0.6110)\quad(156.321)$$

$$R^2 = 0.995 \qquad DW = 2.101,$$

where t is the time trend with t-ratios in parenthesis. The monthly data from December 1999 to December 2010 and totally 133 observations are used in the regression.

It should be particularly pointed out that the estimated coefficient for the constant term in the autoregressive model is statistically insignificant and the estimated coefficient for the lagged M2 is statistical-

ly significant and close to 1. As such, the estimated M2 is to have a nearly linear trend. Thus the estimated autoregressive trend model and the linear time trend model actually converge to the similar estimated time trend (Pindyck and Rubinfeld, 1991). The forecasted M2 from the two models presented in Figure 2 just shows such perfect convergence.

100 million RMB yuan
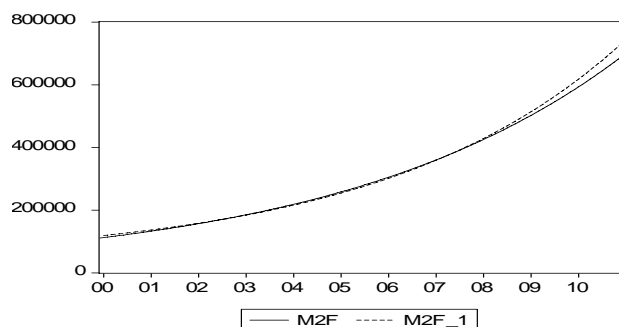
Notes: M2F is the M2 forecast from the log-linear trend model, M2F_1 is the M2 forecast from the autoregressive trend model.

Fig. 2. The forecasted M2 from the two deterministic trend models: December 2000-December 2010

Against this persistent money supply growth trend, the monthly reserve requirement ratios (RRR) shown in Figure 1 follow a quite different path. It was kept stable before 2003 but, since then, pushed up dramatically until the end of 2008 when the Chinese government tried to inject more bank credits into the economy to stimulate economic growth by reducing the ratio slightly. Judging from the different trends of the money supply and reserve requirement ratio, it is clear that the persistent long-term money supply growth trend had not been altered by the drastic changes in reserve requirement ratios. Since the change of reserve requirement ratio works directly in an opposite way against the change of money supply, the persistent long-term money supply growth under the drastic change of reserve requirement ratios does implies that the long-term money supply growth in China must have been affected by other economic variables. Conventional monetary policy instruments such as the reserve requirement ratio could hardly contain the impact of these economic variables on long-term money supply growth.

Since the Chinese economy has achieved strong economic growth since 1999, one may argued that the persistent strong money supply growth should have been managed to facilitate the strong economic growth. But the average annual GDP growth rate over the period of 1999 and 2010 is about 9.5% and the long-term annual money supply growth rate over the past decade is on average 16.8%[1], which is well above

the GDP growth rate. Hence, the Chinese monetary authority has every reason to worry about such inconsistent growth rates of the two and has been cautiously trying to correct such large discrepancy between two growth rates by aggressively pushing the reserve requirement ratio from 6% in 1999 to 17.5% by the middle of 2008. However, such aggressive measure of money reduction policy could hardly stop the persistent strong money supply growth.

Comparing China's money supply to GDP ratio to that of the US as shown in Table 1, one can easily identify the striking difference that the money supply to GDP ratio in China has been about three times of that of the US on average over the past decade. Moreover, there is a considerable increasing trend of such ratio in China while such ratio in US has been basically stable. Intuitively, one may simply interpret this situation as that China has used three times of more money to facilitate transactions of economic activities and moreover such intensity of liquidity has been kept increasing. This suggests that that there is simply too much money or liquidity in the Chinese economy by comparing to the international benchmark.

Table 1. Comparison of money supply and GDP ratios between China and the US (1999-2010)

Year	China	US
1999	131.18%	50.05%
2000	133.54%	50.13%
2001	139.43%	53.65%
2002	152.28%	55.20%
2003	161.41%	55.39%
2004	156.87%	54.95%
2005	161.58%	53.82%
2006	163.08%	53.32%
2007	156.80%	53.80%
2008	158.04%	57.07%
2009	181.96%	59.54%
2010	182.38%	59.32%
Average	156.55%	54.69%

Source: Derived from "The People's Bank of China, Financial Statistics", various years and "US Federal Reserve, Statistical Releases", various years.

Following the theory of endogenous money supply (Kaldor, 1981; Moore, 1988; Palley, 1996; Stephen, 1998; Giancarto, 2002), one plausible explanation of such persistent aggressive money growth is that the money supply could not be exogenously fixed by the monetary authority but instead is required to accommodate the dramatic increase in money demand derived from the nominal income increase. Hence, facing the strong economic growth environment and the increased money demand, those monetary measures implemented by the China monetary authority aiming at reducing money supply could only work at the most in marginally slowing down

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[1] The annualized money supply growth rate over the period of 1999-2008 is derived as the average of percentage changes of M2 from using the data of M2 in December in each year.

the growth rate of money but will not be able to reduce money supply. It is then interesting to know what are the key variables and mechanisms that have contributed to the persistent aggregate money growth in China. Since money supply is the product of money multiplier and monetary base, it follows that the determinants of money multiplier and money base will then decide the money supply. Moreover, if some of the determinants which are assumed to be constant by the traditional monetarist theory are eventually not constant but are economic variables that are beyond the controls of the monetary authority, money multiplier and money base could vary and the money supply will be resulted from dynamic interactions between market forces rather than the monetary aggregate targeted by monetary authority.

Figure 3 shows money supply (M2), money multiplier and money base in China over the period of 1999-2010. Money supply in China has been growing steadily since 1999 and showing relatively little variation over time. However, the two components of money supply, money multiplier and money base,

have been showing considerable short-term variations. As money supply is the product of money multiplier and money base, it is expected that the variations from money multiplier and money base should have traded off each other to arrive a relatively steady money supply over time. Indeed, a closer examination on these variations shows that the money supply growth was driven more by the increase of money multiplier before 2005. But, after 2005, money multiplier started to fall. However, the strong increase of money base has then become the dominant force and enabled the money supply to continue its steady growth. The implication is that there have been strong endogenous factors in causing the change of money multiplier and money base. Moreover, the dynamic interactions between these factors have pushed the money supply to grow steady such that the short-term variation of any individual factor would not substantially affect the money supply to grow along its long-term steady-state growth path. The following sections will analyze the economic variables that have led to these variations of money multiplier and money base.

