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Jan Klingelhöfer, Rongrong Sun

AUTHORS

Jan Klingelhöfer

HenU Center for Financial Development and Stability
Henan University
E-mail: jan.klingelhoef@cfds.henucon.education

Rongrong Sun (Corresponding Author)

HenU Center for Financial Development and Stability
Henan University
E-Mail: rongrong.sun@cfds.henucon.education

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HenU Center for Financial Development and Stability
Dongliuzhai Building, 85 Minglun Street
Henan University, Minglun Campus
Shunhe, Kaifeng, Henan, China
Tel. +86 (30) 897 89-0
<http://cfds.henucon.education>

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

Jan Klingelhöfer and Rongrong Sun¹

Abstract: We study the Chinese experience and provide evidence that central banks can play an active role in safeguarding financial stability. The narrative approach is used to disentangle macroprudential policy actions from monetary actions. We show that reserve requirements, window guidance, supervisory pressure and housing-market policies can be used for macroprudential purposes. Our VAR estimates suggest that well-targeted macroprudential policy has immediate and persistent impact on credit, but no statistically significant impact on output. Macroprudential policy can be used to retain financial stability without triggering an economic slowdown, or as a complement to monetary policy to offset the buildup of financial vulnerabilities arising from monetary easing. The multi-instrument framework enables central banks to achieve both macroeconomic and financial stability.

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

JEL-Classification: E52, E58, E44

¹ Klingelhöfer: School of Economics, Henan University, jan.klingelhoefer@cfds.henucon.education; Sun: School of Economics, Henan University, Rongrong.Sun@cfds.henucon.education.

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1. Introduction

The financial crisis hit economies worldwide during the period of 2007-2009. Such crises are recurrent, deeply rooted in the financial history (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 in 2008-2009, the Great Recession (see, e.g., Reinhart & Rogoff 2009; Ball 2014; Reinhart & Rogoff 2014; Romer & Romer 2015). Over decades, economists have been trying to understand how to identify financial instability early enough for successful countermeasures and how to make the financial system more resilient to shocks. Among them, Minsky (1977) and Kindleberger (1978) have argued that the financial system is prone to turn unstable over periods of prolonged prosperity through endogenous credit booms. That is, the financial imbalances and risks increase with a progressive growth of credit during upswings (e.g., the Great Moderation) and materialize in downturns (e.g., in 2007 when housing prices plunged in the U.S.). Along this line, Eichengreen and Mitchener (2004) provide evidence for the credit-boom view of economic cycles and interpret the Great Depression as “credit booms gone wrong”. More recent studies (e.g., Schularick & Taylor 2012; Jordà *et al.* 2013; Taylor 2015) explore this argument further and find that the past growth of credit predicts future financial instability.² All these findings confirm that “most of expansions of money and credit do not lead to a mania; (...) but every mania has been associated with the expansion of credit” (Kindleberger 1978: 64).

This “credit-booms-gone-bust” finding provides the rationale for using credit booms as one of the early warning indicators of financial fragility. More importantly, in the aftermath of the recent crisis, policy makers take more cautious and preemptive attitude towards the risks of progressive credit growth and rapid asset price rises. Surveillance and policy are designed to preventively use macroprudential tools in response to early warnings rather than in response to shocks. Among both academics and policymakers, the consensus seems to emerge that financial stability needs to move in a macroprudential direction and macroprudential tools are part of the basic macro toolkit (Hanson *et al.* 2011; Blanchard 2016). The current discussions are largely involved in the search for regulations of state-varying capital and liquidity requirements for banks (for example, under Basel III) and state-varying margin controls for various asset markets. All these regulations play similar roles in increasing institutions’ resilience to absorb shocks and better aligning private and social incentives (Blanchard *et al.* 2012).

In the meantime, monetary policy is inseparable from policies toward financial stability (Adrian & Shin 2009). The Bank for International Settlements (BIS) suggests that central banks take over

² Eichengreen and Mitchener (2004), Taylor (2015) and Bordo and Meissner (2016), among others, provide comprehensive literature reviews over studies exploring the interdependence among credit, asset prices and financial instability.

macroprudential responsibility as they are in a stronger position to carry out macro and systemic analysis. This kind of consensus is reflected in the policy design. “Most countries have put in place macroprudential authorities”, as pointed out by Blanchard (2016: 288), either at the central bank (such as in the UK) or separately but with central bank participation (such as in the Euro Area and the United States). The ECB recognizes that macroprudential policy has become a necessary complement to monetary policy and introduced the bi-annual *ECB Macprudential Bulletin* in March 2016, aiming at improved understanding of this new policy (Constâncio 2016). Moreover, since the onset of this crisis, central banks in many advanced economies are returning to their roots by re-assuming a broad mandate that includes both price stability and financial stability (Goodhart 2014).³ This task to safeguard financial stability requires the central bank to play an active role in making policies and monitoring the payment and settlement system, which is more than providing necessary liquidity support as the lender of the last resort (*China Monetary Policy Report 2011Q4*: 16).

This paper presents the Chinese experience, where financial stability has always been one of key objectives of monetary policy of the People’s Bank of China (PBC).⁴ We focus on its policy measures in achieving financial stability, by using macro-level data over the 2000-2015 period. In so doing, we address the following questions: What kind of instruments can a central bank employ in macroprudential management and how effective are they? How does macroprudential policy interact with monetary policy?

Our paper contributes to the existing literature from several perspectives. First, we employ the narrative approach in identifying macroprudential policy actions from all observed policy actions by studying the PBC’s documents to extract the information on the policy intentions behind each policy action. Based on the identified macroprudential policy actions, we build a time series to measure the macroprudential policy stance in China for the period of 2000-2015. Second, we examine the effectiveness of these macroprudential measures on macroeconomic and financial conditions, with their interaction with monetary policies allowed for. Third, in so doing, we use a vector autoregression (VAR) framework to model bidirectional causality of policies and economic/ financial conditions given that the PBC makes its policies, both monetary and macroprudential, based on its perceptions about the economic and financial states. With policy responses controlled for, the VAR model enables us to estimate the causal dynamic effect of policy on the economy in a consistent way.

³ Leaning-against-financial-instability monetary policies are nothing new in the monetary history of advanced economies. For example, financial stability took center stage in the mandate of the United States’ central bank, when the Fed was founded in 1913 (Reinhart & Rogoff 2013). Over its post-1930s history until the early 1980s, the Fed had taken various monetary and credit policy tools, together with a web of regulations that discouraged banks from taking excessive risks (see, among others, Elliott et al. 2013; Gorton & Metrick 2013; Reinhart & Rogoff 2013). This coincides with a “quiet period,” in which the U.S. financial system proved remarkably stable.

