Macroprudential Policy, Central Banks and Financial Stability: Evidence from China

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Abstract: This paper focuses on the Chinese case and studies monetary policy tools that the PBC has been applying in "leaning against credit bubbles" to constrain the potential buildup of financial vulnerability. In so doing, we employ the narrative approach, studying the PBC's documents to extract the relevant information on how it comes to decision of taking various macroprudential policy measures, so as to construct an index of these measures. We then show that all these tools, especially the required reserve ratio, help to smooth the credit cycle and thereby contribute to financial stability.

Key words: macroprudential policy, monetary policy, credit cycle, financial stability

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1. Introduction

The financial crisis hit economies worldwide during the period of 2007-2009. More broadly, financial crises are recurrent plagues, evidenced as a hardy perennial deeply rooted in the financial history in Kindleberger (1978). Quite often, they are concomitant with deep asset market collapses as well as profound drops in output and employment. This time is *not* different: the Crisis triggered downturns of the global economy, the so-called Great Recession (see, e.g., Ball 2014, Reinhart and Rogoff 2009, Reinhart and Rogoff 2014, Romer and Romer 2015). Over decades, economists have been trying to understand how to identify financial instability early enough for successful countermeasure and how to make the financial system more resilient to shocks. Among them, Minsky (1977) and Kindleberger (1978) have argued for the financial instability hypotheses that the financial system is prone to turn unstable over periods of prolonged prosperity through endogenous credit booms. That is, "success can lead to excess, and excess to ruin", as interpreted in Yellen (2010). Or in Crockett (2000)'s words, "it may be helpful to think of risk as increasing during upswings, as financial imbalances build up, and materialising in recessions."

More specifically, Eichengreen and Mitchener (2004) provide evidence for the credit-boom view of economic cycles and interpret the Great Depression as "credit booms gone wrong". A series of recent work by Jorda, Schularick, and Taylor (e.g., Jorda, Schularick, and Taylor 2013, Schularick and Taylor 2012, Taylor 2015) lends compelling support for this argument, where they use the large dataset (on 14 advanced countries over the past 140 years) and find that past growth of credit predicts future financial instability.[2] That is, "most of expansions of money and credit do not lead to a mania; ... but every mania has been associated with the expansion of credit," as summarized by Kindleberger (1978: 64).

This "credit-booms-gone-bust" finding provides the rationale for the mitigation of potential financial fragility through policies leaning against credit booms. The current debates are more involved in the search for, with a few exceptions (among others, Elliott, Feldberg, and Lehnert 2013, Kelber and Monnet 2014), some newly designed regulations on state-varying capital and liquidity requirements for banks[3] and state-varying margin controls for various asset markets. However, "contrary to the common view

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[2] Eichengreen and Mitchener (2004) and Taylor (2015), among others, provide good comprehensive literature reviews over studies exploring the interdependence among credit, asset prices and financial instability.

[3] For example, countercyclical bank capital buffers under Basel III, under which minimum capital requirements vary over the cycle.

that monetary policy and policies toward financial stability should be seen separately, they are inseparable" (Adrian and Shin 2009: 11). Indeed, leaning-against-financial-instability monetary policies were not new either in the monetary history of advanced economies or in the current monetary operations of developing countries. For example, financial stability took center stage in the initial mandate of the United States' central bank, when the Fed was founded (Reinhart and Rogoff 2013). Over its post-WWII history until the early 1980s, the Fed had taken various monetary and credit policy tools, among which are the reserve requirements (Regulation D), interest rate ceilings (Regulation Q), credit controls, etc., to restrain financial imbalances (see, among others, Elliott, Feldberg, and Lehnert 2013, Reinhart and Rogoff 2013); notably, during that period "there were no systemic banking crises in the US", as pointed out by Reinhart and Rogoff (2013: 5). More importantly, many of these tools are still playing an active role in emerging economies, for example, in China.

Since the onset of the Crisis, central banks are returning to their roots by re-assuming a broad mandate. They "were saddled with two objectives at the same time: price stability and financial stability" (Goodhart 2014: 11). This task to safeguard financial stability requires the central bank to play an active role, more than providing necessary liquidity support as the lender of the last resort, in following a macroprudential approach in the making of monetary policies, and monitoring the payment and settlement system (MPR 2011:4, p.16). Moreover, in its report on central bank governance and financial stability, the Bank for International Settlements (BIS) suggests that macro-prudential responsibility should be better performed by central banks as they are in a stronger position to carry out macro and systemic analysis. This view was echoed by Mr. Blanchard, chief economist of the International Monetary Fund (IMF), who, in his report on rethinking the macroprudential policy framework, argued that it is important to give central banks a macroprudential management mandate because they are ideally capable of monitoring macro-economic developments and because monetary policies may weigh on leverage and risk behavior. However, "with the policy interest rate predicated to achieve price stability, we needed a second instrument to maintain financial stability; hence macroprudential instruments" (Goodhart 2014: 11). This paper presents Chinese experience, focusing on roles that monetary policy tools can play in the macroprudential management by studying monetary and credit policy tools that the People's Bank of China (PBC) has been applying to counter the credit cycle and hence constrain the potential build-up of financial vulnerability. To do so, we first employ the narrative approach, studying the PBC's documents to extract the relevant information on how it comes to decision of taking various macroprudential policy measures (for example, credit controls, specific central bank lending schemes,

window guidance[4] and the required reserve ratio), so as to provide a comprehensive survey on them. We show that all these tools, especially the required reserve ratio, help to smooth the credit cycle and thereby contribute to financial stability. This paper hence provides strong supportive evidence for monetary tools being used in the macroprudential management to lean against credit bubbles.

Several papers try to estimate the effectiveness of macroprudential policies, mainly following two lines. The first line is to use cross-country datasets. Among them, Claessens, Ghosh, and Mihet (2013) and Lim et al. (2011) run panel regressions, using data from over forty countries and provide supportive evidence for the effectiveness of macroprudential policies, such as caps on the loan-to-value (LTV) ratio, caps on the debt-to-income ratio, credit ceilings, reserve requirements and capital requirements, in mitigating systemic risks. In a similar vein, Federico, Vegh, and Vuletin (2014) draw their findings based on a panel dataset of 52 countries for the period 1970-2011, but focusing on the reserve requirements policy only and its role as a macroeconomic stabilization tool. They find that compared to industrial countries, developing countries are more likely to actively use this policy as a countercyclical tool.

The second line is to focus on the individual country's experience. Jiménez et al. (2012) examine countercyclical loan loss provisioning, using rich micro-level data from Spanish banks and firms. They show that it smooths cycles in the supply of credit. They then evidence the very large positive effects of this countercyclical macroprudential policy on the macroeconomy in crisis times. He (2013, 2014) focuses Hong Kong's approach to financial stability. In particular, he investigates the effects of caps on LTV ratios on household leverage, credit growth and property prices. He shows that caps on LTV ratios have been effective in constraining household leverage, but do not appear to have sustained effects on housing prices.

A few studies have focused on China's practice and examined its prudential policies. Liao (2012), based in the China Banking Regulatory Commission (CBRC), presents the framework, from a financial regulator's perspective, how China has monitored and assessed systemic risks. He points out that macroprudential policy complements microprudential supervision and in China, financial stability is a shared responsibility among different authorities such as the PBC and the CBRC. Wang and Sun (2013) then use panel data based on 171 banks for the period of 2000-2011 to study a set of policies launched

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[4] It is an administrative tool in a form of "moral suasion" or "indirect pressure" through regular meetings with commercial banks so as to influence the quantity and the structure of bank lending.

by the PBC and the CBRC, including monetary and macroprudential policies, and microprudential supervision – the interest rate, the required reserve ratio, house-related policies, the capital adequacy ratio, the liquidity ratio, and the ratio of reserves for impaired loans/gross loans – and their impacts on credit and house prices. Their findings, based on the panel regressions, are mixed: for the sample of all banks, they did not find significant impact of the required reserve ratio on credit, while facing a hike in this ratio, large banks significantly reduced credit supply.

Our paper supplements the existing literature from several different aspects. First, we focus on China's case and particularly its macroprudential monetary policies, carefully exploring their state-varying and counter-cyclical features and estimating their impact on total lending[5] for the period of 2000Q1 to 2015Q1. Second, in contrast to Wang and Sun (2013)'s practice, we use macro aggregate data as macroprudential policies are targeting financial stability and are more concerned with the system as a whole, though the use of macroprudential policies can be granular. Third, we use a vector autoregression (VAR) model and estimate its impulse response to trace the impact of macroprudential policy innovations on the total credit. In this way, we model decision-making in a dynamic process by considering two-way interaction between policies and credit, with policy responses to the state of credit included as well. Such modelling matches the reality better: the PBC reacts to the credit condition and decides for macropudential actions based on the information on it.

This paper proceeds as follows. Section 2 provides an institutional background of Chinese monetary policy and presents an overview of the PBC's macroprudential monetary policy tools. Section 3 discusses data issues and identifies the credit cycle in China. Section 4 examines the effectiveness of each macroprudential monetary policy tool on the credit cycle. Section 5 concludes.