100 million RMB yuan
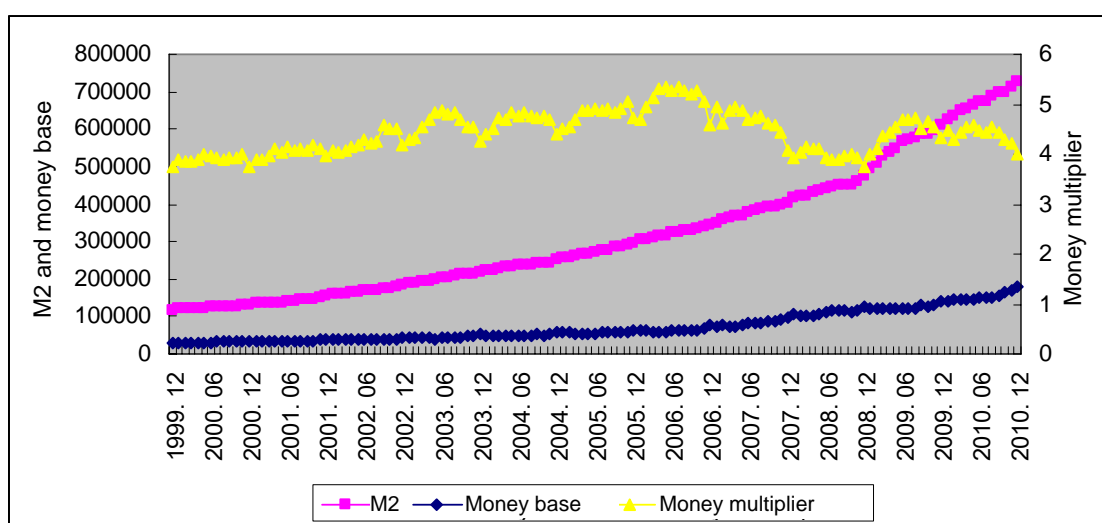
Source: Derived from the People's Bank of China, www.pbc.com.cn.
Notes: M2 and money base are in RMB 100 millions and money multiplier are in times.

Fig. 3. Money supply (M2), money base and money multiplier in China, December 1999-December 2010

2. The behavior of money multiplier against the strong growth of the Chinese economy

By the standard definition of money supply, the total money supply is generated by the use of money base through the money multiplier effect in the commercial bank system. The broad money supply measured by M2 can hence be defined as the product of money multiplier (mm) and money base (MB) as follows:

$$M2 = mm \times MB. \tag{3}$$

The monetary base (MB) consists of currency and reserve. Currency, supplied by the central bank on demand, reflects the preference of liquidity from the public in holding currency rather than the impact of monetary policy. Reserve from financial institutions includes both required reserve and excess reserve. While the reserve requirement ratio is directly regulated by the monetary authority as a specific percentage of total deposit and must be fulfilled by the financial institutions, the excess reserve is the buffer managed by the financial institutions to adjust their positions in credit expansion or contraction in short-run. To keep a substantial amount of extra reserve in the central banking system in a long run is inefficient

for a financial institution, as it should be used in the financial market for better return. The required reserve can also be indirectly affected by the central bank's open market operation and the change of discount rate because these monetary policy instruments can alter the total deposits and lead to the change in reserve requirement. The extra reserve from banks could be indirectly affected by the change of discount rates too.

The distinction between required reserve and excess reserve is not trivial in a central banking system where excess reserve is considerably large. This is because the financial institutions can use the large excess reserve as a buffer to reduce the impact of changes in reserve requirement ratio on the money supply. It can be easily verified that, for the given total deposit, required reserve and excess reserve, the change of reserve requirement ratio can be offset by the change of excess reserve ratio without the change in total deposit. This means that the effectiveness of using reserve requirement ratio by the monetary authority in controlling money supply would be largely discounted if the excess reserve were considerably large. This is an important aspect in understanding the feature of money supply in China.

In the Chinese financial system, financial institutions that are required by the central bank for the reserve requirement are classified into banking financial institutions and non-banking financial institutions. The banking financial institutions include all commercial banks while non-banking financial institutions include the urban and rural credit unions, financial companies, investment trustee companies, and financial leasing companies. Since these non-banking financial institutions also take deposit fund from their clients, they are required for reserve requirement. Adding the reserves from all these financial institutions, the total reserves in the China's central banking system can be derived.

By defining the reserve requirement ratio as *RRR = Required reserve/Deposit*, the rate of excess reserve as *ERR = Excess reserve/Deposit*, the currency/deposit ratio (usually referred as *k*-ratio in the conventional monetary economics literature) as *k-ratio = Currency/Deposit*, money multiplier (mm) can be defined as[1]

$$mm = (1 + k\text{-}ratio) / (k\text{-}ratio + RRR + ERR) \qquad (4)$$

According to equation (4), the changes in *k*-ratio, *RRR* and *ERR* will have opposite impact on the change of money multiplier *mm*. In the monetary statistics published by *PBC*, the required reserve and the excess reserve are not separately reported but mixed together as reserves from different type of financial institutions. To check the consistency of various components in the published money supply statistics from China's monetary authority, PBC, with each component defined in the money multiplier equation, the data series reported by PBC, namely, currency, total reserve from banking financial institutions, non-banking financial institutions reserve deposit, and total deposits are used to derive the money multiplier according to equation (4). M2 is then derived as the product of the derived money multiplier and monetary base. The derived M2 is identical to the M2 published by the People's Bank of China. This confirms the correctness of the derived *k*-ratio, *RRR* and *ERR* specified in equation (4).

In the components of money multiplier, the monetary authority can only have direct control on the reserve requirement ratio but not the currency/deposit ratio and excess reserve ratio. Instead, individuals and financial institutions will consider the change of their position in holding currency and excess reserve and hence the changes of currency/deposit ratio and excess reserve ratio. This suggests that money multiplier could be a variable that cannot be controlled by the monetary authority. This is particularly true if the behavior of currency circulation in the financial system could be effectively changed and excess reserves are considerably large. As such, the monetary policy of reducing money supply through the reduction in money base may well encounter the resistance from the increase of money multiplier as *k*-ratio and ERR could decline. Such counteraction between the changes of money base and money multiplier and thus the effectiveness of monetary policy will be largely determined by the relative importance of the *k*-ratio and ERR in the money multiplier.

Conventionally, RRR is supposed to be the key determinant of money multiplier. *k*-ratio and extra reserve ratio ERR are much negligible as the other determinants. Hence, the monetary authority can easily control both the money multiplier by changing the required reserve ratio and the monetary base by changing the required reserve through open market operation and the change of discount rate. While implementing a monetary policy, the monetary authority could usually choose to keep a stable required reserve ratio and thus a stable money multiplier but change the money base MB through open market operation or the change of discount rate or

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[1] Money multiplier specified in equation (4) can be derived as follows. *Given broad money M2 = Currency + Deposits and currency/Deposit ratio or k-ratio = Currency/Deposit*, M2 can then be defined as *M2 = (1+k-ratio) × Deposit*. The money base MB is given as *MB = Currency + Reserve*. Since reserve can be divided into required reserve and excess reserve, *MB = Currency + Required reserve + Excess reserve*. Given reserve requirement ratio RRR as *RRR = Required reserve/Deposit* and *excess reserve ratio* ERR as *ERR = Excess reserve/Deposit*, *MB = (k-ratio + RRR + ERR) × Deposit* or *Deposit = MB/(k-ratio + RRR + ERR)*. Since money supply is the product of money multiplier times money base or *M2 = mm×MB = (1+k-ratio) × Deposit = (1+k-ratio) × (MB/(k-ratio+RRR+ERR))*, *mm = (1+k-ratio)/(k-ratio + RRR + ERR)*.

both. Such monetary policy action of changing MB could change the money supply through the money multiplier effect. Money supply change is thus considered as being fully controllable by the monetary authority and being exogenous to the change of market conditions, particularly, the changes of market interest rates. If k-ratio and ERR are instead important in determining money multiplier, money supply may not be easily controllable by the monetary authority as money multiplier and thus money supply may well become sensitive to interest rate change. Money supply is thus believed to be endogenous to market condition changes.