⁴ So is it in many emerging economies (see, among others, Cerutti et al. 2015; Chang & Velasco 2016; Zhang & Zoli 2016).

Our main findings are fourfold. First, monetary policy tools, such as reserve requirements, window guidance, housing-market related policies (e.g., the caps on the loan-to-value (LTV) ratio, the mortgage rate, the tax rate policies, etc.), and the supervisory measures, can be used to lean against credit bubbles and improve financial stability. Second, our VAR estimates suggest that both monetary and macroprudential policy are effective in restraining excessive credit expansion. Yet, macroprudential policy has no statistically significant impact on output. Third, compared to monetary policy, macroprudential policy reacts faster to financial conditions. It is the PBC's primary choice to restrain financial vulnerability. Fourth, as for individual policy instrument, window guidance is particularly effective in curbing credit, while only housing market policies are effective in reining in the housing price.

Our second finding about the ineffectiveness of macroprudential policy on output differs from those in the literature. Two reasons account for it: i) our macroprudential policy actions are well identified by using the narrative approach to capture those that aim to smoothen the credit fluctuations or/and improve the resilience of the financial market; ii) macroprudential policy can be well-targeted to safeguard financial stability, not necessarily at the cost of an economic slowdown.⁵ This ineffectiveness builds a buffer for the PBC to rein in the fast growth of credit in attaining financial stability, but without harming real economic activities, when facing two conflicting policy objectives. At the same time, the PBC can use macroprudential policies as a complement to monetary policy to offset the buildup of financial vulnerabilities arisen from a monetary easing.

Our analysis suggests that it is the multi-instrument framework that enables the central bank to use both monetary and macroprudential policy to reinforce each other. A well-designed use of these two policies helps to achieve both macroeconomic and financial stability objectives.

Our paper is related to several strands of the fast growing literature.⁶ The first branch, using mainly panel datasets,⁷ examines the effectiveness of macroprudential policies in constraining financial vulnerability.⁸ Those policies include caps on the LTV ratio, caps on the debt-to-income (DTI) ratio, reserve requirements, capital requirements, limits on credit growth, foreign currency lending, limits on profit

⁵ On the other hand, well-targeted policies might trigger regulation arbitrage, which in turn breeds financial instability. Such distortions and possible loopholes are potential costs of macroprudential policy.

⁶ Ebrahimi Kahou and Lehar (2017) provide a comprehensive review on macroprudential policy. One strand, which we will not be able to discuss in detail, consists of theoretical contributions based on the New Keynesian DSGE models with financial frictions to model the interaction between monetary and macroprudential policy (see, e.g., Angelini *et al.* 2014; Rubio & Carrasco-Gallego 2015; Cesa-Bianchi & Rebucci 2016; Rubio & Carrasco-Gallego 2016; Chen *et al.* 2017).

⁷ Exceptions include, for example, He (2013, 2014) and Tillmann (2015), which run regressions or a Qual VAR, based on macro-level time series data.

⁸ See Cerutti *et al.* (2015) for more literature review on this group of studies.

distribution and dynamic provisioning. A few studies build their findings on panel regressions with cross-country macro-level datasets. For example, Lim *et al.* (2011) and Cerutti *et al.* (2015) provide supportive evidence particularly for the joint effectiveness of macroprudential policies in reducing the growth rate of credit. Cerutti *et al.* (2015) point out that the effectiveness of individual policies is instrument and country specific. Federico *et al.* (2014) find that developing countries actively use the reserve requirements as a countercyclical tool. Several other studies employ bank-level panel datasets. Among them, Claessens *et al.* (2013) run cross-country panel regressions and find that the effectiveness of macroprudential policies is state-dependent. Their efficacy is more obvious in boom times in reducing bank leverage and assets. They hence suggest macroprudential policies adopted in a preemptive way. Jiménez *et al.* (2017) show that countercyclical loan loss provisioning smooths cycles in the supply of credit, using difference-in-differences estimation based on rich micro-level data from Spanish banks and firms.

The second strand is relatively small, but growing literature that reconsiders the interaction of monetary and macroprudential policies as well as their effectiveness on macroeconomic and financial stability.⁹ These studies examine the historical use of macroprudential tools in advanced economies. For example, Elliott *et al.* (2013) and Kelber and Monnet (2014) review and identify macroprudential policies used in the U.S. history and those used by the main European central banks before 1980. Based on the findings in Elliott *et al.* (2013), Zdzienicka *et al.* (2015) build a time series to measure these macroprudential policy actions. Using on distributed lag (DL) model, they find that monetary policy shocks and macroprudential policy actions both have significant effects on real credit growth. Yet, the effects of the former are delayed but more persistent while the impact of macroprudential policy measures is more immediate but shorter-lasting. Aikman *et al.* (2016) carefully identify credit controls adopted by the Bank of England over the 1960-1982 period. Their factor-augmented local projections impulse response functions¹⁰ suggest that monetary policy affected output and inflation, but credit controls acted primarily to modulate bank lending.

The third and final strand consists of a few studies that have focused on China's practice and examined its prudential policies. Liao (2012), from a financial regulator's perspective (China Banking Regulatory Commission (CBRC)), presents the framework how China has monitored and assessed systemic risks.

⁹ Adrian and Liang (2014) and the IMF (2013) provide conceptual guidelines in this line as well as the literature review. One study, Aizenman *et al.* (2017), slightly differs from this line as it focuses on whether and to what extent the peripheral economies (PHs) insulate themselves from the influence of the center economies (CEs, i.e., the U.S., Japan and the Euro Area) by implementing macroprudential policies. Using the panel data, they show that under certain macroeconomic or policy conditions, a more extensive implementation of macroprudential policies would help the PHs to remain monetary autonomy from the CEs.

¹⁰ The impulse response functions are estimated with local projections at each horizon, i.e., regressing the response variables on policy variables and conditioning on the forecasts and factors.

He points out that macroprudential policy complements microprudential supervision and in China, financial stability is a shared responsibility among different authorities.¹¹ Wang and Sun (2013) use bank-level panel data to study a set of policies launched by the PBC and the CBRC, including monetary and macroprudential policies, and microprudential supervision. Their findings, based on the panel regressions, are mixed, possibly due to the lack of careful identification. The impact of the required reserve ratio on credit is not significant for the sample of all banks, but significant for the sample of large banks.

This paper proceeds as follows. Section 2 applies the narrative approach and identifies the PBC's macroprudential policy actions. Section 3 discusses data issues and presents the credit cycle in China. Section 4 sets up a VAR model and estimates the policy efficacy. Section 5 concludes.