2. The PBC's Macroprudential Policy Instruments

The PBC's mandate is defined in the People's Bank of China Act (amended in 2003) as "to maintain the stability of the value of the currency and thereby promote economic growth". At the same time, the PBC's monetary policy is entrusted to "guard against and eliminate systemic financial risk and maintain

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[5] In this paper, we do not address fluctuations in asset prices and the policy effectiveness on them directly, as this issue is subordinate and moreover it can be too complicated. In contrast, credit, especially bank lending to GDP ratio, is a good indicator of financial stability. Large fluctuations in home prices are either a simple consequence of excessive credit or too complicated (e.g., driven by many demand and supply factors, which is exactly China's case where there has experienced rapid urbanization and fast rises in land prices) to be explored in this paper.

financial stability". In summary, the PBC's policy objectives are threefold: price stability, economic growth, and financial stability. In the context of consistent labor surplus for the last decades in China, either freed from the agricultural sector or as a result of laid-off workers from state-owned enterprises (SOEs), job creation through economic growth and thus political stability has been an overwhelming objective for Chinese government. The targets of economic growth are set each year by the government and one of major tasks of the PBC is to implement monetary policy in line of those growth targets.

The last objective, financial stability, is mainly reflected in exchange rate stability (consequently, liquidity management) and credit control/guidance. The RMB exchange rate regime[6] requires that the PBC be actively engaged in foreign exchange interventions and the subsequent sterilization operations. The foreign exchange purchases are first reflected in rises of excess reserves. This resulted excessive liquidity is not necessarily what the PBC wants. The PBC withdraws excessive liquidity through three ways: repo transactions, issuance of central bank bills, and increase of the required reserve ratio (Sun 2015b). Meanwhile, the PBC is intermediate-targeting the new total bank lending, together with the broad money[7] (M2). Besides this aggregate targeting, the PBC attaches great importance to the loan structure in its policy implementation and is actively engaged in "administration of guidance planning" so as to guide bank lending to resolve financial risk (*China Monetary Policy Report 2003:3*, p.6). This will be elaborated in the following sections.

From 1984 until 1997, the operation of monetary policy was based on the credit plan, indicating that central planning still played an important role in the implementation of monetary policy. The PBC set the quantitative bank-specific loan quotas – they are precise lending ceilings for individual financial institutions[8] – and provided liquidity to those banks, which then allocated credit to government-preferred sectors and projects. In 1996, the PBC introduced the growth rates of monetary aggregates (M1 and M2) as nominal anchors and adopted them, together with the loan quotas, as its intermediary targets. Two years later, in January 1998, bank-specific credit quotas were formally abolished. However, it does not imply that the credit policy has since then faded out from the PBC's practice: it is targeting the increase

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[6] In July 2005, China announced to give up its decade-long dollar peg and switch to a managed floating exchange rate regime with a daily movement up to +/- 0.3 percent in bilateral exchange rates. This daily band was extended gradually to the current level (+/- 2 percent).

[7] According to the PBC, monetary aggregates are M0 (currency in circulation), M1 (sum of M0 plus demand deposits) and M2 (the sum of M1 plus savings and time deposits) (see *PBC's Annual Report 2007*).

[8] Such direct lending controls were used by many other central banks in the post-WWII era, for example, in the UK, Japan, France and Korea.

of total bank loans; the PBC routinely employs credit-policy tools to control the quantity of credit and affect the structure of credit. In May 1998, the PBC undertook open market operations on a regular basis – twice per week, on Tuesday and Thursday. There is thus a consensus in the literature to mark 1998 as a turning point of the PBC's monetary policy regime from direct to more indirect control (see, e.g., Cao 2001, OECD 2010, Sun 2013, Xie 2004). This paper focuses on the post-1998 monetary policy regime.

At the moment, the PBC applies a mix of quantity- and price-based monetary policy instruments to achieve various policy objectives. They are supplemented by credit policy tools – specific lending and "window guidance". With monetary policy, the PBC controls the total amount of money supply and credit, while with credit policy, the PBC is actively engaged in directing bank lending and thereby shaping the structure of bank loans. In general, monetary policy tools are more market oriented, while specific credit tools are discontinuous in time and more direct. Table 1 summarizes monetary and credit policy instruments that the PBC applies.

Table 1: Policy instruments applied by the PBC

Monetary policy instruments	
Open market operations	Quantity-based indirect tool, including repurchases transactions, outright transaction, the issuance of central bank bills (CBB)[a] and short-term liquidity operations (SLO)[b].
Central bank lending	Including central bank lending, rediscounting, the standing lending facility (SLF) and the medium-term lending facility (MLF).
Interest rates	Price-based tool, including various central bank base interest rates. The deposit rate and lending rate of commercial banks were highly regulated.
Required reserve ratio	On a discretionary basis and more direct tool.
Credit policy instruments	
Specific central bank lending schemes	On a discretionary basis. Under certain specific eligibility requirements, the PBC provides special funds at a lower cost for a particular group of industries or regions.
Window guidance	Administrative tool in a form of "moral suasion" or "indirect pressure" through regular meetings with commercial banks so as to influence the quantity and the structure of bank lending.

Notes: a. CBBs are short-term securities issued by the PBC, introduced in 2002 to deal with the inadequate supply problem of government bonds. Since then, the PBC has used them extensively to offset rises in liquidity in the banking system as a result of the PBC's foreign exchange purchases. Therefore, CBBs are often referred as sterilization bonds.

b. The SLO was introduced in early 2013, used on a discretionary basis to manage the temporary liquidity fluctuations in the banking system. As a necessary supplement to the regular OMOs, SLOs are mainly repurchase operations with a maturity of less than seven days, carried out in market-based interest-rate tenders.

Source: Authors' updated modification based on Sun (2013: 59).

2.1 Taxonomy

Only since the onset of the recent Crisis, the term "macroprudential" has been widely used to describe policies/regulations that are counter-cyclical, aiming to restrain systemic risks and maintain financial stability, although such actions have been long existing. Our paper reviews the PBC's policies before and after the Crisis. For the prior-Crisis period, we are defining macroprudential policies in retrospect using today's new term. Naturally, we cannot expect that this term appeared in the PBC's policy description for that period. A conceptual outline would be helpful for us to detect and categorize these actions.

Macroprudential policies differ from the microprudential approach in intention and policy framework. The former seeks to safeguard the financial system as a whole, while the latter, the microprudential approach, is a partial equilibrium concept, aiming to prevent the costly failure of individual financial institutions (Hanson, Kashyap, and Stein 2011). Good macroprudential policy is preemptive by taking the punchbowl away just as the party gets going. Its "instruments are intended to be counter-cyclical – to tighten during the boom over asset prices and credit expansion, and to be relaxed, or even removed entirely, during the subsequent slump. … In particular, it is much more granular than the use of interest rates in monetary policy more broadly" (Goodhart 2014: 13). More importantly, in the aftermath of the Crisis, the consensus seems to emerge among both academics and policymakers that financial stability needs to move in a macroprudential direction (Hanson, Kashyap, and Stein 2011).

Furthermore, it is widely agreed that macroprudential policies should increase the resilience of the financial system against financial shocks, contain financial booms; and strengthen the structure of the financial system (FSB, IMF, and BIS 2011, Schoenmaker 2014). We hence define the PBC's policy actions to be of a macroprudential nature if they are aiming to improve the countercyclicality of the credit and/or improve the resilience of the financial system. That is, policy actions are:

(a) Targeting the credit aggregate and in particular, aiming to smooth credit cycle through stimulating credit supply in busts and restraining excess credit in booms; and/or

(b) Targeting the credit structure and more specifically, aiming to soothe maturity mismatching of the assets and liabilities in financial institutions; reduce non-performing loans (NPLs) to resolve the financial risks; rein in asset prices through guiding bank loans away from boomed asset markets.

The first part of our definition follows the "credit-booms-gone-bust" finding, which suggests that macroprudential policies monitor total loans in a countercyclical way. In the second part of our definition, we include those policy actions addressing the maturity mismatch problem and NPLs. These lead to the potential build-up of financial vulnerability that concerns the PBC, as addressed in its Reports repeatedly (for example, *China Monetary Policy Report 2003:3*; *2009:4*). Also, we include actions that particularly target property markets and asset prices. The theoretical argument for this lies in the hypothesis of systematic risk spillovers, i.e., disturbances in property markets would spill over on the rest of the financial system. In his classical work about financial crises, Kindleberger (1978) describes this kind of risk transmission as manias, panics and crashes, as indicated by the book's title. That is, a property mania will often end with a bubble (e.g., the Dutch tulip bulb bubble in the 1630s, the late 1920s stock price bubble, etc.); then a burst of a bubble will eventually endanger financial stability. Thus, it is necessary for central banks to keep an eye on asset price inflation as well, in addition to its traditional mandate of keeping price stability of consumer goods.

The PBC considers real estate industry as one of the key industries of national economy. It is of utmost importance to sustain stable and healthy development of the real estate sector for the quality development of the economy. In practice, the PBC keeps close watch on the housing market. In its quarterly *China Monetary Policy Report*, there is one section, "The Real Estate Industry", which reviews the development of the real estate, its sales and its prices, the growth of housing mortgage loans, and its implication for the financial stability, etc. Quite often, policy measures to curb excessive housing mortgage expansion are discussed as well.