2.1. The endogenous currency-to-deposit ratio in China. The magnitude of k-ratio in China shown in Figure 4 was as large as 15.7% in 2000 and had been considerably larger than the required reserve ratios until 2006. It demonstrates a clear declining trend, going down from 15.7% in early 2000 to less than 7% in 2010, a sharp declining about 50%. Since the change of k-ratio has an opposite effect on money multiplier and hence money supply, the dramatically declining k-ratio has thus been corresponding to the increasing of money multiplier. It thus becomes one of the key determinants in money supply growth in China.
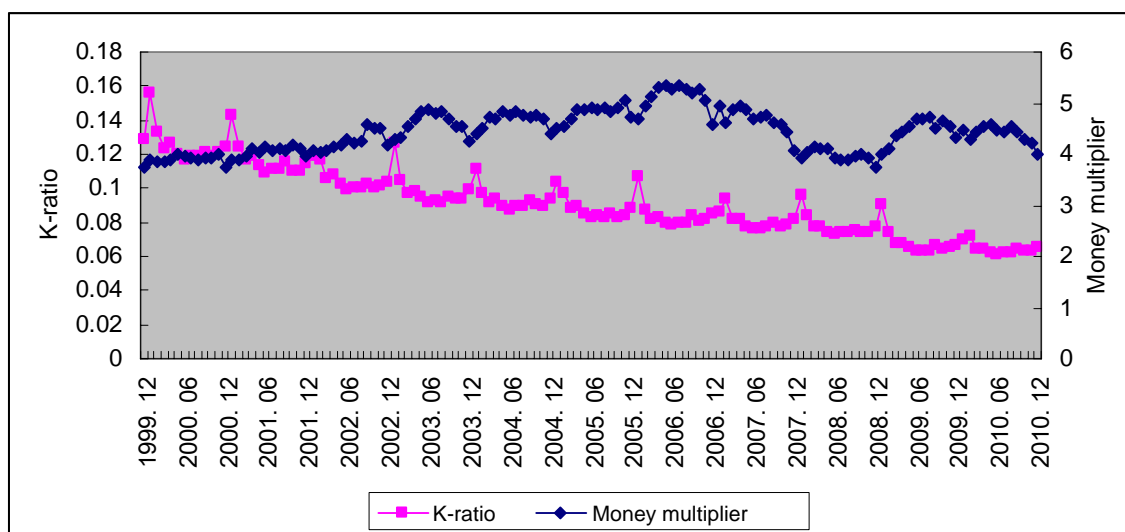

Fig. 4. Monthly currency-to-deposit ratio (k-ratio) and money multiplier (mm) in China: 1999-2010

Note that the multiplier is essentially a mirror image of the k-ratio. As the rapid change of k-ratio has played an important role in explaining the change of money multiplier and hence money supply in China, we need to have a further check on the change of relative importance of currency and deposit in China financial system. Money supply measured by M2 consists of three items: currency, checkable deposit and term deposit. While the total deposit includes both checkable and term deposits, the decline of k-ratio measured as the currency over total deposit can thus be attributed to the proportionally higher increase in both checkable deposit and term deposit relative to currency. Interest in the relative importance of currency and checkable deposit ratio can be traced back to Fisher (1911), who argued that currency and deposits had different income velocities. According to Fisher, currency is mainly for the convenience of small transactions, while checkable deposit is convenient for relatively large transactions. Hence, these two monies are imperfect substitutes. Individuals will decide how much of their money holdings they will allocate between currency and checkable deposits, based on both the relative advantage of each in their planned transactions and relative holding costs. The currency-to-checkable deposit ratio is, therefore,

believed to be decided by real income or wealth, the degree of development of business sector, population density, relative holding costs and custom and habit. Also, it has long been recognized that policy actions can have an indirect effect on currency-to-checkable deposit ratio and thus money multiplier through the presumed effect of policy actions on economic variables such as real income or interest rates (Mishkin, 2005).

The currency-to-checkable ratio in China is derived and compared to k-ratio (currency to total deposit ratio) in Table 2. Clearly, the currency-to-checkable deposit ratio had been declining from 1999 to 2010. This shows that the checkable deposit becomes increasingly more important than currency. Having achieved an average economic growth of more than 9% in the past three decades, GDP per capita and average household income have increased substantially in China (Table 2). The structure of household consumption budget has thus been changed proportionally more toward to the purchase of durable as well as luxury consumer goods. Hence the individuals' money transactions have been changed more towards to using checkable deposits to facilitate consumptions and business activities that need to have relatively large amount of money transactions.

These changes could contribute to the increasing importance of checkable deposit in China and thus the declining of currency to checkable deposit ratio.

The increasing importance of checkable deposit has definitely been closely associated with the rapid development of china's commercial banking system (Chen Siwei, 2008). China has experienced a boom of commercial bank networks over the past decade. Take the development of bankcards as an example, bankcards were not used as a standard instrument for payment in early 1990s but are now widely used as the basic instrument for payment. The first bankcard was issued in 1985 in China as a local card being used only in the restricted region. The nation-wide issue of bankcard was much later in 1989. By 2010, the total bankcards were over 2.42 billions. The Industrial and Commercial Bank of China (ICBC), the largest commercial bank in China, issued its first bankcard in 1989. But it issued more than 300 millions of bankcards by the end of 2010, in which 64 millions are credit cards and others are bank debit cards. Wages and salaries are basically paid through bank accounts in nationwide. The rapid modernization of the commercial bank facilities has led to the rapid increase of checkable deposit accounts and the use of checkable deposit in money transactions.

While the proportional increase of checkable deposit and thus the declining of currency to checkable deposit ratio can explain the declining of currency to total deposit ratio or *k*-ratio, the proportional higher increase in term deposit could also lead to the declining *k*-ratio. Table 2 reports the *k*-ratio together with currency to checkable deposit ratio. It shows that *k*-ratio has declined 50.4% over the period of 1999-2010 while currency to checkable deposit ratio declined 51.0%. As *k*-ratio is measured as currency divided by total deposit and total deposit includes both checkable and term deposit, the slightly more reduction in *k*-ratio implies that term deposits have increased proportionally more than checkable deposits. The ratio of M1/M2 has on average declined over the period of 1999-2010 by 8.2%, showing that households have allocated more of their increased disposable income to relatively long-term deposits. While households allocate relatively more of their income to savings, the proportional cash holding in their total wealth must decline and so is the *k*-ratio.

