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On the People's Bank of China's Financial Strength and Policy Outcomes

Abstract: This paper measures the financial strength of the People's Bank of China from the perspective of balance sheets, and then examine empirically whether its financial strength influences its policy commitments given its financial conditions. The econometric results suggest that, first, the financial strength of the People's Bank of China does affect its policy performance, although the effects are weak and overall results lack robustness with respect to the econometric technique and the choice of alternative measures of financial strength. Second, alternative financial strength indicator plays different role in helping the People's Bank of China achieve its alternative policy objectives. Therefore, maintaining benign financial conditions and a resilient balance sheet are necessary pre-conditions for the People's Bank of China to achieve desirable policy outcomes. Third, the People's Bank of China's current standalone finance is healthy under our stressing tests, despite certain concerns attained.

Key words: Financial Strength, The People's Bank of China, Balance Sheet Analysis, Stress Testing, Policy Performance

JEL Code: E31, E52, E58

1. Introduction

Although a central bank can function well with negative equity given that it can create money to pay its bills, its financial soundness does matter in fulfilling the responsibilities to ensure the monetary and financial stability, particularly, in rainy days. This is because, according to Archer and Moser-Boehm (2013), far

greater financial resources are needed for a central bank in a crisis than in normal times, while the former case might result in extraordinary financial risks. To operate effectively, therefore, a central bank should have on hand minimum and desirable financial foundations based on its own country-specific environments. Considering the unique institutional circumstances in China, in this paper we measure the standalone financial strength of the People's Bank of China (China's monetary authority) in terms of its balance sheets, and examine the impacts of the People's Bank of China's financial situations on the successful implementations of its monetary and macroprudential policies. To our knowledge, our paper constitutes the first independent attempt to explore the financial strength of the People's Bank of China and the nexus between the People's Bank of China's financial strength and macroeconomic outcomes.

The financial resource available to and the financial arrangements for a central bank determine its financial strength, which is defined as the capacity to continue funding and conducting the policy tasks for which the central bank is responsible, without being obliged to do things that would prevent it from attaining its objectives¹. As a functional department under China's state council², the People's Bank of China holds complete fiscal indemnities from the central government³. Nevertheless, a detailed examination on its finances on a *standalone* basis still makes sense for the sake of trust-building, risk-reduction, and efficiency-improving. To that end, this study measures the financial strength of the People's Bank of China from the perspectives of its balance sheet structure, and then investigate the effects of the People's Bank of China's financial conditions on its policy outcomes. The balance sheets of the People's Bank of China have been expanding since 1990s. The changes in the size and structure of the People's Bank of China's balance sheets, on the one hand, reflect the facts of dramatic increases in the monetary base associated with China's rapid economic growth, on the other hand, uncover crucial structural information about the implementations of macroeconomic policies because the People's Bank of China actively utilized its balance sheet to influence the real economy and financial market stability. Moreover, the size and the structure of the People's Bank of China's balance sheets provide

¹ Archer and Moser-Boehm (2013).

² In China, the People's Bank of China is a parallel department as the Treasury under the leadership of the State Council, that is, the People's Bank of China is integrated with the central government.

³ According to the law of the People Republic of China on the People's Bank of China (2003, revised version, Article 39), "The People's Bank of China surrender to the central budget its net profit each accounting year after making general provisions at a level set by the fiscal authority. Losses of the People's Bank of China shall be covered by fiscal appropriation from the central budget."

direct financial foundations and financial resources (also constraints) available for the People's Bank of China to undertake its policy tasks. In addition, we conduct robust tests and examine the health of the People's Bank of China's finance under several hypothetical stress scenarios.

The contributions of this paper include, first, in terms of the People's Bank of China's balance sheets, we define three indicators to quantify the financial conditions of the People's Bank of China. These indicators reveal substantial financial information of the People's Bank of China from several aspects. Particularly, given that the People's Bank of China has never uncovered its profits, we have estimated the revenues and costs and thereby the profits for the People's Bank of China during the investigating period 2000-2017. Second, we employ alternative econometric techniques to evaluate the effects of the financial strength on the policy performance of the People's Bank of China. To our knowledge, this paper is a first independent attempt for the People's Bank of China, complementing the regarding literature. The assessment results of our study suggest that the People's Bank of China's financial strength does influence the performances of its monetary and macro-prudential policies, despite the lower magnitude of the effects and the overall lack of robustness with respect to the econometric technique and the choice of alternative measures of financial strength. Third, our stress-testing results suggest that the People's Bank of China's finance is healthy under assumed scenarios. These results shed insightful lights to the People's Bank of China's policy operations, risk-monitoring, and risk-preventing.

The remainder of the paper is organised as follows. Section 2 discusses the related literature. Section 3 describes the methodology and data. Section 4 examines the effects of the People's Bank of China's financial strength on its policy outcomes. Section 5 conducts robust tests and stress tests. Section 6 summarizes and concludes.

2. Related Literature

Due to the unique ability to enhance the balance sheets without costs through the issuance of non-interest-bearing, non-redeemable debt instruments (base money), and the general credible fiscal supports from central governments, central banks financial conditions have been neglected for a long period. Recently, however, the deteriorating balance sheets of central banks arising from the "Quantitative Easing" or unconventional monetary policy in the aftermath of the global financial crisis has led to more and more concerns about the financial strength of central banks and the consequences on their policy performances. As discussed in Klüh

and Stella (2008), Stella (2008), Archer and Moser-Boehm (2013), Perera et al. (2013), among others, theoretical analysis has suggested that a lack of central bank financial strength can impede the pursuit of monetary and financial stability. They show the theoretical relevant on the basis of the following arguments: the constraints of the ability that the central bank can create unlimited fiat money; the link between the financial problem of central banks and the fiscal distress reducing the timeliness of financial support from the central government; the trade-off relationships between the profitability of a central bank and its policy performance.

Empirical investigation on the link between central bank finances and policy outcomes have produced useful references, despite that most existing literature concentrate exclusively on the success of low inflation (as the exclusive measure of a central bank's policy performance). Stella (2003, 2008) have conducted a series of studies along this line with updated data for a large group of central banks across countries. Defining the financial strength of a central bank as the sum of capital and "other items net" (OIN; from the IFS IMF database) relative to total assets, he found that mean inflation for the central banks with weak finances was 26%, twice as high as for the central banks with strong finances. Ize (2005) used a net worth-based quantitative approach to calculate the minimum capital needed by a central bank to ensure the credibility of its inflation target, and concluded that a substantial capitalization (financial strength) was necessary for allowing the central bank to achieve a low rate of inflation. In further examinations on the effects of a central bank's financial on inflation, Stella (2009, 2010) obtained very similar results as in his preceding papers. More notable, Klüh and Stella (2008) chose four different measures of central bank financial strength to explore the relationship between central bank financial strength and inflation. They applied both simple fixed-effect pooled OLS and Feasible Generalized Least Squares (FGLS) models to a panel of 15 Latin American and Caribbean countries for the period 1987-2005, and confirmed that the financial strength of a central bank is significantly negatively related to inflation. Following Klüh and Stella (2008), Benecká et al. (2012) undertook an in-depth robustness check of their results with broader and more recent panel data sample covering 105 countries worldwide, and found a statistically significant negative relationship between some measures of central bank financial strength and inflation in a few regressions. However, the conclusions lack robustness with respect to the econometric technique and the choice of financial strength measures. Differing from above literature, Adler et al. (2012) estimated the rules of interest rate for a sample of 14 countries and took the deviations from the rule as a measure of central bank financial strength. Their findings suggest that central bank financial strength can significantly influence the conduct of monetary policy. In a recent study, Perera et al. (2013) investigated the empirical relationship between central bank financial strength and

inflation using an unbalanced panel data set for a sample of selected advanced and emerging countries. Their empirical results support a statistically significant and robust negative relationship between central bank financial strength and inflation. It should be particularly noted that the People's Bank of China is excluded from all above studies, possibly due to its lack of independence on one hand, and its heterodox regime on the other hand. This motivates our paper.