Another important guideline that we use to distinguish macroprudential policies from monetary policy actions is to allow macroprodential policies to take a more granular approach (see. e.g., Brunnermeier and Schnabel 2014, Goodhart 2014). This is reflected mainly in two dimensions. First, the central bank might apply different prudential standards to different financial institutions in proportion to their systemic relevance. For example, large systemic important institutions might be subject to higher capital requirements and more intensive supervision, because problems at these institutions pose more severe threats to the stability of the whole system.[9] Second, rather than broad use of monetary policy,

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[9] If we follow the framework of the FSB, the IMF and the BIS (2011), which formulates systemic risks in two dimensions: the time dimension and the cross-sectional dimension, this granular approach addresses systemic risks in the second dimension. Also, it is important to note that the objectives in these two dimensions – in the time dimension to mitigate financial system procyclicality and in the cross-sectional dimension to reduce systemic risk concentrations – are neither necessarily conflicting nor exclusive. Rather, system-wide risks in both dimensions need be monitored and addressed.

macroprudential policy can target particular markets or sectors, such as housing and asset markets, as discussed in the second part of our definition.

The PBC regularly addresses the loan structure and corresponding measures to guide bank loans in its Monetary Policy Reports. However, the PBC does not confine the use of credit guidance to resolving financial risk. Rather, credit guidance is often used to tackle structural imbalances, which have been of major concern to Chinese government. They are reflected in unbalanced economic growth with the buildup of excessive capacity in some sectors and the underinvestment in some other sectors; the rising regional disparity, mainly between coastal and interior regions; the soaring income inequality, especially between rural and urban residents. Together with other policy measures (either fiscal or industrial), monetary policy has been widely used to guide bank loans to underinvested sectors/regions, including small- and medium-sized enterprises (SMEs), agriculture, western underdeveloped regions, job creation, etc. (for example, *China Monetary Policy Report 2003:3*; *2009:4*; *2010:1*). However, policies in this line are better defined as industrial policies. In our identification of macroprudential policy actions, we carefully exclude credit guidance policies aiming to improve the industrial structure from those aiming to improve the resilience of the financial system, as specified in the second part of our definition. Only the latter is defined to be of a macroprudential nature.

Our definition is strictly in line with the PBC's conceptual formulation about "macroprudential". [10] In 2011, it outlined "a countercyclical financial macroprudential management framework" as the one where it relies on "effective measures, (such as) credit policy, differentiated reserve requirements[11] and adjustments in the down payment share for mortgage loans, as well as risk warnings through window guidance" while "closely watching money and credit growth" (*China Monetary Policy Report 2011:4,* p.17). This term has appeared frequently in the PBC's documents to describe its post-Crisis current and future monetary policy. For example, in 2009 it "will establish a macroprudential management system, … (which) is expected to play a counter-cyclical adjustment role across business cycles, enhancing the resilience of the financial system" (*China Monetary Policy Report 2009:3*, p.46); in 2013 and 2014 it has "focused on the goals of macroeconomic management", "neither loosening nor tightening the supply of money",

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[10] In the aftermath of the Crisis, the PBC started to describe its policy adjustment in July 2008 as a policy shift to "flexible and prudent" (*China Monetary Policy Report 2008:3*, p.10). Then around mid-2009, for the first time the term "macroprudential" appeared in the PBC's *China Monetary Policy Report* (2009:2, p.35) in a box article on the international consensus about macroprudential regulations to safeguard financial system stability.

[11] That is, the reserve ratio applied to different banks is allowed to vary, either following a fixed rule (as in the two-tier reserve requirement system) or subject to dynamic adjustment in line with certain criteria.

but "conducting fine-tuning and preemptive adjustments when necessary" (*China Monetary Policy Report 2013:4;2014:1*) such as "to create a good financial environment and monetary conditions for … the economy" ("Press Release" on the 2013:2 MPC Meeting). In so doing, the PBC realized that **"**interest rates and the reserve requirement provide strong signals, it is thus necessary to adopt (more granular) macroprudential measures to guide commercial banks to operate on a sound basis and to refrain from excessive expansion" (*China Monetary Policy Report 2014:3,* p.18).

2.2 Macropudential Monetary Policy Tools

With this definition, we go through the PBC's toolkit to pin down those macroprudential ones. The upper panel of Table 1 presents its monetary policy instruments. They are a mix of quantity and price measures, including open market operations, central bank lending, interest rates and changes in the required reserve ratios. Most of them appear in the list of policy instruments in advanced countries as well. However, in normal times their central banks in practice mainly use open market operations per se. They seldom change the required reserve ratio and the central bank lending is small in quantity.

By contrast, all these monetary policy tools play different important roles in China (Sun 2013). For example, the PBC uses open market operations (OMOs) extensively, via repurchase transactions, outright transactions and the issuance of central bank bills, to absorb the excess liquidity in the banking sector resulting from foreign exchange market interventions, rather than to meet the operational target of a money market rate (as the Fed and the ECB do). The PBC does not crucially rely on the money market interest rate to transmit policy changes to key prices in the banking sector, i.e., the interest rates for deposits and loans. Instead, it exerts direct influences on them by setting the benchmark deposit rates and lending rates (of various maturities), while banks are required to follow with limited autonomy. The PBC uses monetary policy tools (such as OMOs as mentioned above, the required reserve ratio, central bank lending and rediscounting), controlling the quantity of money and hence the supply of bank loans.

Central bank lending: The PBC can affect base money through its borrowing facility (central bank lending) by adjusting the quantity and the rate charged for those loans (the central bank lending rate, also translated as discount rate). This facility functions analogous to discount window of the Fed. Fig. 1 shows the development of the central bank lending rate (with the maturity of 20 days) for the period 1990Q1-2015Q1. In the earlier period, banks relied heavily on the central bank lending. The ratio of the borrowed

reserves (w.r.t. total reserves) was more than 50% till 2002. Afterwards, this ratio declined steadily to 20% by mid-2006, then to 10% by mid-2008, to today's 6% (in May 2015). Recently, the PBC has tended to use more indirect policy instruments by reducing central bank lending. Slowly, banks have been turning to the money market for loans. At the moment, the PBC uses central bank lending more for the purpose to guide bank loans, with new lending extended mainly upon the eligibility requirements, aiming to improve the credit structure, as specified on the PBC's webpage.[12] In 2013, the PBC reclassified its central bank lending in four categories: the central bank liquidity loans, credit policy support loans, the central bank financial stability loans and special policy loans, in an attempt to play a more active role "in managing liquidity and guiding financial institutions' credit structural adjustments" (*China Monetary Policy Report 2013:4*, p.9). Notably, only the first kind of the central bank lending is targeting the liquidity management, while the other three are targeting credit guidance. In certain sense, this tool has been endued with credit-structure management tasks, comparable to "specific central bank lending schemes" listed under "Credit policy instruments". We will discuss this kind of lending in more details then.

Parallel to these changes about the central bank lending, the PBC introduced two lending facilities recently in two steps: the standing lending facility (SLF, mainly short-term) in early 2013 and the medium-term lending facility (MLF) in September 2014, aiming to meet the large-scale demands for liquidity of financial institutions. Lending is extended on collaterals mostly to systemically important financial institutions (SIFIs)[13], essentially large-sized commercial banks, on a discretionary basis (*China Monetary Policy Report 2013:1*, p.14). In this way, the PBC has extended its toolkit to adjust the monetary base, in response to large temporary fluctuations in demand for liquidity in the banking system, such as to mitigate the maturity mismatch problem facing banks and effectively avert financial risks. Also, upon lending the PBC tries to guide bank lending in its desired direction (for example, away from the boomed asset markets, but to key industries, underinvested sectors and SMEs). Meanwhile, the PBC intends to use interest rates charged for these two lending facilities to anchor market interest rates, both short-term and medium-term, as to support its interest-rate marketization reform (this will be elaborated in the ensuing paragraphs).

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[12] See http://www.pbc.gov.cn/zhengcehuobisi/125207/125213/125437/125812/2848043/index.html.
[13] They are institutions that cause risk spillovers, including those "that are so large, so massively interconnected, and so iconic as 'national champions' that no government would ever allow them to fail" (Brunnermeier et al. 2009: 26).

Interest rate controls: The PBC sets central bank base interest rates, including the central bank lending rate, and the rates paid on the required and excess reserves. The interest rate paid on the excess reserves, which was reduced to 0.99% in early 2005 and further lowered to 0.72% in late 2008, serves as a floor for the money market interest rate. Changes in the central bank lending rate signal the market about the policy-makers' intentions and help frame the money market interest rate. However, this interest rate has remained unchanged (at 3.25%) for recent years, as shown in Fig. 1, when the PBC endowed this lending with a new task to guide credit, mainly via eligibility criteria rather than the interest rate.