Table 2. GDP per capita, *k*-ratio, currency-to-checkable deposit ratio and M1/M2 ratio in China: from 1999 to 2010

Year	Per capital GDP (RMB yuan)	*k*-ratio	Currency-to-checkable deposit ratio	M1/M2 ratio
1999	7,159	0.129	0.416	0.390
2000	7,858	0.125	0.404	0.387
2001	8,622	0.117	0.369	0.387
2002	9,398	0.105	0.337	0.377
2003	10,542	0.098	0.315	0.374
2004	12,336	0.093	0.294	0.374
2005	14,053	0.088	0.288	0.361
2006	16,165	0.084	0.285	0.350
2007	18,934	0.081	0.262	0.360
2008	22,640	0.078	0.256	0.351
2009	25,188	0.068	0.236	0.342
2010	29,748	0.064	0.204	0.358
Percentage change between 1999-2010	315.5%	-50.4%	-51.0%	-8.2%

Source: Derived from (1) "China Annual Statistics", National Bureau of Statics of China, http://www.stats.gov.cn/tjsj/ndsj/ ; (2) The Financial Statistics Publications of The People's Bank of China, www.pbc.com.cn.

While the increasing savings in China have been largely linked to the increasing personal income, it also relates to interest rate income that households can generate from their savings. Although the Chinese capital market has gained substantial development over the past decade, most of Chinese households still treat bank savings as the major source of investment for their wealth (Yuan Zhigang and Hong Jun, 2005). The interest rate paid to checkable deposits in China has been remained below 0.5% over the past decade. With such low interest rate, it would not appear that individuals shift their money holdings between currencies and checkable deposits in responsible to variations in their relative holding costs. However, interest rates paid to time deposits over the various term durations have been ranged from 2% to 4% in the period of 1999-2010. It is, hence, rather appealing for households to hold proportionally more of their wealth in term deposits for gaining the interest income. Moreover, the Chinese nationals have had such an inherited tradition in saving for the future. To allocate proportionally more their newly increased income to savings is simply the practice of such tradition (Yu Bin et al., 2009; Aart Kraay, 2000). Arguably, having faced the

substantial increase in housing price, educational cost and medical cost over the past decade, the average Chinese households may have to save proportionally more from their income to prepare for the future uncertainty in those expenditures (Hang Bin, 2009; Louis Kujis, 2006). However, the rate of returns and the future value from holding term deposits can vary markedly with variations in the market conditions in general and the market interest rate in specific. The effect of these variations on the proportion of M1 held in the form of currency depends on the degree of substitutability between term deposit assets as one group and currency and checkable deposit as another. As a result of such substitutions, the K-ratio will decline and respond to the changes of market conditions. More specifically, the changes of market conditions and consequently the changes of opportunity costs of funds in the market could have direct impact on how individuals would choose to hold various types of money, term deposits, checkable deposits and currency.

Since the decreasing k-ratio or the increasing money multiplier has been largely attributed to the factors contributing to market development in the Chinese economy, their impact on the growth of money supply must be understood as being endogenous in the sense that the central monetary authority could hardly set up a long-run money supply target instead it has to provide the money supply required by the market demand for money.

2.2. The variant money multiplier and reserve ratio. Figure 5 shows currency and total deposit in logarithm and money multiplier over the period of 1999-2010. Both currency and total deposit have trended up steadily. Such growth trend from both currency and deposits should be expected from the fast growth of personal income resulted from the strong growth of the Chinese economy. However, a closer examination on Figure 5 shows that the total deposits increase faster than currency as the gap between the two becomes larger over time. It should be noticed that the magnitude of total deposits is much bigger than that of currency if measured in actually money units rather than logarithm form. As such, the faster growth of deposits over currency, even if in small scale, will lead to considerable decline in currency/deposit ratio or the k-ratio. It thus suggests that the declining of k-ratio and hence the increase of multiplier has been closely associated with relatively much stronger growth of deposits over currency.
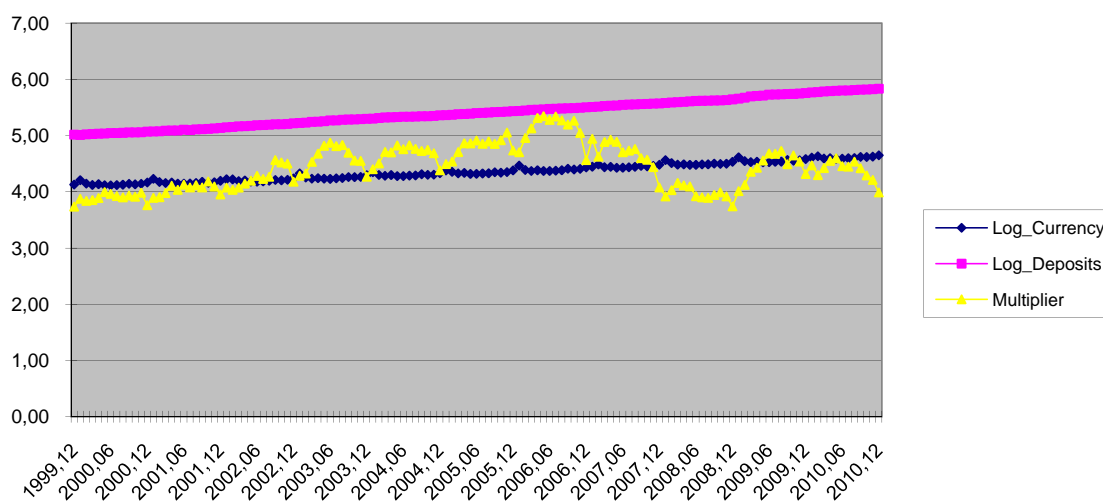
Source: Derived from The Financial Statistics Publications of The People's Bank of China, www.pbc.com.cn.

Fig. 5. Currency, deposit and money multiplier: December 1999-December 2010

However, the change of money multiplier, although trending up over time, has been more volatile than the change of currency and deposit. This seems to suggest that the currency deposit ratio, although can largely explain the long-term trend of money multiplier change, could not reasonably explain the short-term volatility of the money multiplier. There must be some short-term factors contributing to such volatility. The substantial extra reserve in China's commercial banking system is one of the factors.

The total reserve ratio (R/D) is the ratio between the total banks' reserve over banks' deposits. As total banks' reserve consists of the required reserve and the excess reserve, the total reserve ratio (R/D) can be divided into the required reserve ratio (RRR) defined as required reserve over deposit and excess reserve ratio (ERR) defined excess reserve over deposit. Figure 6 shows R/D, RRR and ERR. R/D has not been stable over the period of 1999-2010. The official reserve required ratio was lowered down from 8% to 6% in 1999. This move was attempted to stimulate the economic activities at that time as China was facing the serious problem of deflation. However, the total reserve ratio was as high as 17.3% by the end of 1999. This means that

the excess reserve was 11.3%, which is considerably much higher than the official required reserve. The huge excess reserve kept in China's financial system hinders the PBC's attempt to use the official required reserve ratio as an effective monetary policy instrument in controlling money supply. As shown in Figure 6, the required reserve ratios and the extra reserve ratios have changed basically in opposite directions from time to time, suggesting that the PBC's attempts in changing required reserve ratios have always been discounted by the reserve change in the extra reserve ratios. The total reserve ratio stayed high at over 16% before the middle of 2002. It then systemati-