2. The PBC's macroprudential policy toolkit

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" (Article 3). At the same time, the PBC's monetary policy is entrusted to "guard against and eliminate systemic financial risk and maintain financial stability" (Article 2). In summary, the PBC's policy objectives are threefold: price stability, economic growth, and financial stability. The last objective, financial stability, is mainly reflected in exchange rate stability as well as credit control/guidance. The current managed floating exchange rate regime¹² requires that the PBC be actively engaged in foreign exchange interventions and the attendant sterilization operations.¹³ Meanwhile, the PBC is targeting the new total bank lending and the broad money (M2)¹⁴ on a yearly basis. 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 2003Q3*: 6).

To achieve various policy objectives, the PBC relies on a toolkit including both monetary and credit policy instruments, as described in Table 1. With monetary policy, the PBC aims to alter the stock of

¹¹ The PBC used to be responsible for the comprehensive supervision of the banking, securities, insurance and trust industries. Since the 1990s, the financial supervisory tasks were split into several authorities. The current system is featured with a pattern of separate supervision of financial subindustries. It consists of one Bank (the PBC) and three Commissions (the China Banking Regulatory Commission (CBRC), established in April 2003; China Securities Regulatory Commission (CSRC), established in October 1992; China Insurance Regulatory Commission (CIRC), established in November 1998). Though the regulators hold regular joint Quartet-Supervision meetings to enhance supervision and coordination, this separate supervisory system is criticized to breed regulatory arbitrage arising from market fragmentation and disunity regulatory standards.

¹² In Jul. 2005, China announced to give up its decade-long dollar peg and switch to a managed floating exchange rate regime. The daily movement band in bilateral exchange rates has been extended gradually to the current level (+/- 3 percent).

¹³ 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 2015).

¹⁴ In China, M0 = currency in circulation; M1 = M0 + demand deposits; M2 = M1 + savings and time deposits.

high-powered money outstanding, controlling the quantity of money and hence the supply of bank loans; while with credit policy, the PBC is actively engaged in directing bank lending and thereby shaping the structure of bank loans.

Table 1. The PBC's policy instruments

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) ^c .
Interest rates	Price-based tool, including various central bank base interest rates. The deposit rate and lending rate of commercial banks used to be highly regulated.
Required reserve ratio	On a discretionary basis; a more direct tool.
Credit policy instruments	
Credit policies	For example, down payment requirements, which also affect the money multiplier.
Credit laws and regulations	Sometimes set jointly with other regulators.
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 securities issued by the PBC, introduced in 2002 to deal with the inadequate government bonds traded in OMOs. They had been used extensively as “sterilization” bonds till 2013.

b. The SLO was introduced in early 2013, used on a discretionary basis as a supplement to the regular OMOs. SLOs are mainly repos with a maturity of less than seven days, carried out in market-based interest-rate tenders, mainly.

c. In two steps, the PBC introduced two lending facilities: the SLF in early 2013 (together with the SLO) and the MLF in Sep. 2014. They are intended to meet the large-scale demands for liquidity of financial institutions and with interest rates on these facilities, to guide the market rates. Lending is extended mainly on collaterals to policy banks and large-sized national commercial banks.

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

Monetary policy instruments include open market operations (OMOs), central bank lending, interest rates and changes in the required reserve ratios. Over our sample period of 2010-2015, the PBC used OMOs extensively, via repurchase transactions, outright transactions and the issue of central bank bills, to absorb the excess liquidity in the banking sector as a result of foreign exchange market interventions, rather than to meet the operational target of a money market rate (as the Fed and the ECB do). On the other hand, the PBC does not crucially rely on the money market interest rate to transmit policy changes to key retail interest rates (the deposit and lending rates). Instead, it used to exert direct influences on retail interest rates by setting the benchmark (of various maturities), while banks were required to follow within limited floating bands.¹⁵

¹⁵ Over time, the floating bands for the lending and deposit rate were extended gradually. The last two interest-rate controls, the lending-rate floor and the deposit-rate ceiling, were lifted off in Jul. 2013 and Oct. 2015, respectively.

Credit policy mainly relies on credit ceilings, eligibility requirements for central bank lending, window guidance and down payment requirements on mortgage to “affect the allocation of loans or of deposits or the structure of interest rates”, as pointed out by Friedman (1960: 25). These credit policy tools were widely used by many central banks over the post-WWII era until the deregulation in the 1980s, including those advanced economies as well (see, e.g., Angelopoulou 2007; Elliott *et al.* 2013; Kelber & Monnet 2014; Monnet 2014).¹⁶ In today’s China, the PBC still believes that the development and implementation of credit policy is one of its important duties.¹⁷ The aggregate bank lending is one of its intermediate targets. Besides this, the PBC routinely applies specific central bank lending schemes as well as window guidance, as shown in the lower panel of Table 1, to control the quantity of credit and influence the structure of credit by “guiding” bank lending, often on a more discretionary basis.

Following the specified policy objectives, we can group the observed policy actions into three categories: monetary policy actions that are to achieve macroeconomic stability in terms of output and inflation, sterilization actions (i.e., liquidity management as a result of foreign exchange interventions), and macroprudential policy actions that aim to control total credit / contain financial stability. The first challenge that we face is to disentangle macroprudential policy actions from all others. Does the PBC follow a simple rule to use monetary policy instruments, as listed in the upper panel of Table 1, for the purpose of macroeconomic stability, while using credit policy instruments for the purpose of financial stability? Our reading of the PBC’s policy operations suggests that it is not the case. The PBC has been using instruments, such as reserve requirements and window guidance, for multiple purposes like macroeconomic stability, sterilization and financial stability. In this paper, our identification strategy is to employ the narrative approach, through studying the PBC’s documents, to obtain the extra information on policy intentions behind each action. The following sections present this identification.

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, though such actions have existed for a long time. Our paper reviews the PBC’s policies before and after the crisis. For the prior-crisis period, we are defining macroprudential policy in retrospect using today’s 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.

¹⁶ Credit policy regained its importance in these countries since the onset of the 2007-2008 crisis when facing the ZLB of the nominal interest rate, the central banks turned to quantitative/credit easing, including changing the composition of their asset portfolio between Treasury securities and credit to the private sector or to non-Treasury government entities (Goodfriend 2011).

¹⁷ This is clearly stated on its homepage: <http://www.pbc.gov.cn/jinrongshichangsi/147160/147289/147304/2899801/index.html>.

Macroprudential policy differs 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 *et al.* 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).