Figure 1: The required reserve ratio, and interest rates in China (in %), 1990Q1-2015Q1
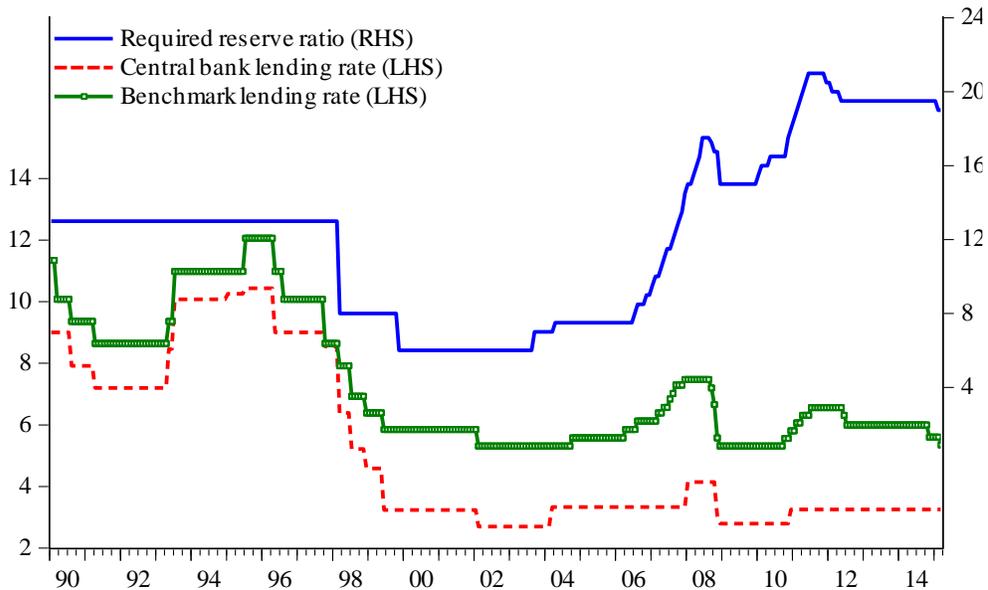
Notes: From 2008Q3 onwards, the reported required reserve ratio is a weighted average of those for large and small banks (see text for explanations). The discount rate is an interest rate at which the PBC lends to commercial banks with a maturity of 20 days; the benchmark lending rate (with a maturity of 1 year) is an interest rates set by the PBC as a benchmark for banks to follow.
Source: CEIC and IMF *International Financial Statistics*.

Moreover, the PBC exerts direct influences on bank deposits collection and bank lending by setting benchmark deposit rates and lending rates (of various maturities), while banks were allowed to adjust their interest rates around the benchmark within a limited band. Over the last decade, the PBC has undertaken market-oriented interest rate liberalization reforms; recently, it has accelerated its reform steps. In 2004, the lending-rate ceiling and the deposit-rate floor were abolished; and the lending-rate floating band was set [0.9, ∞) and that for the deposit rate was (-∞, 1]. In 2012, these two floating bands were extended to [0.7, ∞) and (-∞, 1.1], respectively. In July 2013, the lending-rate floor was abolished, which implies that the risk premium around this interest rate is then market determined, while the PBC

continues updating the benchmark for it, as shown in Fig. 1. In late 2014 and early 2015, the upper band for the deposit rate was further extended to 1.2 and 1.3.

The PBC keeps close watch on home prices. Its policy executive report "China Monetary Policy Report" has one section reviewing current development of home prices. Interest rates on mortgages are subject to the lending rate floor as well. In 2006 and 2008, twice the PBC extended the floating band for mortgage rates especially: the lower bound was cut to 0.85 and 0.7 of corresponding benchmark lending rate. However, in 2009 and 2010 home prices rose quickly. In early 2011, the State Council announced the limit on the purchase of second home. As a part of this series of policies to curb home prices, the PBC introduced a differentiated policy for second home purchases with the down payment ≥60% (compared to that for first home ≥30%) and the mortgage-rate floor 1.1 of the benchmark lending rate (compared to that for first home 0.7). This differentiated policy continued being in effect even after the lending-rate floor in general was abolished in 2013.

Required reserve ratio: Reserve requirements were originally designed to allow banks to maintain liquidity even in case of large deposit withdrawals on the one hand and on the other hand to allow central banks to influence money supply by changing the minimum required ratios. This policy tool has a direct effect on the ability of the banking system to create money and hence extend credit. It was widely employed by central banks in the post-WWII era, for example, the Fed kept adjusting the reserve requirement till 1992; the Bundesbank frequently mended this ratio prior to 1981. However, this instrument has gradually faded out of the monetary policy toolkit of advanced economies in the 1980s and 1990s.[14] In today's advanced economies, the legal reserve-deposit ratios are usually set at a fixed level and kept unchanged.

One exception is that the ECB announced a sudden cut of this reserve requirement to 1% in January 2012 after having kept this ratio unchanged at 2% since it came into being. This suggests that in the post-Crisis era there is no clear cut between conventional and unconventional monetary policy, especially when most of advanced economies have their policy interest rate at the lower zero bound. More importantly, the research interest in this tool has renewed in the aftermath of the Crisis (e.g., Federico, Vegh, and Vuletin

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[14] It is largely because: first, the reserve ratio is like a "reserve tax" on banks as they earn less or none on reserves (in many countries reserves are non-interest-bearing assets) and thus impairs their competition against other financial institutions, which are not subject to reserve requirements; second, as argued by Friedman (1960), changes in reserve requirements are on a discretionary basis and result in large discontinuous quantity changes as well.

2014), mainly in the direction of resurgence of it as a countercyclical macroprudential instrument to dampen credit booms and asset bubbles (see also Reinhart 2010). China's practice thus provides supportive evidence for this argument.

The PBC did not make frequent changes in the reserve ratio in its early years when it applied bank-specific credit quotas to post direct control on the supply of money and bank loans: in 1984 the PBC set the required ratio 40%[15], and one year later it was lowered to 10%. This ratio was then readjusted to 13% in two steps during the following two years and afterwards remained unchanged for a decade. Fig. 1 shows the evolution of the required reserve ratio for the period of 1990Q1 – 2015Q1. The year of 1998 marked the start of a new regime as the PBC abolished credit quotas and switched to more indirect policy tools. This era was accompanied with a dramatic cut of the required reserve ratio in March 1998: the PBC cut the ratio by five percentage points to 8%. In November 1999, the ratio was cut to its record low, 6%, and remained at this level for about four years.

However, the second half of the last decade is featured with a shift of the PBC in favor of more extensive use of this tool.[16] This shift was preceded by surging foreign exchange reserves in the mid-2000s and open market operations failed to offset the resultant monetary expansion, because they "were partly constrained by weaker purchasing willingness on the part of commercial banks" (*China Monetary Policy Report 2006:2,* p.8). Instead, hikes in reserve requirements are more direct and effective in influencing the money supply. In 2006, the PBC started to combine these two tools – open market operations (such as repo and issuance of central bank bills) and variations in the reserve – to "sterilize" the monetary base (ibid, p.8).

Meanwhile, the PBC adjusts the reserve requirement for the purpose of credit management so as to "increase the lendable funds of the financial institutions" (as in November 1999) or "to guide credit growth" (as in September 2003) (*China Monetary Policy Report 2003:3,* p.16). In order to better fulfill its active role in credit management, over time the reserve requirement has evolved to a state-varying macroprudential tool (see China Monetary Policy Report 2014:3, Ma, Yan, and Liu 2013, Wang and Sun 2013). Initially, China's reserve requirement system was relatively simple with a uniform required

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[15] More specifically, 40% was the ratio for savings deposits, 25% for deposits in rural areas and 20% for the corporate deposits.
[16] Like China, central banks in many emerging markets apply variations of the reserve requirements as one of the most important policy tools for liquidity management to stabilize credit (see, e.g., Frankel 2010). For example, in Peru this tool is used as "a first line of defense" facing financial vulnerability and is employed to avoid unsustainable trends in the credit/GDP ratio (Rossini 2012).

reserve ratio applied to all kinds of the non-financial corporate and household RMB deposits[17], regardless of maturity. Then in two steps, the PBC introduced the dynamic differentiated required reserve ratio. In 2008, the PBC adopted a two-tier reserve requirement system. A higher ratio is applied to bigger commercial banks, usually 1-2 percentage points above that applied to small banks[18]. Later in 2011, the PBC introduced "the mechanism to adjust the differentiated reserve requirement on a continuous and case-by-case basis to effectively ensure steady money and credit growth and the soundness of financial institutions by linking aggregate control of money, credit, and liquidity with macro-prudential policy" (*China Monetary Policy Report 2011:4*, p.17). Under this mechanism, the required reserve ratio can be differentiated across banks. This ratio is reexamined on a quarterly basis, based on criteria such as the bank's systemic importance, its contribution to the deviation of aggregate credit growth from its trend and various other prudential indicators. The reserve ratio is calculated according the following formula (Wang and Sun 2013, p. 23):

Ratio = the robustness parameter * (the required CAR – the actual CAR),

where CAR = capital adequacy ratio. The required CAR includes not only the minimum CAR (8%), but also macroprudential requirements, such as a counter-cyclical capital buffer, capital surcharge for SIFIs and capital reserves. "The robustness parameter is based on all of the important indicators of a bank itself, such as its liquidity position, leverage ratio, provisioning, credit rating, level of management of internal risks, payment and settlement cases, and implementation of the credit policy" (Wang and Sun 2013, p.23).