cally declined to about 12-13% when the Chinese economy started to show signs of inflation and economic overheating. This suggests that the commercial banks were releasing their excess reserves to facilitate the expansion of bank loans. From the middle of 2006, the Chinese government tried to contain the overheated investment by raising the required reserve ratios for restricting the expansions of bank loans. But the excess reserve ratio then, as a counter force, started to decline, indicating that the commercial banks had actually used their excess reserves to reduce the impact of increased required reserve ratio on their loan expansion.
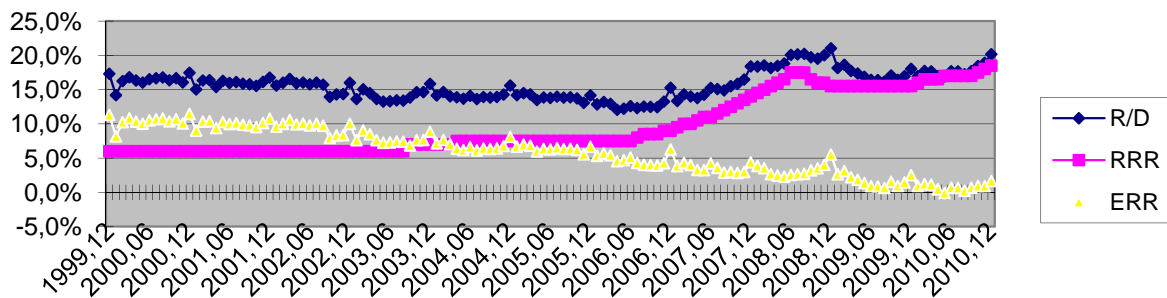
Source: Derived from the Financial Statistics Publication of The People's Bank of China, www.pbc.com.cn.

Fig. 6. Total reserve ratios, required reserve ratio and excess reserve ratio: December 1999-December 2010

The People's Bank of China has raised the required reserve ratio aggressively from 7.5% in the middle of 2006 to as high as 17.5% in the middle of 2008. By the conventional wisdom of money supply theory, the use of required reserve ratio in controlling money supply is always considered as an aggressive monetary policy action by comparing to other actions such as open market operation and change of central bank's discount rate (Mishkin, 2005). It is believed to be not practical for monetary authority to use it in controlling money supply as it will cause the change of money multiplier and disturb the normal operation of the money generation process in the banking system. However, the China's central bank, PBC, has instead used the required reserve ratios as the key measure in implementing its monetary policy in recent years. Moreover, the required reserve ratio has been raised by PBC to a surprisingly high level of over 15.5% for all commercial bank deposits as against any international standards. For example, by the end of 2009, the reserve requirement ratio in the USA is 0% for the transaction accounts with deposits from $0 to $10.7 million, 3% for the accounts with deposits from $10.7 to $55.2 million and 10% for the transaction accounts with deposits more than $55.2 million (Federal Reserve System, 2009). In India, the reserve requirement ratio has been kept below 6% since 1999 (Rakesh Mohan, 2008). What is really surprising is eventually not the abnormally high

required reserve ratio enforced by PBC but the China's commercial banks can keep increasing their bank lending and managed a comfortable excess reserve ratio as well by facing such abnormal high required reserve ratios. Over the period of 2006-2008 when the required reserve ratio was raised up from 7.5% to as high as 17.5%, the commercial bank loans were increased on a yearly base about 13% and the monthly excess reserve ratio remained at about 4% on average. It is evident that the Chinese economy has generated substantial savings in its banking system since 2006 such that the increased savings can be used to absorb the abnormally high reserve requirement imposed by PBC on the one hand and to increase banking lending on the other hand. Moreover, the commercial banks can still manage considerable excess reserve as extra lending capacity to counteract the impact of PBC's increase in reserve requirement ratio on banking lending. Therefore, the abnormally high reserve requirement ratios implemented by PBC can be viewed basically as being forced by the strong growth of savings residing in the commercial banks rather than being a policy initiative for keeping money supply growth under control.

Clearly, commercial banks in China have used excess reserve to offset the increase in required reserve consistently since 1999. Figure 6 shows that the excess reserve ratios have been declining against the rising of required reserve ratios since 1999. Considering that the required reserve ratio in China in July 2006

was 7.5% and the total reserve ratio was about 12.6%, the central bank might have to raise the required reserve ratio by as much as 5% to absorb the excess reserve. Otherwise, any small scale of increase in the required reserve ratio attempted by PBC could easily be counter-balanced from the commercial banks by reducing their excess reserves! PBC was indeed forced to raise the reserve requirement ratio aggressively from the middle of 2006. By early 2010, the banks' excess reserve was almost completely eliminated by the increased required reserve. However, the commercial banks managed to increase their excess reserve capacity quickly. By the end of 2010, the commercial banks' excess reserve ratio went up

to about 2% although the required reserve has been raised to historical high level of 18.5%.

The variations of China's commercial banks' excess reserve have been attributed to the vast and variant savings resources. The monthly variation of total reserve-deposit ratio is then mainly attributed to the monthly variation of excess reserve ratio. The short-term money multiplier volatility is thus corresponding to the volatility of total reserve-deposit ratio. Figure 7 compares the total reserve ratio (R/D) to the volatility of money multiplier (dMM) defined as the residual from the regression of money multiplier against a constant term and a time trend.
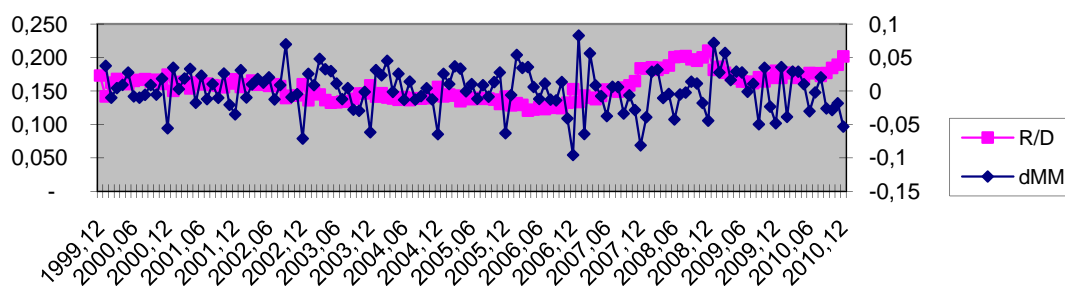
Source: Derived from the Financial Statistics Publication of The People's Bank of China, www.pbc.com.cn.

Fig. 7. The comparison of total reserve ratio and the change of the money multiplier: December 1999-December 2010

The monthly variation of money multiplier shows close association with the monthly change of reserve-deposit ratio. The correlation coefficient between the two is about -0.80, suggesting that the short-term volatility of money multiplier is highly correlated to the short-term change of reserve deposit ratio. Since the short-term change of reserve-deposit ratio has been dominated by the change of excess reserve managed by the commercial banks, the monthly or short-term volatility of money multiplier has thus been largely attributed to the actions of commercial banks in managing their excess reserve in responding to the market condition changes.