Unlike in the previous studies which focus on one dimension of policy performance (e.g., low inflation), we investigate the nexus of the financial strength of the People's Bank of China with several macroeconomic outcomes given the regime of the People's Bank of China's multiple objectives, which include sustainable stable economic growth (nominal income targeting), the price stability, controllable exchange rates, and financial stable indicators. In addition, we test the financial health of the People's Bank of China under hypothetical stress scenarios, the results could provide insightful implications for the People's Bank of China's policy operation and risk reduction. Our study complements the corresponding research by providing China's evidence and new suggestions.

3. Methodology and Data

3.1. Methodology

Due to the lack of authorizing definition and international standard, there exists lots of obstacles to quantify the financial strength of central banks. Considering the unique institutional position and environment in which the People's Bank of China operates, and no accounting information about the equity and the profits are released publicly, we use several complementary indicators to measure the financial strength of the People's Bank of China in this paper.

First, in broad term, we use the ratio of the sum of own capital and currency in circulation to the total assets, to quantify the financial strength of the People's Bank of China. This measure is firstly proposed for the Riksbank's financial independence⁴, reflecting the immediate financial resources available for a central bank to tackle the financial disruptions. Also, according to Stella (2010), adding currency to capital produces a superior measure of the ability of the central bank to attain seigniorage and finance its operational and quasi-fiscal expenditures. Specifically, the formula is given by

⁴ Referring to Part D in Archer and Moser-Boehm (2013), also, Benecká et al. (2012).

$$FSI_t = \frac{CA_t + MO_t}{TA_t} \quad (1)$$

where CA_t denotes the own capital of the People's Bank of China, MO_t is the currency in circulation, and TA_t is the total assets owned by the People's Bank of China at time t , respectively.

Second, following Stella (2008), Klüh and Stella (2008), Adler et al. (2012), and Perera et al. (2013), we employ the sum of the capital and the other items (net) scaled by the total assets to calculate the financial strength of the People's Bank of China. The net other items represents the residual items after taking into account the main asset items and main liabilities items, could serve as a buffer stock to protect central bank capital⁵. In addition, the other items net is available on a monthly basis from the international financial statistics (IFS) dataset of IMF. The second financial strength indicator is calculated by

$$FSII_t = \frac{CA_t + OIN_t}{TA_t} \quad (2)$$

where OIN_t represents the other items (net) at time of t .

Third, we define the financial strength of the People's Bank of China as the ratio of the sum of own capital plus retained profits relative to total assets. The higher ratio suggests a powerful capacity of the People's Bank of China to support its policy operations. The third financial strength indicator of the People's Bank of China is

$$FSIII_t = \frac{CA_t + RP_t}{TA_t} \quad (3)$$

where RP_t denotes the retained profits at time of t . Unfortunately, the People's Bank of China has never published any information about the profits and losses, we would estimate the profits of the People's Bank of China in Section 3.2.2.

To measure the effects of the People's Bank of China's policy operations, we use output gap, inflation rates, the volatilities in the exchange rates as the explained variables. To avoid the endogeneity, we use the OLS and GMM techniques to be robust check. The empirical econometric equation takes the form

$$y_t = \delta y_{t-1} + \alpha FS_t + \beta x_t + \varepsilon_t \quad (4)$$

where y_t denotes the dependent variable. FS_t denotes the financial strength of the People's Bank of China at time t . x_t is a set of the control variables. δ , α , and β denote the coefficients. ε_t represents the error term with IID.

⁵ See, for example, further discussions in Adler et al. (2012).

3.2. Data and Descriptive Analysis

Our sample consists of monthly observations in the period 1999:12 to 2017:12. Given that the People's Bank of China was formally established as China's central bank in 1993 by the law of the People Republic of China on the People's Bank of China (1993), our sample covers enough period to investigate the behaviours of the People's Bank of China. The data were mainly collected from the dataset of the People's Bank of China released on its website, China Economic Information Network (CEIN) database, and *IFS* dataset of the IMF. In what follows, we report a series of historical facts about the evolution of the People's Bank of China's balance sheets during last two decades. Note that the IMF's Special Data Dissemination Standards (SDDS) was not adopted by the People's Bank of China until October 7, 2015. Prior to that date, the People's Bank of China published its data according to the General Data Dissemination System (GDDS) of IMF since 2002. Hence, the structure and contents of the People's Bank of China's balance sheets changed over our sample and were consolidated in terms of SDDS in this study.

The structure of the People's Bank of China's balance sheet at the end of 2017 is arranged in the familiar T-account format in Table 1.

Table 1: The People's Bank of China's Balance Sheet End-2017 (in billions of yuan, RMB)

Assets			Liabilities		
		22116.41			32187.08
Foreign Assets	Foreign Exchange	21478.83	Reserve Money	Currency Issue	7707.36
	Monetary Gold	254.15		Reserves	24380.23
	Other Foreign Assets	383.43		Deposits of Non-Financial Institutions	99.49
	Claims on Government	1527.41		Non-Reserve Deposits	501.92
	Claims on Other Depository Corporation	10223.04		Bond Issue	0.00
	Claims on Other Financial Corporations	598.66		Foreign Liabilities	88.00
	Claims on Non-Financial Sector	10.19		Deposits of Government	2862.60
	Other Assets	1817.45		Own Capital	21.98
				Other Liabilities	532.09
Total Assets		36293.16	Total Liabilities		36293.16

Source: The People's Bank of China

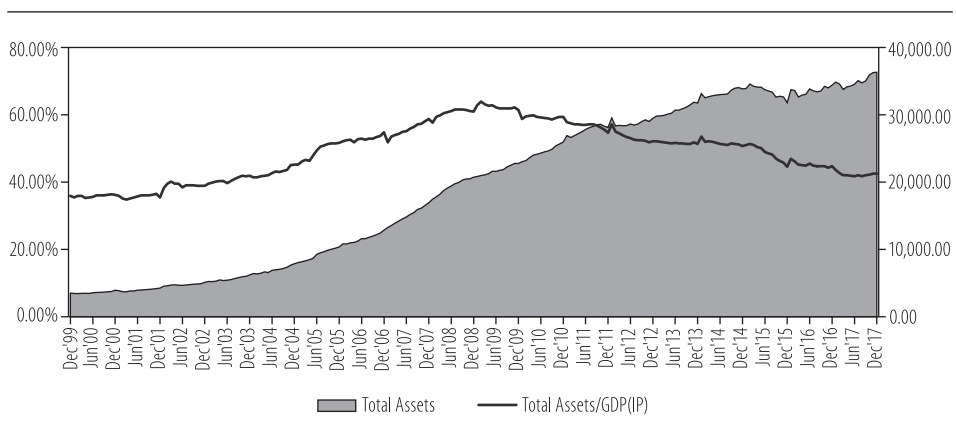
Table 1 shows that in the People's Bank of China's balance sheet, foreign assets, government bonds, and loans to financial institutions are the main compositions of the asset side, and base money, deposits from financial sector and government are the main components of the liabilities side. It is worth noting that the own capital and bond issue accounted for very lower shares of the total liabilities than

that in other important central banks. Particularly, China has accumulated huge amounts of foreign reserves since late 1990s, which dominates the People's Bank of China's foreign assets and accounts for a great fraction of the total assets.