With this framework, the reserve ratio applied to different banks is allowed to vary, either following a fixed rule (as in the two-tier reserve requirement system) or subject to dynamic adjustment in line with above-specified criteria. This policy tool has turned dynamic and differentiated such that it is granular and macroprudential. "The purpose of this mechanism is to help financial institutions to match their credit extensions with their capital levels and the reasonable demands for economic growth. ... It is necessary to impose a higher capital requirement to mitigate the pro-cyclical fluctuations of credit expansion and prevent the build-up of systemic risks. … (This dynamic differentiated reserve requirement) is a transparent, rule-based macroprudential policy tool based on capital requirements. It is different from administrative controls on the lending quota." (*China Monetary Report 2014:3*, p.16)

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[17] Foreign currency deposits are subject to a lower seldom-adjusted reserve requirement (5% since 2007), but not remunerated. In this paper, the reserve requirements policy refers to that for RMB deposits only.

[18] In addition, rural and urban credit cooperatives enjoy a more favourable RRR: currently, it is about 5-6 percentage points lower than that for the large banks.

In this paper, we focus on the macro-level and hence the weighted average required reserve ratio is used from September 2008 onwards[19], based on two-tier reserve requirement system, with ¾ attributed to that for large financial institutions and ¼ to that for small- and medium-sized financial institutions, as reported in Fig. 1. This weight approximates well their capital shares in the banking system.[20]

2.3 Macroprudential Credit Policy Tools

Tools of specific credit policy enable central banks powers to "affect the allocation of loans or of deposits or the structure of interest rates" (Friedman 1960: 25). They include, mainly, credit ceilings, eligibility requirements for central bank lending, window guidance, down payment requirements on mortgage, "through which the competitive position of banks and the relative desirability of different assets are affected and thus the structure of interest rates is altered" (Friedman 1960: 25). They were widely used by many central banks in the post-WWII era, including those advanced economies as well (see, e.g., Angelopoulou 2007, Elliott, Feldberg, and Lehnert 2013, Kelber and Monnet 2014, Monnet 2014). However, these tools are mostly *ad hoc* and regarded as distortionary in terms of the misallocation of resources. Central banks in advanced economies abolished these credit tools in the 1970s and 1980s.

In China, the control on credit has a long history and can be traced back to its central planning era. Today, the aggregate bank lending is still one of nominal anchors that the PBC keeps watch on. Each year, the PBC announces a target for the total bank lending. Moreover, the PBC routinely applies tools of specific credit policy to control the quantity of credit and influence the structure of credit by "guiding" bank lending, often on a more discretionary basis.

The PBC believes that the development and implementation of credit policy is one of its important duties, as stated on its homepage. The current credit policy generally includes four aspects: first, those policy actions that affect the money multiplier and thereby the money supply (for example, down payment requirements on consumer and real estate credit); second, formation of credit laws and regulations; third, preferential loans and other means to guide the credit funds to the policy-preferred industries or regions (for example, through definition of eligibility for rediscounting); and fourth, restrictive credit policy (for

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[19] Another reason is that data on the dynamic differentiated reserve requirement for each individual bank are not published.
[20] It is worthwhile to point out that the frequent changes in reserve requirements have drawn a lot of attention – they were publicly announced and newsworthy. However, as the PBC's Governor, ZHOU Xiaochuan, pointed out (Caixin 2012), variations in reserve requirements are not necessarily indicative of monetary easing or tightening, but are more related to the liquidity or macroprudential management (see also Sun 2013, 2015a, b).

example, through "window guidance" the credit funds are guided away from certain industries) (see the PBC's homepage, Chinese version). The first two are concerned with the regulations of credit markets while the last two address specific uses of credit and are more important.

Rediscounting (upon eligibility requirements): Central banks make loans to commercial banks and hence increase the money supply by "rediscounting" commercial banks' assets such as undue discounted bills. The PBC started rediscounting operations in 1986 when there was a serious problem of payment arrears among enterprises and it was originally designed to increase the money supply. However, recently rediscounting has been used quite often under certain specific eligibility requirements to "guide the direction of credit funds and promote the credit structure adjustment" (*China Monetary Policy Report 2008 Quarter IV*: 14). For example, in 1994 the PBC extended rediscount quotas of 10 billions yuan for five industries and four products; in 2008 an additional discount quota of 25.6 billion yuan was arranged for financial institutions located in the disaster-hit areas; in 2010 rediscount operations amounted 171.2 billion yuan, of which 32 percent was linked to agriculture and the remaining was lent to SMEs. Through those rediscounting schemes, the PBC provided special funds at a lower cost for a particular group of industries or regions. This more or less official administrative control is one of the most important instruments at the PBC's disposal to affect both the quantity and the structure of the bank lending.

Window guidance: In addition to specific rediscounting schemes, the PBC uses window guidance – a form of "moral suasion" or "indirect pressure" – to influence the quantity and the structure of bank lending. The PBC believes that window guidance plays an important role in guiding market expectations, improving policy transparency and thereby enhancing the effectiveness of monetary policy (*China Monetary Policy Report 2006 Quarter IV*: 13). Besides, through communicating with the commercial banks about its policy favors and disfavors, the PBC "guides" the quantity and direction of credit funds. According to Geiger (2006), window guidance must be effective in China given Chinese political hierarchy system.

Since 1998, the PBC has held monthly meetings with financial institutions. "The practice has since become institutionalised with the PBC publishing notices aimed at curbing lending in particular sectors from time to time. The PBC also regularly reports on its "window guidance" in its *China Monetary Policy Report*" (OECD 2010: 50). The main purpose of window guidance is to "improve credit policy guidance

and encourage financial institutions to properly adjust the credit structure and manage the pace of credit provisions" (*China Monetary Policy Report 2010 Quarter IV*: 8).

Although the focus of the PBC's window guidance varies slightly from year to year in accordance with the economic situation, there is a general guideline for window guidance – the PBC guides financial institutions to follow "the principle of differentiated treatment" in making loans (*China Monetary Policy Report 2005 Quarter IV*: 13). Financial institutions are suggested, on the one hand, expanding credits to priority sectors, including agriculture, SMEs, job creation, education, and the nonpublic sector, and on the other, restricting loans to certain industries, such as high energy-consuming or heavily-polluting industries, industries with overcapacity. The guiding directions – support vs. restrict – are clearly stated in the PBC's monetary policy reports. For example, in 2008 the PBC used window guidance "to appropriately restrict loans to enterprises with overcapacity (…), and strengthen credit support to priority areas" (*China Monetary Policy Report 2008 Quarter IV*: 15-16). In 2009, the PBC guided banks "to strengthen credit support to key sectors (…), to impose strict control over credit extensions to enterprises in high energy-consuming industries" (*China Monetary Policy Report 2009 Quarter IV*: 16).

Meanwhile, through "moral suasion" and "indirect pressure", the PBC has been trying to slow down the rapid growth of bank lending and thus control the size of credit expansion during the period of credit boom. For example, in 2006 the PBC held a series of window guidance meeting with commercial banks, "alerting them of the risks of rapid credit growth and warning them against blind credit expansion" (*China Monetary Policy Report 2006 Quarter IV*: 12-13). Again in 2007, the PBC continued using window guidance "to convey the purpose of the macro-adjustment measures, (…) guide (commercial banks) to control the size and pace of credit expansion" (*China Monetary Policy Report 2007 Quarter IV*: 11).

The above review of the PBC's toolkit suggests that with monetary policy, the PBC controls the total amount of money supply and credit, while with credit policy, the PBC is actively engaged in directing bank lending and thereby shaping the structure of bank loans. When financial distortions are more acute in some particular sectors, as is often the case, monetary policy like the interest rate is too blunt a tool; rather credit policy works well. These credit policies are granular, aiming at the credit quantity and structure, and hence restraining build-up of risk of the whole system. They are macroprudential in nature. In the aftermath of the Crisis, monetary policies, such as the (redesigned) required reserve ratio and the

central bank lending, are endowed with macroprudential management tasks: they have turned more granular and targeting at the liquidity quantity and credit allocation among different industries.

2.4 Other Macropudential Measures in China

3. Macroprudential Indicators

In this paper, we follow the literature, using the ratio of total credit to GDP as a cyclical indicator (see, e.g., Borio and Lowe 2002, Hahm et al. 2012, Hume and Sentance 2009). Also, this ratio, being a useful measure of procyclicality, has been widely used as a reference variable in designing prudential supervisions and policies, for example, Basel III framework and Geneva Report on bank regulation (see, e.g., Brunnermeier et al. 2009, FSB, IMF, and BIS 2011).

We focus on the period of 2000Q1-2015Q1 (subject to the data availability). Our data are collected from various sources. The monetary aggregates and macroeconomic data (i.e., nominal GDP, real GDP growth and inflation) are from *IMF International Financial Statistics*. The aggregates such as total loans, total assets and total deposits are based on the PBC's statistic table "Summary of Sources and Uses of Credit Funds of Financial Institutions", available from the PBC's statistic dataset. Financial institutions in this table include the PBC, banking depository financial institutions (i.e., banks, credit cooperatives and finance companies) and banking non-depository financial institutions (such as financial trust and investment corporations, financial leasing companies, auto-financing companies, as well as loan companies). Total loans or total lending is defined as the end-of-period amount of outstanding RMB lending issued by those financial institutions to the real economy (non-financial enterprises and households). Analogously, total deposits is defined as the end-of-period sum of RMB deposits placed at those financial institutions and total assets as the end-of-period sum of total RMB funds at those financial institutions.