Furthermore, it is widely agreed that macroprudential policy should increase the resilience of the financial system against financial shocks, contain financial booms, strengthen the structure of the financial system (FSB *et al.* 2011; Schoenmaker 2014). We hence define the PBC’s policy actions to be of a macroprudential nature if they are state-varying, aiming to smooth credit cycle, and/or improve the resilience of the financial system. More specific, these policy actions include those:

- (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 booming asset markets.

The first part of our definition follows the “credit-booms-gone-bust” finding, which suggests that macroprudential policy should 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 build-up of potential financial vulnerability that concerns the PBC, as addressed in its Reports repeatedly. 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”. 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.

Another important guideline that we use to distinguish macroprudential policy from monetary policy actions is to allow macroprudential policy to take a more granular approach (see. e.g., Brunnermeier & 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.¹⁸ Second, rather than broad use of monetary policy, 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 *China Monetary Policy Report*. However, the PBC does not confine the use of credit guidance to resolving financial risk only. Our reading suggests that credit guidance is often used to tackle structural imbalances as well. Together with other policy measures (either fiscal or industrial), monetary policy has been widely used, through either central bank lending schemes or window guidance, 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 2003Q2; 2009Q4; 2010Q1*). Yet, these policy actions are better defined as structural or industrial policies. We carefully exclude them from those aiming to improve the resilience of the financial system.

Our definition is strictly in line with the PBC's conceptual formulation about "macroprudential". 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 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 2011Q4*: 17). Since then, this term has appeared frequently in its documents to describe its monetary policy. The PBC also 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 (...) refrain from excessive expansion" (*China Monetary Policy Report 2014Q3*: 18).

With this definition, we apply the following identification strategy. First, we identify the intentions behind each observed policy action. Second, we disentangle those policy actions, consistent with our definition, as macroprudential actions. Third, we quantify the identified macroprudential policy changes.

We apply the narrative approach to identify policy intentions by studying *China Monetary Policy Report*. This Report is an executive summary of monetary policy, published each quarter by the PBC since 2001. It reviews all the policy actions with detailed reasoning. It hence gives us sufficient information on the intentions behind each policy action. As a cross check, we also study the PBC's *Chronicle of Events*.

¹⁸ If we follow the framework of the FSB, the IMF and the BIS (2011), which formulates systemic risks in two dimensions: the time dimension (to mitigate financial system procyclicality) and the cross-sectional dimension (to reduce systemic risk concentrations), this granular approach addresses systemic risks in the second dimension.

In so doing, we build a table of the PBC's macroprudential policy changes on a monthly basis over the period of 2000M1-2015M12 together with the brief summaries of policy actions extracted from the PBC's records. This table is presented in the online appendix. We quantify the policy changes with 1, 0 and -1. With 1, we define as a macroprudential tightening, aiming to curb the fast growth of total credit and/or rapid rise of property prices; tackle problems such as accelerating nonperforming loans and maturity mismatching. 0 indicates a neutral policy without changes. With -1, we define as a macroprudential ease, where policies tend to expand credit and/or stimulate the development of the real estate industry; encourage consumption loans. The policy instruments that the PBC uses in a macroprudential manner mainly include: the required reserve ratio, window guidance, housing policy and supervisory pressure. For each of them, we construct a time series to measure the policy stance that their adjustments convey. Then, summing up individual time series, we construct a time series to measure the overall stance of macroprudential tightness/ease. In converting these five time series into a quarterly basis, we take a simple sum. These indicators on a quarterly basis take values beyond 1, 0 and -1. The larger (smaller) the value is, the tighter (easier) is the stance of the macroprudential policy.

2.2 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.

The PBC did not make frequent changes in the reserve ratio until the mid-2000s, as shown in Fig. 1.¹⁹ However, due to the liquidity management need arisen from foreign exchange interventions, in 2006 the PBC started to use both open market operations and variations in the reserve ratio to “sterilize” the monetary base (*China Monetary Policy Report 2006Q2*: 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 2003Q3*: 16). Initially, China's reserve requirement system was relatively simple with a uniform required reserve ratio applied to all kinds of the

¹⁹ Like China, central banks in many emerging economies use 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). On the contrary, in today's advanced economies, the legal reserve-deposit ratios are usually set at a fixed level and kept unchanged.

non-financial corporate and household RMB deposits, regardless of maturity.²⁰ Then in two steps, the PBC introduced the dynamic differentiated required reserve ratio (see China Monetary Policy Report 2014Q3, Ma *et al.* 2013; Wang & Sun 2013). 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.²¹ 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 macroprudential policy” (*China Monetary Policy Report 2011Q4*: 17). More specific, the reserve requirement applied to different banks is allowed to vary, reexamined on a quarterly basis with reference to 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 frequent changes in reserve requirements have drawn a lot of attention. 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, 2015, forthcoming).

We record the changes in the required reserve ratio only when this policy shift is clearly stated to target at the total credit aggregate or when this policy tool is used in a differentiated way. For example, in September 2003 and the second half of 2006 (Jul, Aug and Nov), the PBC clearly stated that hikes in the reserve ratio were aiming to control the rapid growth of credit. In the second half of 2007 (Aug, Sep, Oct and Dec), January 2008, the first half of 2011, December 2011 and February 2012, the adjustments in the reserve ratio were accompanied with differentiated modifications. That is, those institutions of low CAR (capital adequacy ratio), high NPLs or high credit growth were subject to a higher reserve ratio. More targeted cuts of the ratio were found in July 2008, the first half of 2014 (Mar, Apr and Jun) as well as several times in 2015, applying to certain institutions only (e.g., Urban Commercial Banks (UCB) or Rural Credit Cooperatives (RCC)) or to those institutions only that met the specific lending criteria (mainly, referring to the lending to agro and SMEs).

Fig. 1 shows four identified individual macroprudential policy instruments on a quarterly basis in four panels. This macroprudential reserve requirement (RRR_MPP) time series is presented together with the headline reserve ratio (RRR),²² with their correlation coefficient reported in the Figure as well (t-statistics

²⁰ Foreign currency deposits are subject to a lower seldom-adjusted reserve requirement (5% since 2007). In this paper, the reserve requirements policy refers to that for RMB deposits only.

²¹ In addition, rural and urban credit cooperatives enjoy an ever more favourable requirement ratio. Currently, it is about 5-6 percentage points lower than that for the large banks.