3.2.1. Changes in the Size and Structure of the People's Bank of China's Balance Sheets

Figure 1 plots the changes in the total assets of the People's Bank of China and the ratios of total assets relative to GDP (monthly data proxy by industrial production) for the period 1999–2017. The total assets held by the People's Bank of China have increased approximately 10 times since 1999, raising from 3534.98 billion yuan RMB (right hand-axis, RHA) at the end of 1999 to 36293.16 billion yuan at the end of 2017. The ratios of the People's Bank of China's total assets relative to GDP (left hand-axis, LHA) ranged averagely from 35% to 65%, in contrast with the average ranges between 10% and 20% of other main central banks in most advanced countries during normal periods (Ferguson et al. 2014). The watershed for the ratio was in November 2009, when it peaked at 65.20%. Until November 2009, the ratio was rising, whereas after that date, the ratio was declining gradually. The decline in the size of the People's Bank of China's balance sheets (measured by the ratio of total assets to GDP) which started in November 2009 indicates that the People's Bank of China exited quickly from the quantitative easing monetary policies, which was a part of the so-called “Four Trillion” package to tackle the adverse spill-over effects of the 2008 global financial crisis.

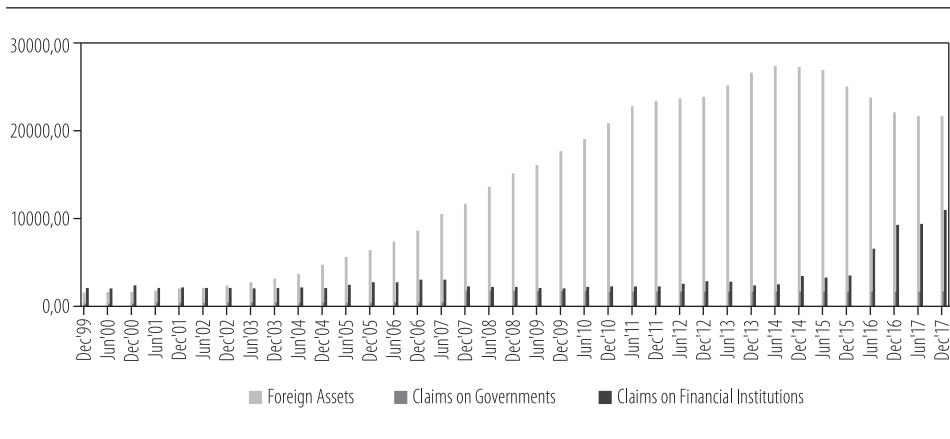
Figure 1: Total Assets of the People's Bank of China for the Period 1999–2017
(in billions of yuan, RMB for Righthand Vertical Axis)



Source: The People's Bank of China

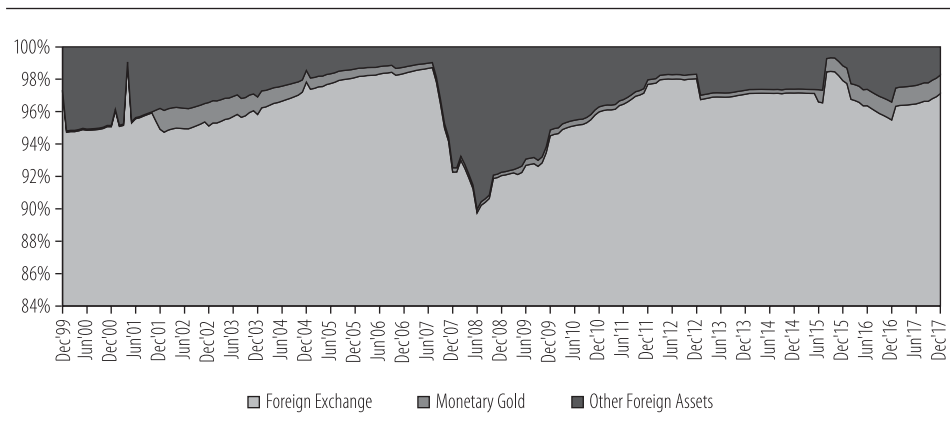
The foreign assets, claims on government (government bonds), and claims on financial institutions (loans to financial sector) are main components of total assets. These three items range from 83% to 99% of the total assets over the sample period. Figure 2 plots the evolution of the values for these three key assets of the People's Bank of China.

Figure 2: Foreign Assets, Government Bond and Loans to Financial Institutions
(in billions of yuan, RMB)



Source: The People's Bank of China

Figure 3: Shares of the Foreign Assets

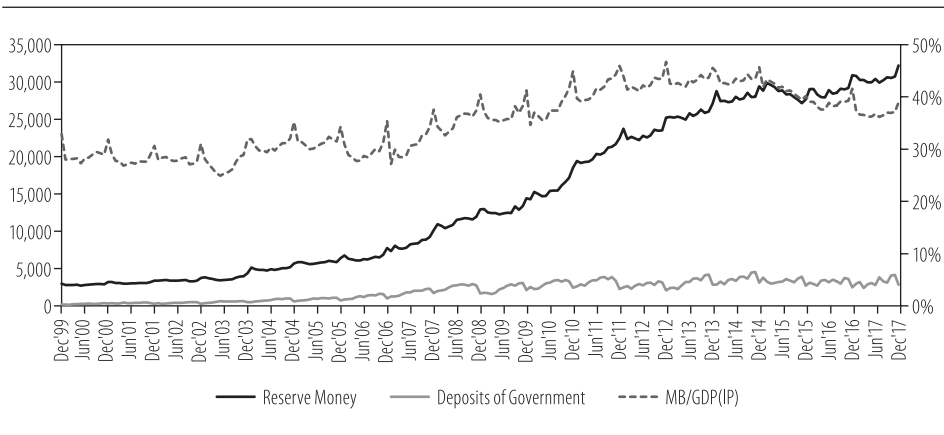


Source: The People's Bank of China

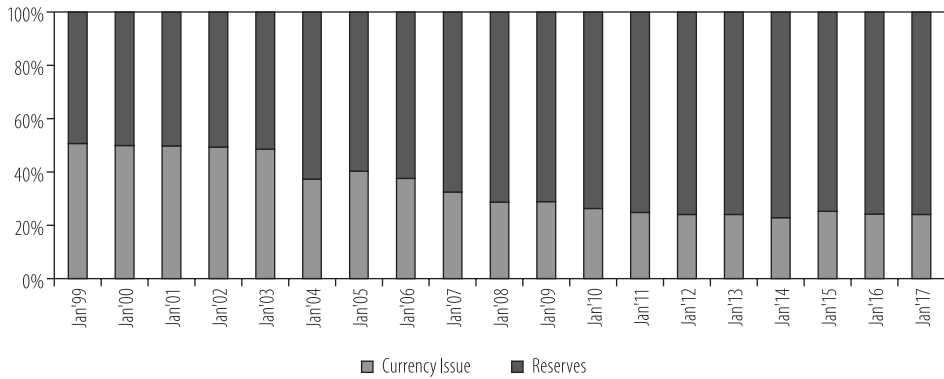
In particular, as illustrated in Figure 3, the foreign exchanges dominates the foreign assets as its shares remain above 90% over the sample period.