Table 2 presents a snapshot of the aggregate asset and liability structure of all Chinese financial institutions (as defined above, with the PBC included) for selective years, all values as the end-of-year outstanding amount, based on the PBC's statistic table "Summary of Sources and Uses of Credit Funds of Financial Institutions". Total financial assets have almost decupled over the last 15 years, from 13 trillion yuan in 2000 to 132 trillion yuan in 2014, which are mainly (more than 85% throughout the whole

period and in the early 2000s more than 90%) funded by various deposits. The main assets that financial institutions hold are loans: the loan-to-asset ratio was as high as 0.74 in 2000 though it declined to the trough of 56% in 2008; then it climbed slowly back to above 60%. Another distinct feature is reflected in the accumulation of foreign reserves in financial institutions. Their share in total assets tripled to the peak of 31% over the period 2000-2008; afterwards it dropped slowly and in 2014 it was 22%. As for portfolio investment, in general financial institutions did not invest much in securities: throughout the period the securities-to-asset ratio was quite stable, remaining at 0.12-0.15.

Table 2: Aggregate balance sheet of all the Chinese financial institutions

	2000		...	2004		...	2008		...	2011		...	2014	
	¥ trillion	% of assets		¥ trillion	% of assets		¥ trillion	% of assets		¥ trillion	% of assets		¥ trillion	% of assets
Assets	13.33	100%		26.19	100%		53.84	100%		91.32	100%		132.35	100%
Loans	9.94	74.5%		17.74	67.7%		30.34	56.4%		54.79	60%		81.68	61.7%
Securities	1.97	14.7%		3.09	11.8%		6.53	12.1%		10.93	12%		21.04	15.9%
Foreign Reserves	1.43	10.7%		5.26	20.1%		16.84	31.3%		25.36	27.8%		29.41	22.2%
Other assets	0.001	0.01%		0.10	0.4%		0.13	0.2%		0.24	0.3%		0.22	0.2%
Liabilities	13.85	103.9%		26.65	101.8%		52.20	97%		87.09	95.4%		120.96	91.4%
Deposits	12.38	92.9%		24.05	91.8%		46.62	86.6%		80.94	88.6%		113.86	86%
Cash	1.47	11%		2.15	8.2%		3.42	6.4%		5.07	5.6%		6.03	4.6%
Financial Bonds	0	0.02%		0.40	1.5%		2.09	3.9%		1.00	1.1%		0.98	0.7%
Other liabilities	0	0		0.06	0.2%		0.07	0.1%		0.08	0.1%		0.09	0.1%
Capital (Assets-Liabilities)	-0.52	-3.9%		-0.46	-1.8%		1.64	3%		4.23	4.6%		11.38	8.6%

Source: Authors' calculation and compilation, based on the PBC's statistic table "Summary of Sources and Uses of Credit Funds of Financial Institutions" of various years.

Table 2 suggests that in China, the financial system is still dominated by deposit-taking banks. These banks play a traditional financial intermediary role: they take deposits and make loans; these two account for a large proportion of their balance sheet. Meanwhile, commercial banks have been subject to the regulation since 1995 that the loan-to-deposit ratio not exceed 0.75. It implies that the expansion of loans in each individual bank crucially relies on its ability to attract depositors. Given the deposit-rate ceiling, small banks are often in an inferior position to compete with large national banks. Large national banks are the main source of lending; their stability is of particular significance to the financial system. The PBC exerts direct influence on their lending, not only the quantity but also the structure, through various monetary and credit policy measures as well as window guidance. The observation made by Reinhart and Rogoff (2013: 5) for the U.S. case is true for China as well: "whatever distortions that these policies may have led to in terms of misallocation of resources, it is important to note that there … (have been) no systemic banking crises (in China)."

On the other hand, Chinese real economy heavily relies on (bank) loans for external financing while direct financing plays a limited role mainly because of less developed capital markets. Indirect financing amounted to over 90% of total financing in the early 2000s; with a steady rise of direct financing (through corporate bonds and stocks), this share declined slowly, but it still accounted for about 80% of total financing to the real economy in 2014 (*China Monetary Policy Report 2014:4*). The wax and wane of this aggregate, total credit, have particular important implications for the Chinese economy.

We then examine trend and cyclical components of the credit and monetary aggregates over the full sample period. Fig. 2 shows ratios of three aggregates – broad money, total loans and total assets – to GDP, with all variables in nominal term and GDP annualized (as a moving sum of up-to-current four quarters). Together, we also show the estimated trend (based on the Hodrick-Prescott filter with the smoothing parameter $\lambda = 1600$, as is typical for quarterly data) for the loan-GDP ratio. Broad money and total financial assets both expanded faster than GDP, showing a strong secular uptrend relative to GDP, with some swings accompanied as well. Meanwhile, these two aggregates remained a roughly stable relationship to each other, particularly in the early 2000s. Their ratios to GDP have risen rapidly and reached 2 in 2015Q1. The latter one, the asset-GDP ratio, suggests that there has been a huge expansion of the balance sheet of financial institutions relative to the size of the economy over this period. A close look at its components indicates that this huge expansion was partly due to the accumulation of foreign exchange reserves. As shown in Table 2 and discussed above, in 2000 foreign reserves amounted to 10% of total assets while in 2014 they accounted for 22%.

On the contrary, the loan-GDP ratio did not evidence such a strong upward trend. Rather, it fluctuated along a moderate growth drift, as illustrated with the HP-filtered trend. Fig. 2 suggests two hump-shaped credit booms: one in 2003-2004 and the other in 2009-2010, each lasting about two years. The latter hike, the 2009-2010 credit boom, followed an obvious large credit slip in 2008. Overall, a kind of cyclical pattern is suggested.

A moderate growth of total loans relative to broad money seems not to promise a stable linkage between these two aggregates. Indeed, the loan-money ratio shrank slowly but steadily in the early 2000s, as shown in Fig. 3, from close to 0.8 in the beginning of 2000 to around 0.65 by the end of 2005. Afterwards, it remained relatively stable at this level. This suggests that the relation between credit and money has

evolved over time.[21] Targeting broad money does not necessarily guarantee the central bank having certain control over aggregate lending, which is particularly true for the early 2000s period. It lends support for the PBC's operating framework with both aggregates – money and credit – included as its intermediate targets.

Figure 2: Aggregates relative to GDP, 2000Q1-2015Q1
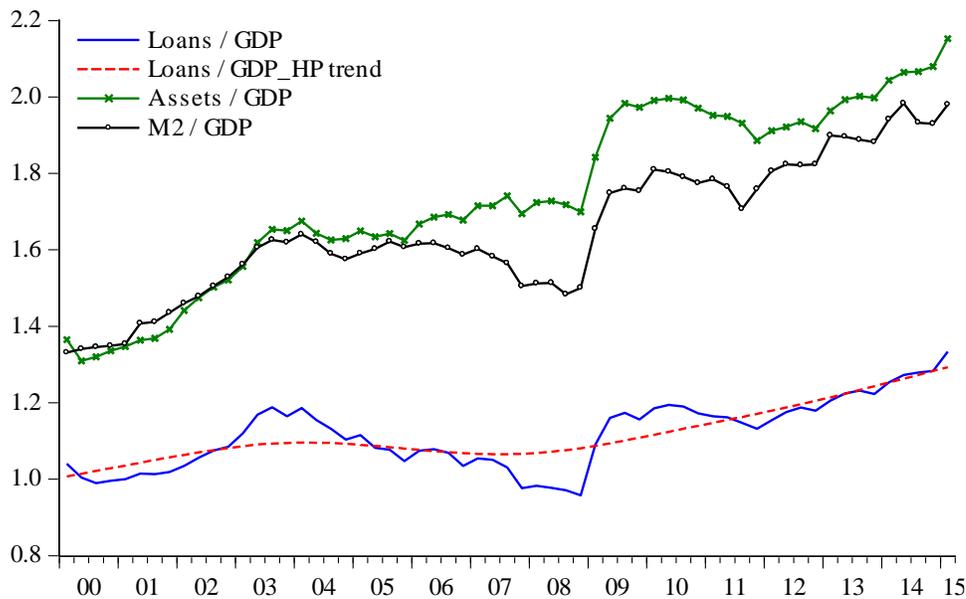
Note: The ratios are calculated by authors based on the quarterly data from *IMF International Financial Statistics*, the PBC's statistic dataset.

By contrast, assets relative to M2 show a different pattern. The asset-M2 ratio was relatively stable, around 1 in the early 2000s; then in the second half of the 2000s, it climbed up to 1.15 in 2008; in the 2010s, it dropped back, yet remained above 1. It seems that starting from the late 2000s, aggregate liabilities of financial institutions have turned out more than traditional monetary aggregate – M2, although the size of the excess part is relatively small. Referring back to Table 2, the aggregate balance sheet of all the financial institutions, suggests that two sources could explain this part. First, these institutions has increased their debt in the form of bond funding.[22] Second, banks' net worth (defined with capital) has been improved, as shown in "Capital" in the Table. The capital-to-asset ratio was

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[21] This finding is comparable to what Schularick and Taylor (2012: 1034) observe for the U.S. case, where the relation between money and credit have changed so much that they define two distinct "eras of finance capitalism".