²² From 2008Q3 onwards, the reported headline required reserve ratio is a weighted average of those for large and small banks (with $\frac{3}{4}$ attributed to the former and $\frac{1}{4}$ to the latter, as applied in the CEIC data).

in parentheses). Most of the RRR_MPP adjustments are accompanied with the changes in the RRR. However, only a small proportion of the RRR changes falls in the category of the macroprudential policy actions. Moreover, several targeted cuts in the post-2008 period (particularly, in 2014) are applied only to a very small fraction of banks (UCB and RCC), which is not captured in the headline reserve ratio. Not surprisingly, the correlation coefficient between these two time series is essentially close to zero and not significant.

Figure 1. Individual macroprudential policy instruments, 2000Q1-2015Q4

Source: Authors' calibration.

2.3 Window guidance

In addition to other measures, the PBC uses window guidance – a form of “moral suasion” or “indirect pressure” – to influence the quantity and the structure of bank lending through regular meetings with banks. It 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 2006Q4*: 13). In 1998, the PBC started to hold monthly meetings with financial institutions – analysis of economic and financial situations (*China Monetary Policy Report 2001Q4*: 2). Thereafter, this practice has turned institutionalized and regularly, which is reported in its *China Monetary Policy Report*. The main purpose is to “improve credit policy guidance and encourage financial institutions to adjust the credit structure and manage the pace of credit provisions” so as to ensure the credit to be guided to the sectors of the PBC’s favors (*China Monetary Policy Report 2010Q4*: 8).

According to Geiger (2006), window guidance must be effective in China given Chinese political hierarchy system. Chen et al. (2017), using an open-economy DSGE model, study the stabilizing effects of window guidance. They find that window guidance can help provide additional stimulus in the face of large negative productivity and financial shocks, but it is ineffective to steer the economy in the presence of small supply shocks or demand shocks (either large or small). Furthermore, the PBC's Report provides some snapshots of the efficacy of window guidance as a complementary policy measure. For example, between July and September of 2003, the PBC "summoned 3 window guidance meetings (...) to give out warning of the possible systemic risks that could be caused by the excessive credit expansions. (...) Since July, the state-owned commercial banks have taken appropriate measures to address the excessive credit growth. (...) Most joint-stock commercial banks made necessary adjustment to their credit growth as well. Between July and September, the monthly growth of credit was RMB100 billion yuan, less than the average in the first half of the year" (*China Monetary Policy Report 2003Q3*: 16-17).

Although the focus of the PBC's window guidance varies slightly from year to year in accordance with the economic situation, a general guideline for this practice throughout the time is that the PBC guides financial institutions to follow "the principle of differentiated treatment" in making loans (*China Monetary Policy Report 2005Q4*: 13). From time to time, the PBC warns banks against lending to particular sectors. The guiding directions – support vs. restrict – are clearly stated in the PBC's monetary policy reports (various issues of *China Monetary Policy Report*). Those actions are identified as macroprudential that aim to improve financial resilience.

Also, we identify those as macroprudential that through window guidance, the PBC has been trying to have impact on the credit growth over the credit cycle. For example, in April 2001, 2004-2007 and 2009-2011, in these window guidance meetings the PBC guided banks to reinforce loan management, warned them against fast growth of bank loans and the maturity mismatching problem, alerted them of the new credit risks, guided banks to improve assessment mechanism and pushed differentiated mortgage policies (various issues of *China Monetary Policy Report*). These events are identified as macroprudential tightening. Macroprudential easing is found in various cases where the PBC pushed banks to issue consumption loans, for example, in 2002-2003, 2008 and 2013-2015. As shown in Fig. 1, frequently the PBC uses this window guidance for the macroprudential purpose, with the tightening clustered in 2004-2007 and 2009-2011 period and the easing centered in 2013-2015 period.

2.4 Supervisory pressure

As other central banks, the PBC, jointly with other regulators (e.g., CBRC), supervises and invigilates the financial development as well as systematically important financial institutions (SIFIs) to safeguard

the financial stability.²³ In so doing, the PBC, alone or jointly, issues a series of laws and regulations. Over this period, many of these regulations are aiming to standardize and improve market order, e.g., to set up frameworks and rules for the money market and the capital market; to push the development of the capital market, for example, “Regulations on Interbank RMB Borrowing” issued in June 2002. Such practices we do not consider as macroprudential. Rather, we identify those regulations as macroprudential that reinforce banking lending criteria (e.g., forbid unauthorized consumption loans in 2001); regulate collaterals; call for attention to risk management, NPLs and maturity mismatching problem (e.g., in 2003 and 2005); reinforce financial regulations and controls (e.g., in 2006-2007); reinforce the risk warning system (in 2010). More examples include that in 2000-2001, the PBC regulated closure of failed financial institutions to show its determination to safeguard the financial system. It is clear that most of supervision works in the direction to control rapid credit expansion and alert of potential risks. These actions are identified as macroprudential tightening, as shown in Fig. 1. Only in two cases, supervision works in the direction to push banks to issue loans and set up the joint supervision system (in 2002 and 2008), which are identified as macroprudential easing.

2.5 Housing policy index

The PBC considers real estate industry as one of the key industries of the national economy. It is important to sustain stable and healthy development of the real estate sector to ensure the targeted GDP growth rate. 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 market, sales and prices, the growth of mortgage loans, and its implication for the financial stability, etc. Quite often, policy measures to curb excessive mortgage expansion are discussed.

We identify housing policy actions, mainly taking following forms: regulations on mortgages as well as mortgage rates, the caps on the LTV ratio and credit policies on real estate developments. First, in 1999 and 2000, the PBC, jointly with the other regulators, extended the maturity of mortgages and issued regulations to standardize mortgages in order to support mortgage borrowing. In February 2002, the PBC lowered the mortgage rate to push mortgage borrowing. In general, the mortgage rate is subject to the lending-rate floor as well. Yet, in 2006 and 2008, twice the PBC lowered the boundary of the mortgage-rate floating band. Moreover, the mortgage and the mortgage rate can be set differentiated, targeting at different kinds of demand. For example, the mortgage rate was increased for the 2nd home purchases in September 2007; the mortgages for 3rd home purchases were suspended in September 2010.

²³ For example, in the U.S., “the Federal Reserve will (...) supervise all systemically important institutions. (...) Supervision and regulation must serve as the first and main line of defence in addressing systemic risk” (Yellen 2010: 5).

Second, starting from 2001, the LTV ratio is subject to a cap: the mortgage with zero down payment is forbidden. This cap is set by the PBC, since 2003 jointly with the CBRC. One important feature of this cap is that quite often, it is set differentiated across regions, across apartments of different sizes and targeting at different kinds of demand. For example, the LTV cap was lowered only in areas with fast rising housing prices in March 2005; the cap was lowered for large apartments (i.e., > 90 m²) in June 2006; targeting at 2nd home purchases, the LTV cap was lowered in September 2007 and early 2011.