On the supply side, monetary base and deposits of government are two key components. Figure 4 presents the changes in the values of monetary base and deposits of government. As shown in Figure 4, while the monetary base had been expanding for the period of 1999-2017, the ratios of monetary base (MB) to GDP (RHA) with seasonal features were relatively constant over time prior to 2008, suggesting that the growth of monetary base is mainly associated with the growth of nominal GDP over this period. The rise in the ratio of monetary base to GDP which started in 2008 reflects a short-lived quantitative easing policy in the aftermath of the global financial crisis. Monetary base consists of currency issue and reserves from commercial banks, the latter has been rising arising from increasing required reserve ratios by the People's Bank of China to control the liquidity in the banking system, and it had held relatively higher share of monetary base since 2008 (Figure 5).

Figure 4: Monetary Base and Deposits of Government (in billions of yuan, RMB, LHA)

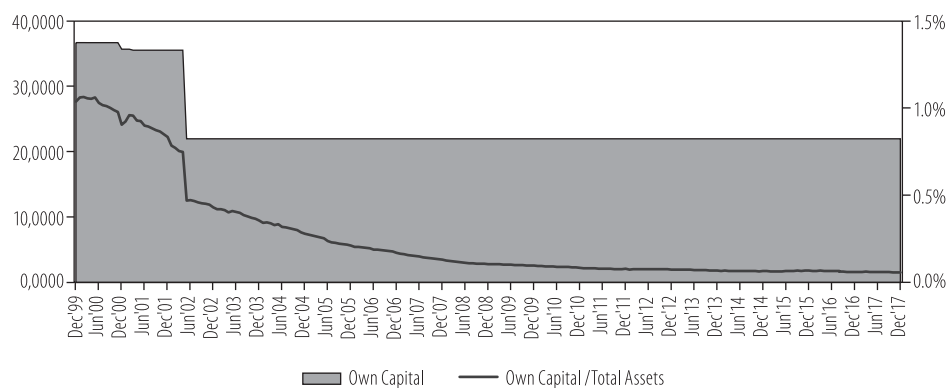


Source: The People's Bank of China and Author Estimation

Figure 5: Shares of Currency and Reserves in Monetary Base

Source: Author's Estimation

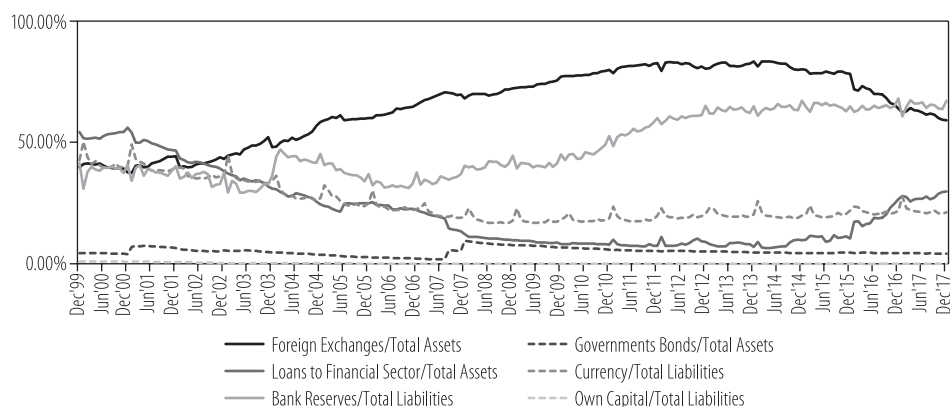
The own capital, as the equity of the People's Bank of China, fell from 35.52 billion yuan to 21.98 billion yuan in May 2002, and has remained at 21.98 billion since then. The ratio of the own capital to total assets has been declining over time, recently it remained at approximately 0.06% (RHA, Figure 6).

Figure 6: The Own Capital and Its Ratio to Total Assets (in billions of yuan, RMB, LHA)

Source: The People's Bank of China and Author's Calculation

Figure 7 depicts the evolutions of the main compositions relative to total assets/total liabilities on the basis of the People's Bank of China's balance sheets over the period 1999-2017. Note that the increasing ratios of foreign exchange to total assets stem from the huge accumulation of foreign reserves in China and from the continuous appreciation process of RMB until July 2015, when there happened a financial turmoil with a stock collapse followed by a depreciation process of RMB with gradual fall in this ratio onwards. The jumps in the bank reserves relative to total liabilities and in the claims on the government to total assets starting in mid-2008 reflect the opposite monetary operations of the People's Bank of China, on the one hand, the People's Bank of China reduced the market interest rate aiming at improving debt service costs through purchasing government bonds (OMO), on the other hand, the People's Bank of China raised the required reserve ratio aiming at constraining the liquidity to depress the asset prices⁶. The remarkable jump in the ratio of loans to financial sector to total assets which started in end-2015 reveals that the People's Bank of China had conducted certain credit easing policies⁷ since then.

Figure 7: Evolutions of the Main Contents Relative to Total Assets



Source: Author's Calculation

⁶ The People's Bank of China didn't tackle the surging house price by raising interest rates due to the fear on the increasing debt service burdens of local governments.

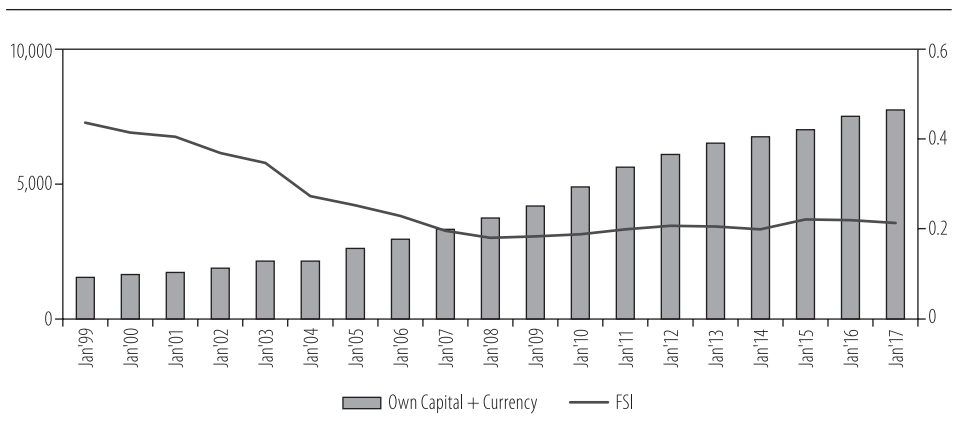
⁷ The distinction between quantitative and credit easing policies, see, for example, Van den End and Pattipilohy (2015, p1): "the former refers to a policy whereby a central bank increases its balance sheet size without changing the composition of central bank assets. By contrast, credit easing policies refer to a change in asset composition, while leaving total balance sheet size unchanged."

3.2.2. The Financial Strength of the People's Bank of China - Descriptive Analysis

In this subsection, we calculate the financial strength indicators designed for the People's Bank of China and provide a descriptive analysis. As defined in section 3.1, we employ the following three measures of the People's Bank of China's financial strength: the ratio of the sum of own capital plus currency in circulation to total assets, the ratio of the sum of the own capital and other items (net) to total assets, and the ratio of own capital plus retained profits to total assets.

The value of own capital plus currency and its ratio to total assets are calculated and reported in Figure 8. While the sum of own capital and currency is increasing over the period, the FSI fell from 0.437 in 1999 to 0.181 in Dec 2008, and then remained between the range of 0.2-0.25.