While the variation of reserve-deposit ration can explain part of the variation of money multiplier as suggested above, there must be other disturbing factors that could have also contributed to such increased volatility of money multiplier. One candidate of such disturbing factors is the intervention of monetary authority on the money supply through the so-called "window operation". The window operation practiced by the Chinese monetary authority and other macroeconomic management bodies as an effective mean in controlling money supply is simply administrative intervention from the monetary authority (Zhengquan Shibao, 2005; Fangzheng Zhengquan 2004). It was originally referred to the instructions from the monetary authority on which industries should be restricted from bank credits. In recent years, real estate development, iron and steel, cement and other construction

materials have been in the list of such restricted industries. These instructions were not that effective when they were firstly introduced, partly due to the reluctance and even resistance from the local governments which would insist on expanding those restricted industries for the purpose of local economic prosperity and partly due to the counter measures adopted by various local commercial banks which would manage to keep supplying bank credits to those restricted projects for the purpose of maintaining the profitability of their bank accounts[1]. Moreover, there have been no systematic mechanism and measures of implementing the window operation instructions. This has rendered the window operation very much arbitrary in the sense that it might be effective for certain regions or cities but not for others and for a short period but not the period that the monetary authority would aim for. The monetary authority has recently become somehow more experienced in implementing the window operation. However, due to the nature of administrative intervention, the window operation could still be effective at most for certain regions and in very short period. The implementation of window operation has thus been affected more or less in an administratively forced interruption of normal financial market opera-

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[1] For example, the local bank would try to supply the bank credits required by the real estate developer to its subsidiary company which produces building materials that could be used for infrastructure. The real estate developer for real estate development would ultimately use the bank credit so supplied.

tion and led to the increased volatility of money supply generation process in the short run.

In summary of the above discussion on the behavior of money multiplier in China in the period of 1999-2010, we found that the money multiplier was far from stable but volatile. While the continuously downward shift of k-ratio contributed to the increase of money multiplier, the PBC's aggressive effort in shifting up the reserve requirement ratio was attempted to stop the trend of money multiplier increase. But such government effort was largely offset by the reduction of the excess reserve ratios that was hold by the commercial banks in considerable size. Since k-ratio and excess reserve ratio are determined by the market activities, they demonstrated considerable changes resulted from changes in the market. The interaction of these factors in the money supply generation process has thus contributed to a variant money multiplier. To better understand such determination of money multiplier in China, the following simple logarithm regression model is estimated to explain how the change of money multiplier could have been determined by the variables of k-ratio, reserve requirement ratio (RRR) and excess reserve ratio (ERR).

$$\text{Log}(mm)_t = C_0 + C_1 \text{Log}(k\text{-}ratio)_t + C_2 \text{Log}(RRR)_t + C_3 \text{Log}(ERR)_t + e_t, \tag{5}$$

where C_0, C_1, C_2 and C_3 are the estimated coefficients and e_t is the error term. A simple AR(1) process is also specified in the regression model to accommodate the serial correlation that often occurs in the estimated errors from a simple OLS regression

using monthly time-series data. Although the regression model is apparently simple, the estimated results reported in Table 3 do show the significant relationship between money multiplier (mm), k-ratio, required reserve ratio (RRR) and excess reserve ratio (ERR). Specifically, the estimated coefficients of all explanatory variables are statistically significant at 1 percent significance level and have the expected signs. The various reported statistics inferences such as adjusted R-square, log likelihood ratio, Durbin-Watson statistics and F-statistics indicate that the regression model has good explanation power.

The variant money multiplier suggests that the money supply and thus money demand[1] have been non-stationary stochastic process with no tendency to return to a deterministic trend line. As many other economic time series, the money supply and demand in China could approximate random walks, the variance of forecast error could increase exponentially as the time horizon is extended. The policy implication is that any simplistic attempt from the monetary authority in controlling the money supply for the so-called long-term market equilibrium may not work at all simply because such long-term equilibrium could hardly and accurately be forecast, except by chance (Nelson and Plosser, 1982; Woon Gyu Choi and Seonghwan Oh, 2000). Since the money supply in China has the persistence of long-term upward shifting trend, the short-term interruption of money supply generation process by the administrative interference such as window operation could cause substantial short-term deviation of money supply from its long-term trend.

Table 3. The estimation results of money multiplier determinant (equation (5))

Dependent variable: Log (Money multiplier)			
Estimation method: OLS Sample: Monthly data from December 1999 to December 2010 Total observations used in the estimation: 133			
Variable	Estimated coefficient	*t*-statistics	Probability
Log (*k*-ratio)	-0.1539	-5.2485	0.0000
Log (RRR)	-0.2957	-4.4711	0.0000
Log (ERR)	-0.0804	-10.8913	0.0000
AR (1)	0.9456	33.1284	0.0000
Constant	0.1716	0.9869	0.3256
R-squared	0.9450	Durbin-Watson stat.	2.4491
Adjusted *R*-squared	0.9432	*F*-statistic	536.602
Log likelihood	316.416		

3. The endogenous factors for the change of monetary base in the Chinese economy

The money base or the total reserve money in China's monetary system consists of cash (C), reserve from commercial banks, other depository and financial institutions (R).

Since money base is one of liability items in the PBC's balance sheet, the change of money base can be assessed from the structural change of the PBC's whole

balance sheet, i.e., from the asset side and the liability side. The relationship between the asset items and the liability items can be specified as follows:

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[1] The M2 reported by any monetary authority must be referred to both money supply and money demand. Eventually, in the actual operation of money market, the demand for money must be identical to money supply as it is actually the supply of money existing in the money market. For example, deposits in any bank are simply money accepted as a mean of payment. Depositors can always spend them to purchase goods and services of other financial assets (Moore, 1997).

$FX + CG + CB + COF + CNF + OA = C + R + \\ + B + GD + FL + OC + OL,$ (6)

where, in the assets side, FX indicates foreign exchange reserve[1], CG are the claims on government securities such as government bonds, CB are the claims on depository financial institutions such as commercial bank's borrowings from PBC, COF are the claims on other financial institutions, CNF are the claims on non-financial institutions, OA are the other assets; in the liability side, C is the cash, R are the total reserve deposits, B is the bill and note issued by PBC, GD are the government deposits, FL is the foreign liability, OC is the PBC's own capital, OL are the other liabilities.

Since $MB = C + R$, equation (6) can be simplified into:

$FX + CG + CB + COF + CNF + OA = \\ = MB + B + +GD + FL + OC + OL.$ (7)

The money base MB can thus be specified to be equal to the various items of asset and liability as:

$MB = FX + CG + CB + COF + CNF + OA - \\ - B - GD - FL - OC - OL.$ (8)

We will use equation (8) to assess how the change of money base has been attributed to the changes in the asset and liability items. The structure of PBC's balance sheet in the selective years from 1999 to 2010 is presented in Table 5 for this assessment.

Since 1999, foreign exchange as the dominant part of foreign asset and claims on government has dominated the increase of the PBC's asset while money base, bond issues and government deposits have dominated the increase of the PBC's liability. By the structure of equation (6), this means that the change of MB since 1999 has been largely corresponding to the changes of FX, CG, B and GD. Since CG as the asset item has been quite close to GD as the liability item, these two items in relation to government can be offset each other. Hence, the change of MB can be largely explained by the changes of FX and B. This means that the change of both sides of equation (8) can be approximated by:

$MB \approx FX - B.$ (9)

A closer examination on the growth rates of MB, FX and B reveals that FX has increased much more dramatically than MB and B. This suggested that the increase of foreign exchange has been largely taken by the increase of both money base and bond issued by PBC. This has been essentially the PBC's management of its balance sheet: from the asset side, the surging foreign reserve has to be taken into its total foreign asset; from the liability side, money supply has to be increased to take in the surging net foreign exchange earning from the increasing trade surplus on one hand but, on the other hand, issue PBC bond to take some of the increased money issuance back from the depository financial institutions. Therefore, the increase of money base is largely the difference between the increased foreign reserve and the increased PBC bond.