In one case, this housing-market related policy is reflected in the adjustments of the tax rate. In November 2008, the real estate tax rate was cut to 1% for the 1st home purchases of apartments smaller than 90 m²; the stamp tax and the land VAT were freed for private sales of apartments.

All these above-mentioned policy actions work on the demand side of the housing market. Meanwhile, we identify one policy action that work on the supply side – credit policies applying to real estate developers. For example, the real estate development loans were subject to more strict assessment in March 2002 and August 2003. In 2006, the entry to the real estate developments tightened. In 2010, 2011 and 2013, the PBC pushed financial services to support the affordable and government-subsidized housing projects so as to restrain the speculation in the housing market.

Based on these actions, we summarize the housing policy index as tightening in case of a rising mortgage rate, a lowering LTV cap or controlling the real estate development; and easing vice versa. This housing policy index is presented in Fig. 1 as well. With a few exceptions (2000:2, 2002:1, 2008:4), in general the housing policy is tightening over this sample period.

In contrast to the other policy actions identified in the previous sections, this housing policy is a borrower-based tool that works on the credit demand side through restraining households' or real estate developers' borrowing, while all other three measures (the reserve requirement, window guidance and supervisory pressure) are bank-based tools that work on the credit supply side by effecting the commercial banks' lending decisions.

2.6 Other policy actions

Our reading suggests that sometimes, other policy instruments were also used to safeguard financial stability, for example, open market operations (OMOs) and central bank lending (CBL). In eight cases, open market operations had macroprudential features. In 2006 (May to Jul) and 2007 (Mar, May, Jul, Aug and Sep), through OMOs the PBC issued central bank bills, targeted at those banks of ample liquidity and excess loan growth, intending to send them warning signals (*China Monetary Policy Report 2006Q2*;

2007Q2; 2007Q3). Most of central bank lending and standing lending facilities are aiming to provide liquidity to the regions of natural disasters or guide banks to lend to certain industries (agro loans; loans to SMEs or policy-preferred industries) (various issues of *China Monetary Policy Report*). Only in three cases, we identify central bank lending as macroprudential when it was well tailored and aiming to improve financial stability. In 2001 (Feb and Dec) and 2004 (Jan), through targeted central bank lending schemes, the PBC provided liquidity to those Urban Commercial Banks (UCCs) and RCCs, which had high level of NPLs or faced insolvency risk, to safeguard financial stability.

A separate time series for each of these two instruments is a sequence of zeros with very limited variations. It is difficult to assess their individual impact on credit. But we take these OMO and CBL actions into account while building the overall macroprudential policy stance time series.

2.7 Overall macroprudential stance indicator

The above review suggests that with several instruments, the PBC is actively engaged in directing bank lending and influencing the private sector's borrowing behaviors. When financial distortions are more acute in some particular sectors, as is often the case, monetary policy is too blunt a tool. On the other hand, macroprudential policy is granular, targeting at the credit quantity and credit allocation, and hence restraining the build-up of systemic risk.

By summing up the indices of individual instruments, we build a time series of an overall indicator to measure macroprudential ease/tightness. Fig. 2 presents this overall indicator, together with the Sun monetary policy indicator (the Sun-MP index, hereafter). As discussed above, the PBC uses multiple policy tools and none of them itself is sufficient to measure the PBC's monetary policy stance (see, among others, He & Pauwels 2008; Shu & Ng 2010; Xiong 2012; Chen *et al.* 2013; Sun 2013, 2015). Sun (forthcoming) builds a time series of a narrative index to comprehensively measure the PBC's policy stance by referring to its macroeconomic stability objectives (output and inflation).²⁴ In this paper, we use this index as our monetary policy indicator.

These two time series are significantly positively correlated. We observe two clustered periods where these two policy stances take the same position: in the 2003-2007 period both monetary policy and macroprudential policy are tight; while in the 2012-2015 period these two policies are both easy. However, in the periods of 2001 and 2010, these two policy positions differ. Moreover, the correlation

²⁴ It is a 5-value time series of index, with 2 indicating very tight, 1 tight, 0 neutral, -1 easy and -2 very easy. Using this index, Klingelhöfer and Sun (2017) estimate a regime-switching Taylor-type response function for the period of 2000-2015, modelling the PBC's reaction to output gap and inflation deviation.

coefficient of these two policies is only 0.53, as reported in Table 2, indicating that these two policy stances do not necessarily change at the same time. The PBC seems to be able to take different policy stances towards different policy objectives, particularly when facing conflicting macroeconomic and financial conditions. Such flexibility is due to its multiple-instrument framework that allows it to employ different policy instruments to address different problems.

Figure 2. The overall MPP indicator, together with the Sun-MP index, 2000Q1-2015Q4

Source: Authors' calibration and Sun (forthcoming).

Table 2. Correlations between various policy measures

	Sun-MP index	MPP_overall	RRR_MPP	Window guidance	Housing policy	Supervision
Sun-MP index	1.00 -----					
MPP_overall	0.53 [4.94]	1.00 -----				
RRR_MPP	0.48 [4.36]	0.63 [6.45]	1.00 -----			
Window guidance	0.52 [4.77]	0.79 [10.00]	0.28 [2.32]	1.00 -----		
Housing policy	0.27 [2.24]	0.66 [6.85]	0.29 [2.42]	0.35 [2.91]	1.00 -----	
Supervision	-0.09 [-0.71]	0.45 [3.95]	0.05 [0.36]	0.23 [1.89]	0.22 [1.81]	1.00 -----

Note: T-statistics are reported in parentheses.

Source: Authors' estimation.

Table 2 reports the correlation coefficients between various policy measures, with t-statistics in parentheses. Monetary policy is positively correlated with three individual macroprudential instruments,

but not significantly correlated with the supervisory pressure. As expected, the overall MPP policy index is significantly positively correlated with all four individual policy instruments, ranging from 0.45 to 0.8. The moderate pairwise correlations among individual macroprudential instruments suggest that the co-movement of these individual policies is limited. This indicates that the PBC does not necessarily tighten/ease all these instruments when adjusting its macroprudential policy stance. Nor can any single instrument be described as a dominant instrument. Rather, it seems that the PBC has been employing these instruments in a discretionary and flexible way.

3. Measuring financial conditions

In this paper, we use the total credit to measure financial conditions. Consistent with the credit-booms-gone-bust findings, total credit, often scaled as the ratio to nominal GDP, is a useful measure of procyclicality (see, e.g., Borio & Lowe 2002; Hume & Sentance 2009; Hahm *et al.* 2012). Also, this ratio 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 *et al.* 2011).