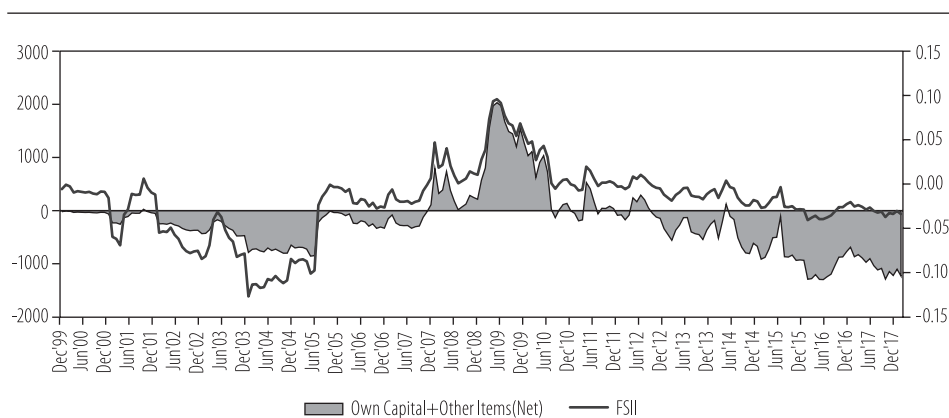
Figure 8: Own Capital Plus Currency and FSI (RHA) (in billions of yuan, RMB, LHA)



Source: Author's Calculation

The sum of own capital and the net other items and the second financial strength indicator are estimated and presented in Figure 9.

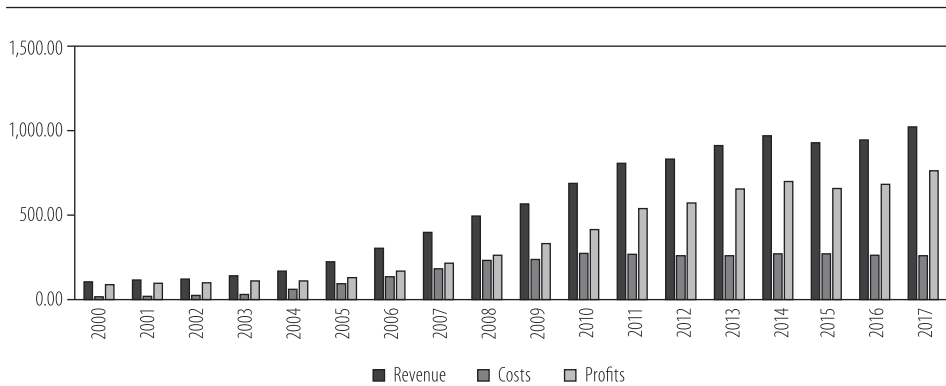
Figure 9: Sum of Own Capital and Other Items (Net), and FSII (RHA)
(in billions of yuan, RMB, LHA)



Source: Author's Calculation

As the People's Bank of China has never released any information about its annual profits and the ratio of the retaining profits, we estimated the annual revenue and costs and thereby the profits in terms of the People's Bank of China's balance sheets on the basis of certain necessary assumptions. The first assumption that we made is that the increase or decrease in the book value of the foreign assets (including foreign exchanges and monetary gold) arising from the depreciation or appreciation of RMB is not calculated into the revenue. Second, every stock variable is measured according to its annually average value. Third, we assume that the annually average yield rate of foreign exchange and government bond is 3%. Fourth, given that the interest rates for required reserves, excess reserves, and government deposits are 1.62%, 0.72%, and demand deposits rate, respectively, we use 1% as the consolidated average interest rate for these deposits. Fifth, the lending rates to financial sector were assumed to be 50 bps higher than the interbank rates. Sixth, the operating costs of the People's Bank of China were not calculated due to its tiny size compared with other costs items⁸. Finally, we assume that 30% of annual profits were allowed to be retained by the P People's Bank of China BC. The estimated results of the revenue, costs, and profits for the period 2000-2017 are shown in Figure 10.

⁸ Until now, the People's Bank of China only released the operating costs for two years: 0.58 billion yuan for 2011, and 0.68 billion yuan for 2012. Both are tiny compared with the total costs of the respective year.

Figure 10: Estimated Annual Profits of the People's Bank of China (in billions of yuan, RMB)

Source: Author's Calculation

Note that Qian and Yv (2014) estimated the profits of the People's Bank of China for (only) 2013 at approximately 180 billion, which is lower than ours in 2013 because they calculated the losses in the book value of foreign assets owing to the appreciation of RMB.

4. Empirical Results

Given that the People's Bank of China targets multiple objectives: stable nominal economic growth, currency stability, and financial stability, we examine the effects of the People's Bank of China's financial strength on these policy outcomes one by one in this section. Referring to other literature, the control variables in our study include growth rate of GDP, the interest rate, the world oil price index, and the GDP gap of the OECD countries. As our sample data are monthly, we apply X12 seasonal adjusting technique to those variables with seasonal features. The world price index cycle and China's GDP gap are abstracted from the monthly data of seasonally adjusted world oil price index and the growth rates of industrial production (proxy GDP) by using H-P technology (Lamda is taken as 14400), respectively. Table 2 provides the descriptive statistics of all model variables.

Table 2: Descriptive Statistics of Monthly Model Variables

Variables	No. of obs.	Mean	Std. Dev.	Min	Max	Source
Output Gap	217	0.00	2.86%	-15.97%	14.84%	Author
Exchange Rate	217	7.25	0.85	6.10	8.28	CEIN
Inflation Rate	217	2.18%	2.08%	-1.80%	8.70%	CEIN
FSI	217	25.31%	8.36%	16.76%	51.32%	Author
FSII	217	-1.96%	4.02%	-12.66%	9.56%	IFS, Author
FSIII	217	0.82%	0.36%	0.49%	1.84%	Author
Growth Rate of GDP(IP)	217	12.24%	4.72%	-2.40%	28.43%	CEIN
Interest Rate	217	2.39%	0.74%	0.84	6.58	CEIN
OECD GDP Gap	217	0.03%	1.11%	-3.04%	2.67%	CEIN
World Oil Price Index	217	117.73	57.15	34.74	249.66	IMF

4.1. Effects of the People's Bank of China's financial strength on the output gap

First, we examine if the financial strength of the People's Bank of China has impacts on the output gap (GDP gap), which is one of the most important targets of the People's Bank of China's policy. The control variables comprise the growth rate of GDP, interest rate, OECD countries GDP gap, and world oil price index cycle. According to the methodology (Equation (4)) described in Section 3.1, the effects of alternative financial strength indicators on the output gap are estimated through OLS and GMM approach (with lagged dependent variable and lagged explanatory variables as instruments), respectively. Table 3 summarizes the results.

Columns 2 and 3 in Table 3 report the results for FSI: the People's Bank of China's financial strength has negative effects on output gap both in OLS and GMM technologies, and the effects are significant in the former and insignificant in the latter.

Similarly, for the FSIII, the OLS estimation shows that the financial strength exerts significantly negative impacts on output gap, while the GMM approach indicates that the negative effects are insignificant (Columns 6 and 7 in Table 3).

The FSII has insignificant influence on stabilizing the output gap both in employing OLS and GMM methods, as illustrated in Columns 4 and 5.

It is worth noting that China's output gap is positively associated with the growth rate of GDP, the output gap of OECD countries, and the world oil price index cycle, and negatively related with interest rates in most cases of our estimation.