Table 4. The changing structure of asset and liability of the People's Bank of China: 1999-2010 (RMB 100 million yuan)

	1999	2001	2003	2005	2008	2010	% change between 1999 and 2010
Total asset	35,349	42,540	62,004	103,676	207,095	259,275	633.5
Total foreign asset	17,486	26,685	31,141	63,339	162,543	215,520	1132.5
Foreign exchange (*FX*)	14,458	19,860	29,841	62,139	149,624	206,767	1330.1
Claims on government (*CG*)	1,582	2,821	2,901	2,892	16,195	15,421	874.8
Claims on depository financial institute (*CB*)	15,373	11,311	11,982	12,692	8,432	9,486	-38.3
Claims on other financial institutes (*COF*)	0	0	7,255	13,226	11,852	11,326	56.1*
Claims on non-financial institutes (*CNF*)	3,833	8,547	206	66	44	25	-99.3
Other assets (*OA*)	0	0	8,516	11,459	8,027	7,598	-10.8*
Total liability	35,349	42,540	62,004	103,676	207,095	259,275	633.5
Money base (*MB*)	31,478	38,671	51,346	62,520	129,222	185,311	488.7
Currency (*C*)	13,455	15,688	19,745	24,031	37,115	48,646	261.5
Reserve from commercial banks and other depository and financial institutes (*R*)	18,021	22,982	31,600	38,488	92,106	136,665	658.4
Bond issues (*B*)	118	0	3,031	20,296	45,779	40,497	34219.5
Government deposit (*GD*)	1,785	2,850	4,954	7,527	16,963	24,277	1260.1
Foreign liability (*FL*)	0	0	482	641	926	720	49.4
Own capital (*OC*)	366	355	219	219	219	220	-39.9
Other liability (*OL*)	541	-516	474	10,648	9,719	8,249	1424.8

Source: Derived from the Financial Statistics Publication of The People's Bank of China, www.pbc.com.cn.
Note: The total asset and liability may not be added because of rounding. * The percentage change is over the period of 2003-2010.

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[1] The foreign exchange reserve held by the PBC includes foreign exchange, gold and other foreign asset. Foreign exchange has been always more than 95% in the total foreign asset.

China has been experiencing the surging increase of foreign exchange reserve from its substantial foreign trade surplus in recent decade. China's official foreign reserve was only US$146.2 billions in 1999 but surged to US$3,133 billions in 2010, an increase of more than 13 times. Under the controlled floating foreign exchange system that China has implemented since 1994[1], the central bank has to issue money to absorb the over-supplied foreign exchanges and thus causes the increase of money supply. Since 1994, the money supply increase due to such foreign exchange absorption has been a dominant part of the money supply increase from the central bank. As the central bank has been more or less forced to absorb the over-supplied foreign exchange through increasing money supply, the monetary base has to be increased and thus been increasingly becoming endogenous.

While the PBC started to take in foreign reserve in the early 2000s, it seems that it could afford the impact of such action on money supply growth such that it didn't issue bond to commercial banks for absorbing the increased money back from the monetary system. But since 2003, the increase of foreign reserve has become so dramatic that the money base has to be increased abnormally. To be able to reduce the burden of taking in foreign reserve by increasing money base, the PBC has then started to increase the issues of PBC bill and note substantially. The bill and note issued by PBC are mostly in short durations of 3 month, 6 month and 1 year. They have long been distributed to commercial banks according to their asset sizes but sometimes are issued specifically to those commercial banks that have made aggressive loans. The coupon rates offered from PBC have been generally lower than the interest rates of corresponding deposit offered from the commercial banks[2]. As such, the commercial banks have been in fact forced to purchase the PBC bill and note by using their excess reserve. Otherwise, the commercial banks' excess reserve should have kept increasing as a result of the increasing foreign exchange savings from individuals, companies and institutions in the commercial banks[3]. Such sterilization program of controlling the money base growth is unique and definitely not conventional as it is not conducted through the open market operation but through an enforcement arrangement from the central bank to the commercial banks.

PBC, as a central bank, is simply a monetary authority and cannot have any alternative use of the fund raised from the bond issues. When foreign reserves keep increasingly in China, the size of this sterilization program has to keep growing and more PBC bill and note has to be issued and the matured PBC bill and note have to be renewed into next term. It is important to notice that the excess reserves from the commercial banks that have been used to purchase PBC bills and notes are largely corresponding to foreign exchange savings from individuals, companies and institutions. Ultimately, these excess reserves will have to be used by these depositors. This means that such sterilization program cannot be kept running forward forever. The accumulated market liquidity by PBC through such sterilization program has to be ultimately released into the market in the future. Hence, the massive issues of PBC bonds would mean that the PBC has been accumulating the future money base growth capacity or, to some extend, the future inflation! It is in this regard, the power of such sterilization program in controlling money base growth has its limitation and PBC could not be able to use it effectively in setting up the long-term target of money supply. Moreover, it is also important to note that the increased foreign reserve cannot be fully absorbed by such sterilization program either. Eventually, as shown in Table 5, the growth rates of PBC bill and note issues, although quite considerably, has been much lower than the growth rate of foreign exchange reserve. The source of PBC's foreign reserve is the foreign exchange earnings from individuals, companies and institutions. A substantial part of the foreign exchange earnings, after converting into RMB yuan, have to be used by these individuals, companies and institutions domestically. Therefore, the PBC's sterilization program could only partially reduce the money base growth but couldn't ultimately control the impact of foreign exchange reserve growth on money base.

Figure 8 shows the changing trend of money base, foreign reserve and PBC's bill and note over the period of 1999-2010. It is clear that the surging foreign exchange reserve has led to the growth of money base.