Our sample period is 2000Q1-2015Q4. The data are collected from various sources. The macroeconomic data (i.e., nominal GDP, real GDP and its growth, 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 at a monthly basis. Financial institutions in this table include the PBC, banking depository financial institutions and banking non-depository financial institutions.²⁵ Total loans are 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 are 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 3 presents a snapshot of the aggregate asset and liability structure of all Chinese financial institutions for selective years, all values as the end-of-year outstanding amount. Since 2000, China has experienced fast financial deepening and developments: Total financial assets have more than decupled, from 13 trillion yuan in 2000 to 154 trillion yuan in 2015. The main assets that financial institutions hold are loans: the loan-to-asset ratio was as high as 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

²⁵ According to the PBC, the former includes banks, credit cooperatives and finance companies, while the latter refers to financial trust and investment corporations, financial leasing companies, auto-financing companies, as well as loan companies.

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 2015 it was 17%. As for portfolio investment, in general financial institutions did not invest much in securities: throughout 2014 the securities-to-asset ratio was quite stable, remaining at 12%-15%, with the exception of 22% in 2015.

Table 3. Aggregate balance sheet of all the Chinese financial institutions, 2000-2015

	2000		...	2004		...	2008		...	2011		...	2015	
	¥ 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%		154.12	100%
Loans	9.94	74.5%		17.74	67.7%		30.34	56.4%		54.79	60%		93.95	61.0%
Securities	1.97	14.7%		3.09	11.8%		6.53	12.1%		10.93	12%		33.20	21.5%
Foreign Reserves	1.43	10.7%		5.26	20.1%		16.84	31.3%		25.36	27.8%		26.59	17.3%
Other assets	0.001	0.01%		0.10	0.4%		0.13	0.2%		0.24	0.3%		0.38	0.2%
Liabilities	13.85	103.9%		26.65	101.8%		52.20	97%		87.09	95.4%		143.11	92.9%
Deposits	12.38	92.9%		24.05	91.8%		46.62	86.6%		80.94	88.6%		135.70	88%
Cash	1.47	11%		2.15	8.2%		3.42	6.4%		5.07	5.6%		6.32	4.1%
Financial Bonds	0	0.02%		0.40	1.5%		2.09	3.9%		1.00	1.1%		1.01	0.7%
Other liabilities	0	0		0.06	0.2%		0.07	0.1%		0.08	0.1%		0.08	0.1%
Capital (Assets-Liabilities)	-0.52	-3.9%		-0.46	-1.8%		1.64	3%		4.23	4.6%		11.01	7.1%

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.

On the liabilities side, financial institutions are mainly (more than 85% throughout the whole period and in the early 2000s more than 90%) funded by various deposits, while funding through financial bonds is increasing but still limited.²⁶ The FIs' net worth (defined with capital) has been improved, as shown in "Capital" in the Table 3. The capital-to-asset ratio was initially negative in 2000; but in 2007 it turned out positive and remained around 4% afterwards till 2012. This ratio rose rapidly to 5.5% and 8.6% in 2013 and 2014, respectively.

Table 3 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 that the loan-to-deposit ratio not exceed 75%. It implies that the expansion of loans at 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. On the other hand, 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. Whatever distortions that these policies may have

²⁶ By contrast, under a market-based financial system (e.g. in the U.S.), financial institutions rely on financial markets to raise funding to supplement their traditional deposit funding and hence the broad money is no longer a good measure of liquidity (Adrian & Shin 2008; Shin & Shin 2011).

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 equity), this share declined slowly, but still accounted for about 80% of total financing to the real economy in 2014 (*China Monetary Policy Report 2014Q4*). It suggests that the total bank loans well approximate the debt accumulation in the Chinese economy.²⁷

Fig. 3 presents four financial condition measures that are used in this paper, among which Fig. 3.1 displays the total loans, scaled as the loan-GDP ratio, together with its HP-filtered trend.²⁸ The loan-GDP ratio fluctuated along a moderate growth drift, as illustrated with the HP-filtered trend. It suggests two hump-shaped credit booms: one in 2003-2004 and the other in 2009-2010, each lasting about two years. The latter hike followed an obvious large credit slip in 2008.

Fig. 3.1 also displays the macroeconomic condition, measured with real economic growth and inflation. Over the sample period, 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. Output growth in the 2014-2015 period remained around 7%. In general, high economic growth did not trigger much high inflation in China: inflation was moderate, 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.

The first financial condition indicator, bank loans, measures how loose credit is in the aggregate. Yet, as pointed by Jordà *et al.* (2014), it also matters for what kind of purpose credit is used. We include three additional measures in different model specifications. For example, in the baseline model we also include the nominal average housing price (¥ / m²)²⁹, as shown in Fig. 3.2. Alongside some seasonal patterns, this housing price displays a clear upward trend over the sample period. The housing price, which the

²⁷ Alternatively, one can use the PBC's new measure of broader credit, "Aggregate Financing to the Real Economy" (AFRE), to gauge the debt accumulation. Starting from 2012, the PBC provides the AFRE statistic table on a monthly basis, including bank loans, trust loans, entrusted loans plus direct financing through corporate bonds and equity. However, this short sample period does not allow us to draw any reliable statistical inference. On the other hand, the total bank loans, used in this paper, include both bank loans and trust loans, as listed under the AFRE, which account for the majority of the AFRE (minus equity). Of course, neither of them can capture the off-balance loans, of which the majority is wealth-management products (WMPs) that have expanded fast since the end of the 2000s.

²⁸ The ratio is defined as total loans to GDP, both in nominal term and GDP annualized (as a moving sum of up-to-current four quarters). Its trend is estimated with the Hodrick-Prescott filter (with the smoothing parameter $\lambda=1600$).

²⁹ It is calculated as commercial residence sales / areas, based on the monthly data from the NBS.

PBC monitors closely, helps gauge the real estate market conditions that in turn have significant implications for financial stability.

Figure 3. Four financial condition measures

Source: Authors' calculation, based on the data from the NBS, the PBC and the *IMF IFS*.

In the extended alternative models, we replace this housing price with either the share of medium- and long-term loans in the total loans or the share of loans to households in the total loans. In Fig. 3.3, the bank loans are decomposed into two parts according to the maturity. In the early 2000s, around 70% of the total bank loans were short term. Throughout the time, the share of medium- and long-term loans grew up and reached 56% by the end of 2015. This share sheds some light on the potential systemic risk due to the banks' maturity mismatch problem, which the PBC pays close attention to.