4.2. Effects of the People's Bank of China's financial strength on inflation rates

Ensuring the value of Chinese currency (RMB) stable is a legal responsibility of the People's Bank of China based on the law of the People Republic of China on the People's Bank of China (1993, 2003). In actual policy operations, however, the inflation target is not the primary goal of the People's Bank of China compared with the nominal economic growth (or employment), partly because that the People's Bank of China is a department under China's State Council rather than an independent institution. Nevertheless, the People's Bank of China consistently committed to a stable price level.

Table 3: Impacts of Financial Strength on Output Gap (Dependent Variable: Output Gap)

Financial Strength	FSI		FSII		FSIII	
Variables	OLS	GMM	OLS	GMM	OLS	GMM
Output Gap (-1)	0.348*** (0.056)#	0.684** (0.056)	0.382*** (0.058)	0.716*** (0.053)	0.370*** (0.057)	0.699** (0.050)
Financial Strength Indicator	-0.063*** (0.015)	-0.012 (0.012)	-0.014 (0.039)	0.039 (0.038)	-0.722* (0.389)	-0.028 (0.294)
Growth Rate of GDP	0.230*** (0.028)	0.090** (0.040)	0.171*** (0.025)	0.077** (0.038)	0.187*** (0.026)	0.077** (0.036)
Interest Rate	-0.478*** (0.153)	-0.324 (0.213)	-0.832*** (0.133)	-0.348* (0.205)	-0.665*** (0.157)	-0.372 (0.233)
OECD GDP Gap	0.248* (0.150)	-0.106 (0.135)	0.293* (0.156)	-0.134 (0.149)	0.293* (0.155)	-0.118 (0.143)
World Oil Price Index Cycle	0.016** (0.007)	0.013 (0.011)	0.020*** (0.007)	0.013 (0.010)	0.018** (0.007)	0.015 (0.011)
Adjusted R2	0.46	0.32	0.42	0.29	0.43	0.30

#: standard errors are reported in parentheses; ***, **, and * denote 1%, 5%, and 10% significance, respectively.

Following Klüh and Stella (2008), to avoid heteroskedastic error terms, the inflation rates are rescaled by actual inflation rate divided by one plus actual inflation rate. New measure of inflation rates ranging from 0 to 1, according to Perera et al. (2013), can be interpreted as the rate of depreciation of purchasing power. Using the same methodology as above, we estimate the effects of the People's Bank of China's financial strength on inflation rates, the results are presented in Table 4.

It shows that both the FSI and FSIII have significantly negative impacts on inflation rates under OLS method, and insignificantly negative effects under GMM method, implying that the stronger financial strength of the People's Bank of

China helps restrain inflation. FSII is irrelevant to inflation. In addition, the growth rate of GDP and the GDP gap of the rest of the world are more important positive determinants of China's inflation rates.

4.3. Effects of the People's Bank of China's financial strength on exchange rates

Ensuring the external price stability of RMB is also an important goal of the People's Bank of China. Table 5 demonstrates the empirical results of the effects of the People's Bank of China's financial strength on RMB's exchange rate against US dollar (number of RMB per dollar).

The empirical results suggest that the FSI (+) and FSII (-) have significantly effects on exchange rates under OLS estimation, however, the relevant effects are insignificant when using GMM method, suggesting the weak influences of the People's Bank of China's financial strength on pursuing of the stable exchange rates. The effects of FSIII are insignificant. Particularly, it shows that exchange rate of China's currency is significantly negatively affected by the growth rate of GDP and OECD GDP gap. That is, when the two latter variables rise, Chinese currency will appreciate.

Table 4: Effects of Financial Strength on Inflation (Dependent Variable: Inflation Rate)

Financial Strength	FSI		FSII		FSIII	
Variables	OLS	GMM	OLS	GMM	OLS	GMM
Inflation Rate (-1)	0.866*** (0.032) #	0.897*** (0.068)	0.904*** (0.026)	0.962*** (0.031)	0.859*** (0.031)	0.950*** (0.043)
Financial Strength Indicator	-0.010* (0.005)	-0.014 (0.011)	-0.0003 (0.010)	0.009 (0.014)	-0.300** (0.123)	-0.095 (0.150)
Growth Rate of GDP	0.026*** (0.009)	0.043* (0.024)	0.014** (0.007)	0.023* (0.013)	0.024*** (0.008)	0.017** (0.008)
Interest Rate	0.094* (0.052)	0.029 (0.081)	0.020 (0.036)	-0.060 (0.064)	0.109** (0.051)	0.007 (0.069)
OECD GDP Gap	0.099** (0.041)	0.076 (0.060)	0.091** (0.042)	0.042 (0.048)	0.110*** (0.042)	0.055 (0.055)
World Oil Price Index Cycle	0.0004 (0.002)	-0.003 (0.004)	0.0005 (0.002)	-0.003 (0.004)	0.001 (0.002)	-0.005 (0.004)
Adjusted R2	0.92	0.91	0.92	0.91	0.92	0.91

#: standard errors are reported in parentheses; ***, **, and * denote 1%, 5%, and 10% significance, respectively.

4.4. Effects of the People's Bank of China's Financial Strength on Macprudential Objectives

The global financial crisis has suggested again the importance of financial stability to the sound and sustainable economic development. As the central banks play the key role in attaining this objective by conducting so-called macroprudential regulation in most countries, investigating the link between the financial condition of a central bank and its ability to achieve the macroprudential policy task is therefore an important research issue. In this section, we take the volatility of the growth of total loans and the fluctuations in asset prices as the main indicators of macroprudential policy, and quantify the effects of the People's Bank of China's financial strength on the financial stability in China. Tables 6 and 7 illustrate the estimation results.

Table 5: Effects of the Financial Strength on Exchange Rate
(Dependent Variable: Exchange Rates)

Financial Strength	FSI		FSII		FSIII	
Variables	OLS	GMM	OLS	GMM	OLS	GMM
Volatility of Exchange Rate (-1)	1.000*** (0.003)	1.002*** (0.006)	1.003*** (0.002)	1.006*** (0.017)	1.001*** (0.002)	1.007*** (0.003)
Financial Strength Indicator	0.001* (0.0004)	0.0007 (0.0006)	-0.002*** (0.001)	-0.001 (0.0008)	0.013 (0.009)	0.006 (0.026)
Growth Rate of GDP	-0.002*** (0.001)	-0.0026* (0.0015)	-0.002*** (0.001)	-0.004** (0.002)	-0.002*** (0.001)	-0.004*** (0.002)
Interest Rate	0.0002 (0.003)	-0.0013 (0.0042)	-0.001 (0.003)	0.0004 (0.004)	-0.001 (0.003)	-0.002 (0.006)
OECD GDP Gap	-0.006** (0.002)	-0.0082** (0.0033)	-0.006** (0.002)	-0.0076** (0.0032)	-0.006** (0.002)	-0.008** (0.004)
World Oil Price Index Cycle	-0.0002 (0.0001)	0.0001 (0.0002)	-0.0002 (0.0001)	0.0001 (0.0002)	-0.0002 (0.0001)	0.0001 (0.0002)
Adjusted R2	0.99	0.99	0.99	0.99	0.99	0.99

#: standard errors are reported in parentheses; ***, **, and * denote 1%, 5%, and 10% significance, respectively.

Table 6 reveals that FSII is significantly positively related with the growth of total loans both under OLS and GMM regressions. The links between two other two financial strength indicators and the growth of total loans are insignificant. The growth of GDP (+), OECD countries GDP gap (-), and world price index (-) are significantly associated with the growth of total loans.

Given that the house price index is not available after 2011, we use the house prosperity index to proxy the house price index. Table 7 demonstrates that FSI (+) and FSIII (+) are significantly related to the house prosperity index under OLS approach, while the effects of FSII (-) are insignificant. The main determinants of the house price are growth of GDP (-) and interest rate (-).