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[1] In November 1993, the Third Plenum of the Fourteenth CPC Central Committee, the highest economic regulatory authority in China, approved a comprehensive reform strategy in which foreign exchange management reforms were highlighted as a key element for a market-oriented economy. A market-based unified floating exchange regime and RMB convertibility were seen as the ultimate goals of the exchange reform. A foreign exchange surrender and purchase system (FESPS) was put in place in 1994. Firms were to surrender their foreign exchange earnings from current account transactions and purchase foreign exchange from a foreign exchange designated bank (FEDB) when a payment in foreign currency was needed. The RMB thereby achieved so-called conditional convertibility under the current account since 1994. In 1996 foreign-funded enterprises were included in the system and China officially announced its acceptance of Article VIII of the IMF Articles of Agreement.
[2] For example, the interest rate of PBC's one-year bond issued in 2009 is 1.328% and the interest rate of one-year term deposit offered from the Industrial and Commercial Bank of China (ICBC) in 2009 is 2.25%.
[3] The total deposits in commercial banks increased from RMB 231,330 billion yuan in the December 2004 to RMB 306,178 billion yuan in September 2006. With such substantial increase of deposits in the commercial banks, the reserve and thus money base should have increased equally for the given reserve-deposit ratio if the PBC failed to force the commercial banks to use their substantial excess reserves to purchase its issued bonds.
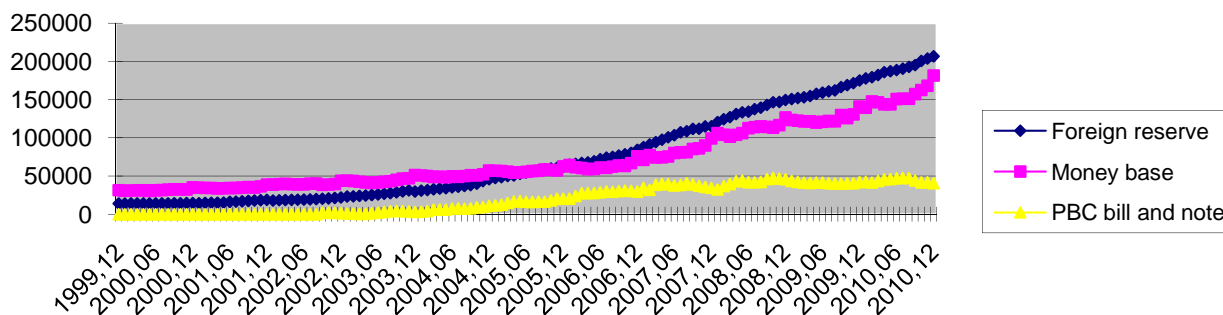
100 million RMB yuan

Fig. 8. Monetary base, foreign exchange reserve and PBC's bill and note: December 1999-December 2010

But the increasing PBC's bill and note since 2003 has played a role in curbing the money base growth from being fully dominated by the foreign exchange reserve growth. However, since the growth of foreign exchange reserve has been so strong, the increase of PBC's bill and notes could only partially offset its impact on money base. Moreover, as shown in the figure, the gap between foreign exchange reserve and PBC's bill and note has become bigger and bigger, indicating that the ability from PBC to reduce the impact of foreign reserve growth on money base growth by issuing bill and note has become increasingly limited.

Based on the above discussion, the following OLS logarithm regression model of money base (MB) is estimated to verify how the changes in foreign reserve (FX) and PBC bill and note (PBC_B_N) could affect money base (MB):

$$\text{Log} (MB)_t = b_0 + b_1 \text{Log} (FX)_t + \\ + b_2 \text{Log} (PBC\_B\_N)_t + e_t, \qquad (10)$$

where b_0, b_1 and b_2 are the estimated coefficients and e_t is the error term. As in the money multiplier regression, a simple AR(1) process is specified in the regression model to accommodate the serial

correlation that often occurs in the estimated errors from a simple OLS regression using monthly time-series data. The estimation result is presented in Table 5. The regression has a good explanation power as shown by its high R^2 and F-statistic values. The coefficients for foreign reserve and PBC's bill and note have the expected signs and all statistically significant at 1% significance level. The magnitude of the estimated foreign reserve coefficient is much larger than that of PBC's bill and note. As the regression uses the logarithm variables, it means that the elasticity of foreign reserve over the money base is much bigger than the elasticity of PBC's bill and note over the money base. Specifically, the coefficient of foreign exchange reserve is 0.7658 and the coefficient of PBC's bill and note is -0.0615. It suggests that 1% increase in foreign exchange reserve could lead to 0.7658% increase in money base while 1% increase in PBC's bill and note could only reduce the money base by 0.0615%. Overall, the regression supports the view that the change of money base has been basically determined by the change of foreign exchange reserves while the change of PBC's bill and note has only played some marginal role.

Table 5. The estimation results of money base determinant equation

Dependent variable: Log (Money Base)			
Estimation method: OLS Sample: Monthly data from December 1999 to December 2010 Total observations used in the estimation: 133			
Variable	Estimated coefficient	t-statistics	Probability
Constant	3.2250	3.2832	0.0014
Log (*FX*)	0.7658	8.6616	0.0000
Log (*PBC_B_N*)	-0.0615	-2.7237	0.0077
AR (1)	0.9316	22.7289	0.0000
R-squared	0.9941	Durbin-Watson stat.	2.1629
Adjusted R-squared	0.9939	F-statistic	5429.206
Log likelihood	195.6757		

Conclusion

This paper attempts to explain the persistent strong long-term money supply in China over the last decade by considering the determinants of money multiplier and money base. It finds that the changes of money multiplier and money base have been largely determined by the changes of *k*-ratio, excess reserves in the commercial banks and foreign exchange reserve. These variables are market-driven and beyond the control from the PBC. As such, the persistent strong long-term money supply in China has been largely endogenous. The Chinese monetary authority, the PBC, has tried to use conventional instruments such as to increase reserve requirement ratio and unconventional instruments such as to issue PBC bill and note in the effort in containing the growth of money supply. But these PBC's efforts could only have played a marginal role. Ultimately, it is those market-driven variables, which have played the deterministic role in pushing the aggressive long-term money supply growth in China.

It is arguably that the monetary policies implemented by the monetary authority in China, if by any mean to be effective and meaningful, could have only followed the money supply growth path required by the market forces. It is the Chinese economic growth model, the evolving financial system and the process of financing deepening which have fundamentally contributed to the changes of *k*-ratio, excess reserves in the commercial banks and foreign exchange reserves, that have determined the persistent strong long-term growth rate of money supply in China. Thus, subject to the market-driven endogenous money supply growth, the monetary policies implemented by the Chinese monetary authority could at most marginally affect the money supply growth path in short-term but could hardly alter the long-term money supply growth path. This means that any substantial actions from the Chinese monetary authority, such as raising the required reserve ratio and issuing PBC

bill and note, should be understood as being short-term in nature and not as being a deterministic initiative to set certain long-run monetary targeting objective for the market to follow. The various monetary policy changes from time to time have been eventually adaptive policy measures to offset the extraordinary impact of market condition changes on the long-term money supply growth path. For example, the issue of PBC's bill and note is aimed at absorbing part of the surging foreign exchange reserve that, if not being taken away, would otherwise cause the money supply to grow so much more than its long-term growth rate. Ultimately, these monetary policies implemented by PBC could not affect the long-term money supply growth path.

Knowing the persistent strong long-term money supply growth and the limitation of using monetary policy by the China monetary authority to change this long-term money supply growth path is important in many aspects. The persistent strong long-term money supply growth could have serious implication on the long-term economic stability of the Chinese economy. While the long-term money supply growth rate has been persistently so much higher than the GDP growth rate, it could ultimately lead to either massive asset bubble or chronological unfolding of high inflation. Since the persistent strong long-term money supply growth has been endogenously driven by the economic factors such as foreign exchange earnings and savings that are fundamentally determined from the growth model of the Chinese economy, the attempt of changing such money supply growth path through monetary policies would be ineffective and short-lived as it could not change the foundation of the economic growth model. Hence, one should not expect the Chinese government and monetary authority to have such ability to take initiatives in changing the monetary fundamentals such as the national credit aggregate and exchange rate of RMB.

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