[22] Adrian and Shin (2008) and Shin and Shin (2011) argue that under a market-based financial system, e.g., that in the U.S., broad money is no longer a good measure of liquidity (i.e., the aggregate liabilities of the system) as financial institutions rely on financial markets to raise funding to supplement their traditional deposit funding as well.

initially negative in 2000; but in 2007 it turned out positive and remained around 4% afterwards till 2012. In 2013 and 2014, this ratio rose rapidly to 5.5% and 8.6%, respectively.

**Figure 3: Aggregates relative to broad money, 2000Q1-2015Q1**
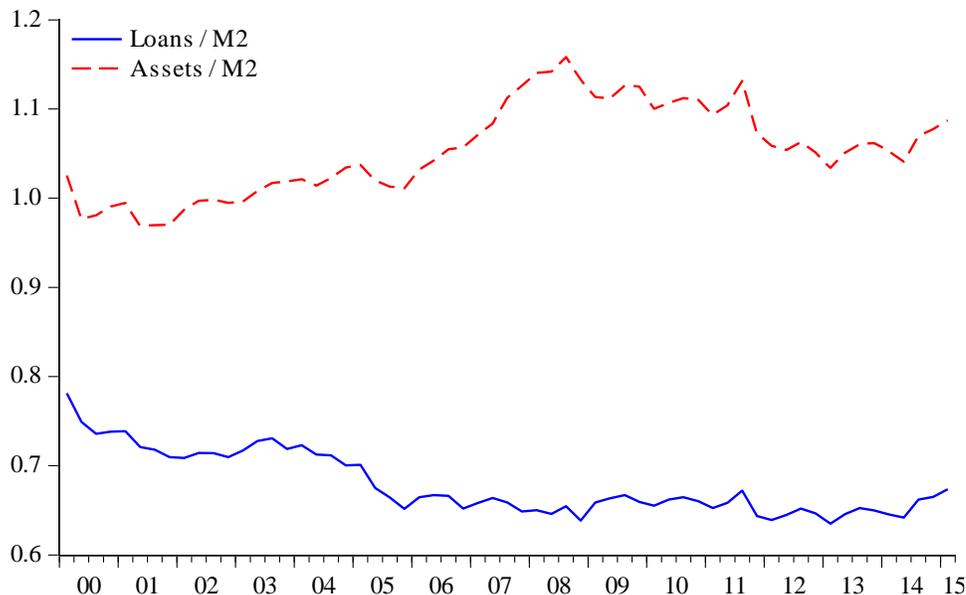
Note: See note to Fig. 2.

To examine the relation between the credit cycle and business cycle, we represent the loan-GDP ratio as well as its HP-filtered trend in Fig. 4, but placed together with real economic growth and inflation. Over the past fifteen years, the Chinese economy has grown at a relatively stable rate, around an 8-10% annual rate, except a boom over the 2006-2007 period (with a growth rate of 12-14%) and a subsequent slowdown in 2008. In 2009Q1, the growth rate reached the trough, 6.6%; afterwards it gained momentum and moved back to 8-10%. Since 2012, output growth has remained below 8%, but above 7%. High economic growth did not trigger much high inflation in China over last fifteen year: inflation was moderate in general, except 2004, 2007Q3-2008Q3 and 2011, when it went up to above 5%, with the highest inflation of 8% in 2008Q1. In 2009, China experienced deflation. However, in general these three series do not demonstrate clear connections. The possible reason could be that our time series are relatively short and we do not have sufficient data on either business cycle or financial cycle. By contrast, studies, based on large historical data, either focusing on a single country (the U.S.) or a group of countries, find supportive evidence for the link between these two cycles: financial distresses are associated with recessions; credit booms are connected with economic expansion (see, e.g. Bordo and Haubrich 2010, Mendoza and Terrones 2008, Reinhart and Rogoff 2014). This finding strengthens the

financial accelerator theory, as modelled in Bernanke, Gertler, and Gilchrist (1996), in the way that credit matters, "above and beyond its role as a propagator of shocks hitting the economy" (Schularick and Taylor 2012: 1058). Or in Kindleberger (1978: 64)'s words, "most of expansions of money and credit do not lead to a mania; ... but every mania has been associated with the expansion of credit."

Figure 4: The financial cycle and the business cycle, 2000Q1-2015Q1
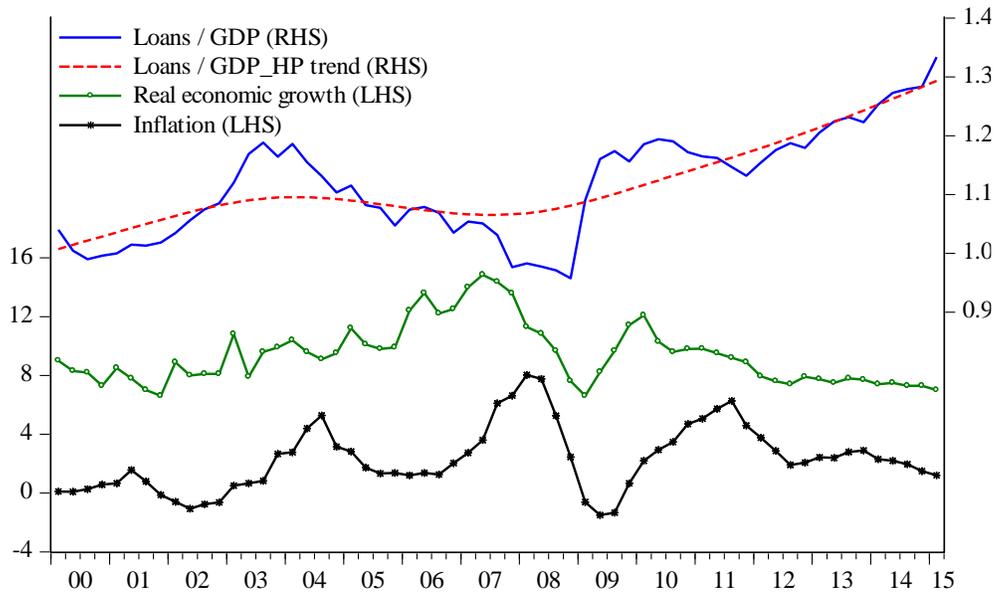

Note: See note to Fig. 2.

A cyclical pattern analysis requires large datasets. Nevertheless, we could examine dynamic linkages among them by looking at their co-movement. Figure 5 plots correlations between real growth, inflation and the loans-GDP ratio (both lagged and led four quarters) for the sample period. Inflation was positively correlated with the lagged loan-GDP ratio. It suggests that a hike in total lending (relative to GDP) was followed by a rise in the inflation rate, most likely with a four-quarter delay. It is plausible: as evidenced in the literature, excessive lending drives up assets price and hence contribute to a high inflation.

Real growth was negatively associated with lagged total lending. This provides supportive evidence for the hypothesis of "credit-booms-gone-bust": excessive lending is not sustainable and eventually it ends with an economic slowdown. Meanwhile, real growth was negatively highly correlated with the loan-GDP ratio at lead. It suggests that low economic growth was often followed by an increase of total lending. It is possible when rises in lending were used to stimulate economic growth. Indeed, as discussed

above, the PBC has been actively employing credit policy tools to achieve its mandate – high economic growth and low inflation. Lending reacts to the state of the economy: we find that real growth and inflation both Granger-cause changes in the loan-GDP ratio.

Figure 5: Dynamic interaction between the financial cycle and business cycle
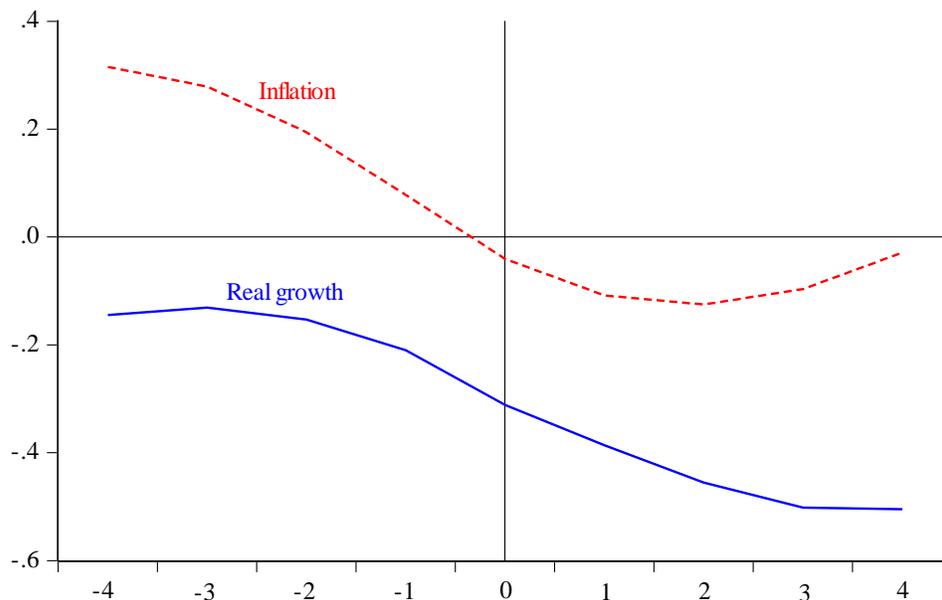
Note: The correlations are calculated based on quarterly data between the loan-GDP ratio (lagged/led) and real growth, inflation for the sample 2000Q1 – 2015Q1.
Source: Author's estimation.