Tables 6 and 7 illustrate that the People's Bank of China's financial strength could influence the objective of its macroprudential policy in several cases, however, the effects and magnitude are very low, and the effects of alternative financial strength are diverse.

5. Robust and Stress Tests on the People's Bank of China's Finance

5.1. Robust Tests

We have used alternative econometric technique (OLS and GMM) and alternative measure of the People's Bank of China's finance for robust tests in above section. In this section we conduct further robust tests by changing the measure of the explained variable and the key control variable.

First, we use the future average value of the financial strength, $\bar{y}_{t+4,t+k}$, to replace its current value, y_t , then equation (4) transforms to: $\bar{y}_{t+4,t+k} = \alpha FS_t + \beta x_t + \varepsilon_t$. This is conducive to avoid possible endogeneity and time lag effects. In this paper, we estimate the average value of dependent variables for next 4 to 15 months, and then the examinations in Section 4 are repeated. For simplicity, only the results for the output gap are presented (Table 8).

Table 8 demonstrates that the People's Bank of China's financial strength (FSI, FSII) does affect the future output gap significantly under GMM approach, moreover, the FSI maintains the significantly negative effects in Tables 3 and 8. However, compared to Table 3, the effects of the FSII and the FSIII are instable and non-robust. Similar results are obtained in simulating the effects of the People's Bank of China's financial strength on other policy indicators.

Table 6: Effects of the People's Bank of China's Financial Strength on Loans Growth
(Dependent Variable: Log of Total Loans)

Financial Strength	FSI		FSII		FSIII	
Variables	OLS	GMM	OLS	GMM	OLS	GMM
Log of Total Loans (-1)	1.000***# (0.0002)	1.001*** (0.0007)	1.001*** (0.0002)	1.001*** (0.0007)	1.001*** (0.0002)	1.000*** (0.0004)
Financial Strength Indicator	-0.0001 (0.0001)	-0.0001 (0.0001)	0.0003** (0.0001)	0.0006* (0.0003)	-0.0017 (0.0014)	-0.0024 (0.0020)
Growth Rate of GDP	0.0001 (0.0001)	0.0004* (0.0002)	0.0001 (0.0001)	0.0003* (0.0002)	0.0001 (0.0001)	0.0004** (0.0002)
Interest Rate	-0.0015* (0.0008)	-0.0019 (0.0031)	-0.0011 (0.0009)	-0.0018 (0.0032)	-0.0014* (0.0008)	0.0018 (0.0018)
OECD GDP Gap	-0.0014** (0.0006)	-0.0003 (0.0008)	-0.0015*** (0.0006)	-0.0005 (0.0009)	-0.0013** (0.0005)	-0.0006 (0.0007)
World Oil Price Index Cycle	-0.0004* (0.00002)	-0.0001* (0.0001)	-0.00004* (0.00003)	-0.0001* (0.0001)	-0.00004 (0.00003)	-0.0001* (0.0001)
Adjusted R2	0.99	0.99	0.99	0.99	0.99	0.99

#: standard errors are reported in parentheses; ***, **, and * denote 1%, 5%, and 10% significance, respectively.

Table 7: Effects of the People's Bank of China's Financial Strength on Asset Price
(Dependent Variable: Log of House Prosperity Index)

Financial Strength	FSI		FSII		FSIII	
Variables	OLS	GMM	OLS	GMM	OLS	GMM
Log of House Prosperity Index (-1)	1.001***# (0.0006)	1.007*** (0.004)	1.001*** (0.0005)	1.007*** (0.0042)	1.001*** (0.0006)	1.006*** (0.002)
Financial Strength Indicator	0.0001* (0.0001)	0.00001 (0.0001)	-0.0001 (0.0001)	0.00001 (0.0003)	0.0021* (0.0012)	0.0001 (0.002)
Growth Rate of GDP	-0.0002* (0.0001)	-0.0010** (0.0005)	-0.0002** (0.0001)	-0.0010* (0.0006)	-0.0001 (0.0001)	-0.0008** (0.0003)
Interest Rate	-0.0015** (0.0006)	-0.0091 (0.0058)	-0.0017** (0.0007)	-0.0091 (0.0058)	-0.0016** (0.0006)	-0.007*** (0.0028)
OECD GDP Gap	0.0001 (0.0004)	0.0011 (0.0012)	0.0001 (0.0004)	0.0012 (0.0012)	0.00003 (0.0004)	0.0009 (0.0011)
World Oil Price Index Cycle	-0.00001 (0.00002)	0.00001 (0.0001)	-0.00001 (0.00002)	0.00002 (0.0001)	-0.00001 (0.00002)	0.00002 (0.0001)
Adjusted R2	0.97	0.95	0.97	0.95	0.97	0.96

#: standard errors are reported in parentheses; ***, **, and * denote 1%, 5%, and 10% significance, respectively.

Second, we change the key control variable, replacing the interest rate by broad money (log form of M2), then repeat the regressions in Section 4 using equation (4). Table 9 shows the results for output gap⁹.

Table 8: Robust Test of Financial Strength on Output Gap (I)
(Dependent Variable: Average Value of Future Output Gap)

Financial Strength	FSI		FSII		FSIII	
Variables	OLS	GMM	OLS	GMM	OLS	GMM
Financial Strength Indicator	-0.002 (0.009)	-0.029* (0.015)	0.024 (0.023)	0.106** (0.050)	-0.059 (0.227)	-0.162 (0.341)
Growth Rate of GDP	0.035** (0.017)	0.068* (0.036)	0.035** (0.015)	0.082** (0.035)	0.034** (0.015)	0.071* (0.037)
Interest Rate	-0.179* (0.096)	0.012 (0.311)	-0.185** (0.080)	-0.269 (0.215)	-0.177* (0.096)	-0.344 (0.300)
OECD GDP Gap	-0.338*** (0.090)	-0.413* (0.225)	-0.334*** (0.089)	-0.455** (0.223)	-0.337*** (0.089)	-0.189 (0.211)
World Oil Price Index Cycle	-0.030*** (0.005)	-0.030 (0.023)	-0.030*** (0.004)	-0.021 (0.025)	-0.030*** (0.005)	-0.051** (0.020)
Adjusted R2	0.34	0.27	0.34	0.25	0.34	0.24

#: standard errors are reported in parentheses; ***, **, and * denote 1%, 5%, and 10% significance, respectively.

Table 9: Robust Tests for Financial Strength on Output Gap (II)
(Dependent Variable: Output Gap)

Financial Strength	FSI		FSII		FSIII	
Variables	OLS	GMM	OLS	GMM	OLS	GMM
Output Gap (-1)	0.302*** (0.054)	0.636*** (0.078)	0.314*** (0.055)	0.663*** (0.075)	0.309*** (0.055)	0.646*** (0.075)
Financial Strength Indicator	-0.041*** (0.015)	-0.018 (0.013)	0.018 (0.036)	0.055 (0.040)	-0.213 (0.372)	-0.163 (0.266)
Growth Rate of GDP	0.297*** (0.031)	0.126* (0.068)	0.281*** (0.031)	0.124* (0.067)	0.279*** (0.031)	0.115* (0.066)
Broad Money	-0.201*** (0.038)	-0.081 (0.061)	-0.261*** (0.031)	-0.104* (0.064)	-0.249*** (0.037)	-0.096 (0.070)
OECD GDP Gap	0.134 (0.145)	-0.078 (0.135)	0.121 (0.147)	-0.130 (0.150)	0.130 (0.148)	-0.079 (0.140)
World Oil Price Index Cycle	0.011* (0.007)	0.006 (0.008)	0.012* (0.007)	0.006 (0.008)	0.012* (0.007)	0.007 (0.008)
Adjusted R2	0.50	0.37	0.49	0.35	0.49	0.35

#: standard errors are reported in parentheses; ***, **, and * denote 1%, 5%, and 10% significance, respectively.

⁹ Results for inflation, exchange rate, and financial stable indicator are similar, and provided when required.

Comparing to Table 3, we find that the continuously consistently negative effects of the FSI remains significant under OLS in Table 9, while the significantly negative effects of FSIII become insignificant in Table 9.

In sum, it shows that the effects of certain measures of financial strength indicator (especially, the FSI) are robust in several investigations, while overall results lack robustness with respect to the economic technique and the choice of alternative measures of financial strength.

5.2. Stress Tests

Following Stella (2009, 2010), we design three hypothetical stress-testing scenarios in terms of the People's Bank of China's balance sheets: 10% losses in the risky assets (loans to financial sector), and 20% appreciation or depreciation of RMB within one year (a standard for a currency crisis).

In the People's Bank of China's balance sheets, the risk-free assets consist of foreign assets, monetary gold, and claims on government. Three items, the claims on other depository corporations, the claims on other financial corporations, and claims on non-financial sector constitute the risky-assets, in which the first one dominates. The recent practice of the People's Bank of China's monetary policy generates three types of highly risky assets:

A. *Standing Lending Facility (SLF, launched in Jan, 2013)* was an instrument to provide large amounts of liquidity support to financial institutions (policy banks and commercial banks) under request, likely the Marginal Lending Facility provided by ECB. Its maturity is 1-3 months. The accepted collaterals include high-rated bonds and superior credit assets. At the end of 2017, the balance of SLF was 130.42 billion yuan, accounting for 1.2% of total risky assets.

B. *Medium-Term Lending Facility (MLF, launched in September 2014)* “was designated to inject medium-term base money to financial institutions (policy banks and nationwide commercial banks) that have complied with the requirements of the macro-prudential management. The interest rates of MLF will serve as the medium-term policy rate, and the MLF is expected to play a role in reducing the financing cost of the real sector.” (Highlights of China's Monetary Policy in the Third Quarter of 2014, The People's Bank of China, 2014, <http://www.pbc.gov.cn/en/3688229/3688353/3688362/index.html>). The MLF operations accepted government securities, central bank bills, China Development Bank bonds, policy financial bonds, local government debts, AAA-rated corporate debenture bonds

as collaterals. Its maturity is 3 months. The total outstanding of MLF was 4521.5 billion yuan at the end of 2017, which accounts for 41.74% of total risky assets.

C. Pledged Supplementary Lending (PSL, launched in April 2014) aims to provide long-term lending support for city housing improvements, city utility and projects of “one belt one road” to National Development Bank, Export and Import Bank of China, and Agricultural Development Bank of China. The accepted collaterals are similar as the SLF. The contract term is 1 year. The outstanding balance of PSL was 2687.6 billion yuan at the end of 2017, which accounts for 24.82% of total risky assets.

In the first hypothetical scenario, some banks would default on their borrowing from the People’s Bank of China and that less than full value would be recovered from the collaterals. Applied to the end-2017 balance sheet (Table 1) and the abovementioned three projects, 10% losses in the highly risky assets yielded approximately 733.95 billion yuan losses in asset side. On the basis of our three measures of the People’s Bank of China’s financial strength, at end-2017, FSI could support 10.53 times losses in highly risky assets, negative FSII at end-2017 fails to support any losses in risky assets, and for FSIII, according to our estimation, the retained profits of the People’s Bank of China in 2017 was approximately 228.3 billion yuan, plus the own capital, can only cover the 34.1% losses in highly risky asset, however, if the People’s Bank of China is allowed to retain its annual profits in 2017, then the sum of own capital plus profits is 783.01 billion yuan, which is enough to compensate the whole hypothetical losses in highly risky assets, although the People’s Bank of China’s own capital, 21.98 billion yuan at end-2017, can only cover 2.99% losses in highly risky asset.

China announced the adoption of a floating exchange system in May 2015. Since then, the volatility of exchange rate has increased. Prior to August 2015, RMB had been appreciating, exchange rates raised from 8.28 to 6.10, and the appreciation had accelerated after 2011. August 2015 marketed the downturn of the value of RMB against US dollar. The exchange rate of RMB fell from the peak of 6.10 to the lowest 6.95, depreciating approximately 13.87%. Simultaneously, the foreign exchange in the assets of the People’s Bank of China fell from 264,069 billion yuan in July 2015 to 214,788 billion yuan in December 2017 for supporting the exchange rate of RMB, losing approximately 18.67%. The second scenario simulates these processes.

When RMB depreciates 20%, theoretically, the book value of the foreign assets held by the People’s Bank of China would increase 20% and thereby generate a premium of 4295.77 billion yuan (book profits) in the book value of total assets

of the People's Bank of China's at the end of 2017. These wouldn't cause more exposures to the People's Bank of China theoretically, however in reality, the depreciation of RMB resulted in the dramatically fell in the foreign exchanges held by the People's Bank of China due to the intervention of the People's Bank of China against the capital outflow. On the other hand, if RMB appreciates 20% in terms of the People's Bank of China's balance sheet at the end of 2017, the foreign assets would fall and yield 4295.77 billion yuan losses in the book value. Considering the financial strength of the People's Bank of China at the end of 2017, the own capital plus annual profits (FSIII) only cover 18.23% of the losses, while the own capital plus the currency is 1.8 times losses. When RMB appreciates, however in reality, the foreign assets increased because Chinese residents sell the foreign exchanges to the banking system, therefore we see an accelerated accumulation of the foreign exchanges and a remarkable increase in the total assets of the People's Bank of China for the period 2007-2015.

Not surprisingly, our stress-testing results show that the People's Bank of China's standalone finance is healthy, and even in most severe disrupting episodes, the People's Bank of China doesn't need recourse to outside financial sources.

6. Conclusion

The People's Bank of China's financial strength has been given less concerns due to its lack of independence and its complete fiscal indemnities from the central government. Our study is the first attempt to examine the standalone finance of the People's Bank of China in detail in terms of its balance sheets. In this paper, we firstly define three indicators to quantify the financial conditions of the People's Bank of China, which uncover substantial financial information of the People's Bank of China from several aspects. Particularly, given that the People's Bank of China has never published the profits, we have estimated the revenues and costs and thereby the profits for the People's Bank of China over the period 2000-2017. Secondly, we employ OLS and GMM techniques to evaluate the effects of the financial strength on the policy performance of the People's Bank of China. The empirical results suggest that the People's Bank of China's financial strength does influence the performances of its monetary and macro-prudential policies, despite the lower magnitude of the effects. Therefore, maintaining benign financial conditions and a resilient balance sheet are necessary pre-conditions for the People's Bank of China to achieve desirable policy outcomes. Thirdly, our stress tests show that the People's Bank of China's finance is healthy under assumed scenarios. These results shed insightful lights to the People's Bank of China's policy operations, risk-monitoring, and risk-preventing.

However, cautions should be paid to explaining and applying our results. The robust tests suggest the overall lack of robustness with respect to the econometric technique and the choice of alternative measures of financial strength. Particularly, no financial strength indicator maintains a significantly negative coefficient across all econometric methods in our study.

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