4. How effective are macroprudential policies on the credit cycle?

To examine effectiveness of macroprudential policies, in particular, the required reserve ratio, on the credit cycle, we let the economy be described in the following structural macroeconomic VAR model given in Eqs. (1)-(2):

$$Y_t = \sum_{i=0}^{k} B_i Y_{t-i} + \sum_{i=0}^{k} C_i P_{t-i} + \sum_{i=0}^{k} M_i FX_{t-i} + A^y v_t^y \qquad (1)$$

$$P_t = \sum_{i=0}^{k} D_i Y_{t-i} + \sum_{i=0}^{k} G_i P_{t-i} + \sum_{i=0}^{k} N_i FX_{t-i} + A^p v_t^p \qquad (2)$$

where boldface variables denote vectors or matrices. Variables are classified into two groups – **Y** and **P**, which stand for vectors of non-policy variables and policy variables, respectively. The vectors v^y and v^p are mutually uncorrelated structural error terms. Non-policy vector **Y** consists of macroeconomic variables – real GDP growth (Y) and inflation (π) based on the CPI; and a financial variable, loans (L) in logarithm that measure total lending to real economy. For policy variables, we include required reserve ratio (RRR) and one narrative indicator to measure monetary conditions (NI). As discussed above, the

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PBC uses multiple policy tools and none of them itself is sufficient to measure the PBC's policy stance, as many studies argue (see, among others, Chen, Chen, and Gerlach 2013, He and Pauwels 2008, Shu and Ng 2010, Sun 2013, 2015a, b, Xiong 2012). Sun (2015a) builds a time series of a composite policy indicator to measure the PBC's policy ease and tightness, by studying its documents. In this paper, we use this narrative index as a measure of the PBC's policy stance. Meanwhile, we include foreign exchange reserves (FX), in logarithm, as an exogenous variable in the model.

All the endogenous variables in the system depend on their own lags, and both contemporaneous values and up to k lags of all other variables. Eq. (1) describes how macroeconomic variables (not only output and inflation, but also the credit aggregate) evolve over time, with the policy impact on them incorporated. Eq. (2) can be considered as the policy response function of the PBC to the state of economy as well as the credit condition. With this specification, the required reserve ratio is modelled as a multi-functional tool as it has been indeed used in China: a monetary policy tool (as a response to Y and P), a "sterilization" tool (it is allowed to react to foreign reserves), and a macroprudential tool (to counter loans). Besides the required reserve ratio, the PBC applies other policy tools to achieve high growth, low inflation and financial stability. They are jointly incorporated into the composite policy index, NI.

Quarterly data for the period 2000Q1-2015Q1 are used and two lags are included, i.e., $k = 2$. To identify the model, we follow the literature and propose a recursive ordering assumption[23] (known as Cholesky decomposition in the VAR literature) on the contemporaneous relationship between variables. We assume that policy variables affect **Y** vector, macro variables and credit, with one-period lag, i.e., $C_0 = 0$. We further assume that **P** vector is ordered as (NI, RRR).

Fig. 6 shows the impulse responses of total loans (Column a), NI (Column b) and RRR (Column c) to one-S.D. innovations, together with two-standard-error bands. Due to the space limit, the impulse responses of Y and π are not reported here. In Column a, the last-row graph suggests that the required reserve ratio did have expected impact on the aggregate lending. Following a rise in the reserve ratio, the total lending dropped and reached to the trough after four quarters. Afterwards, this negative impact on the lending dampened out slowly (in about one and half years). Column b indicates that, in responses to an output shock and an inflation shock, the PBC tightens its policy, as the theory predicts. It also tightens monetary policy in reaction to a credit innovation, though the uncertainty around this estimation is high.

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[23] That is, it assumes that the variable ordered first in the VAR is contemporaneously unaffected by all other variables.
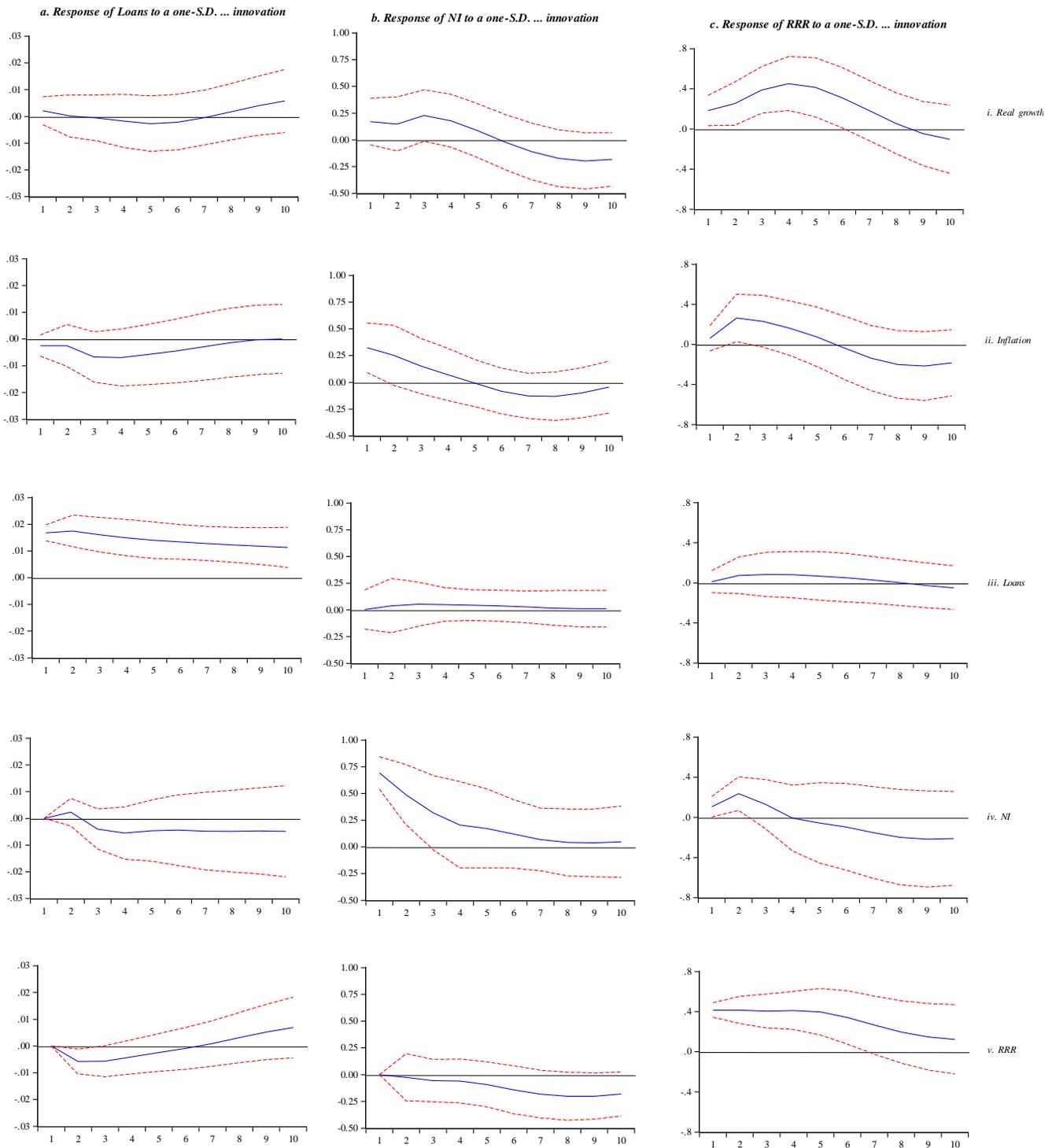
Column c suggests that the required reserve ratio is used as a monetary policy tool as well as a tool to manage the credit aggregate. The PBC raises this ratio to rein in high output growth and high inflation. Facing an unexpected rise in credit, it increases this ratio as well. Together with Fig. 6(a), it we can conclude that these two variables, the required reserve ratio and total lending, interface. The required reserve ratio has been used as a macroprudential policy tool; it reacted to the credit aggregate. Observing excessive lending, the PBC raised the required reserve ratio to withdraw liquidity and curtain the total lending.

Overall, the results of this section lend support to the view that (i) the PBC tried to "lean against the credit bubble" during the last two decades, and (ii) macroprudential policies (especially, the dynamic differentiated required reserve ratio) are effective in curbing turbulent surges in credit.

5. Conclusion

This paper draws two main conclusions, based on the stylized fact of the PBC's monetary operations. First, "obsolete" monetary policy tools, especially credit policies and the dynamic reserve requirement, can be used to lean again credit bubbles and improve financial stability. Second, these tools are effective in restraining excessive credit expansion.

Figure 6: Impulse responses

a. Response of Loans to a one-S.D. ... innovation   *b. Response of NI to a one-S.D. ... innovation*   *c. Response of RRR to a one-S.D. ... innovation*

Note: The impulse responses are estimated from the VAR model specified in the system (1)-(2) (see text for explanations). The dotted red lines are two-standard-error bands.

Source: Authors' estimation.

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