In Fig. 3.4, the total bank loans are decomposed into those to firms and households. This kind of decomposition is only available since 2007. The loans to households accounted for 18% in 2007. Over time, this share climbed up steadily, except a minor reversal in 2008. By the end of 2015, it was close to 30%. This share gauges the accumulation of household credit, mostly of mortgages. It sheds light on potential default risks in the housing market. On the other hand, our reading suggests that many of the PBC's policy actions were designed to stimulate/restrain bank loans to households.

4. Estimation of the policy efficacy

4.1 Baseline model

To examine effectiveness of macroprudential policies, we let the economy be described in the following structural VAR model,³⁰ given in Eqs. (1)-(2):

$$\mathbf{Y}_t = \mathbf{Con}_t^Y + @trend + \sum_{i=0}^k \mathbf{B}_i \mathbf{Y}_{t-i} + \sum_{i=0}^k \mathbf{C}_i \mathbf{X}_{t-i} + \mathbf{A}^Y \mathbf{v}_t^Y \quad (1)$$

$$\mathbf{X}_t = \mathbf{Con}_t^X + @trend + \sum_{i=0}^k \mathbf{D}_i \mathbf{Y}_{t-i} + \sum_{i=0}^k \mathbf{G}_i \mathbf{X}_{t-i} + \mathbf{A}^X \mathbf{v}_t^X \quad (2)$$

where boldface variables denote vectors or matrices. Variables are classified into two groups – $\mathbf{Y}$ and $\mathbf{X}$, which stand for vectors of macroeconomic/financial-condition variables and policy variables, respectively. The vectors $\mathbf{v}^Y$ and $\mathbf{v}^X$ are mutually uncorrelated structural error terms. Macroeconomic and financial-condition block $\mathbf{Y}$ contains a vector of four variables, all in logarithm: real GDP index (Y) (seasonally adjusted), consumer price index (CPI), the total bank loans (L) and the average housing price (HP), obtained from the IMF IFS, the OECD, the PBC and the NBS (with compilation), respectively. In the policy block $\mathbf{X}$, we include monetary policy index (MP) and the overall macroprudential policy index (MPP). In addition, a constant and a time trend are included.

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 and financial-condition variables evolve over time, with the policy impact on them incorporated. Eq. (2) can be considered as the PBC's policy response function to the macroeconomic and financial conditions. We include a monetary policy indicator as monetary policy, which responds to the economic conditions (output and inflation), does have impact on the financial conditions as well. Controlling for monetary policy helps to obtain unbiased consistent estimates of the impact of macroprudential policies. On the other hand, with this specification, we can explore the interaction of monetary policy and macroprudential policy.

Quarterly data for the period 2000Q1-2015Q4 are used and two lags are included, i.e., $k = 2$.³¹ To identify the model, we follow the literature and propose a recursive ordering assumption (Cholesky decomposition) on the contemporaneous relationship between variables. We assume that policy variables affect $\mathbf{Y}$ vector with one-period lag, i.e., $\mathbf{C}_0 = 0$. We further assume that $\mathbf{X}$ vector is ordered as (MP, MPP). Our estimates with MPP ordered after MP gives the lower bound of macroprudential impact on the economy.

³⁰ Alternatively, we also follow Jordà (2005), using a local projection approach to compute impulse response functions (IRFs). In general, the obtained IRFs are qualitatively similar to what we estimate with the VAR model, but less precise and more erratic.

³¹ Allowing $k = 4$ in the baseline model, we obtain qualitatively same conclusions from the estimated impulse responses.

4.1.1 Policy effects and policy responses

Fig. 4 shows the impulse responses estimates of the accumulated impacts of one-standard-deviation innovation to two policy variables (MP, MPP) on output and the price level over the 20-quarter horizon, together with one-standard-error bands. The fact that policy variables are both qualitative measures will not allow us to compare the magnitude of the estimated responses. Instead, our comparison will focus on the timing, significance level and persistence of the estimated impulse responses.

Following a monetary policy shock (a tightening, shown in the first row), both output and prices drop, with prices starting to decline with a 2-year time lag. The negative impact of monetary tightening is persistent. After 5 years, output is still statistically significantly below the level that it would otherwise be. Interestingly, the impacts of macroprudential policies on both output and prices display similar patterns as those from monetary policy. Yet, the uncertainty around these estimates is high: None of them is statistically significant.

Analogously, Fig. 5 shows the impulse responses estimates of the accumulated impacts of one-standard-deviation innovation to two policy variables (MP, MPP) on loans and the housing price over the 20-quarter horizon, together with one-standard-error bands. The first row suggests that both monetary policy and macroprudential policy have significant impact on the credit growth, though the timing of the policy impact differs. A macroprudential policy tightening turns out to have an immediate impact on the total credit: The lending drops immediately and reaches the trough after about 2 years. Afterwards, this negative impact on the lending remains at this level. In contrast, a monetary policy tightening affects the total credit with a 2-quarter time lag; the trough is found 2.5 years later. Similarly, its impact on the credit is persistent. After five years, the credit is still significantly below the level that it would otherwise be.

However, macroprudential policy is found not to have significant impact on the housing price with high uncertainty around these estimates, while following a monetary policy tightening, the housing price drops.

Figure 4. Baseline model: Accumulated Impulse responses – policy effects on the macroeconomy

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 one-standard-error bands.

Source: Authors' estimation.

Figure 5. Baseline model: Accumulated Impulse responses – policy effects on financial conditions

Note: See note to Fig. 4.

Source: Authors' estimation.

We also ask the question whether policies respond to financial conditions. Fig. 6 shows the reaction of monetary policy and macroprudential policy to the total credit and the housing price, together with one-standard-error bands. Compared to monetary policy, macroprudential policy responds to both credit and

the housing price immediately. This suggests that in response to a credit or a housing-price shock, the PBC chooses to tighten macroprudential measures immediately and significantly. Macroprudential policy is the PBC's primary policy choice to address its financial stability concerns.

Figure 6. Baseline model: Accumulated impulse responses – policy reaction to financial conditions

Note: See note to Fig. 4.
Source: Authors' estimation.

4.1.2 Policy shocks and volatility

Besides the dynamic policy effects discussed above, in Fig. 7 we report the VAR forecast error decomposition. This helps answer the question how policy shocks contribute to the volatility of various economic aggregates. A curve in each panel gives the percentage of the variance of the k-quarter ahead forecast errors in Y, CPI, L, HP, MP and MPP that attribute to shocks to each variable. The estimated confidence intervals are not reported in the figures to keep them readable.

In general, the own shocks account for the majority of the volatility of the underlying variable, with this percentage dropping fast in the near future forecast and then stabilizing at the 2-year horizon. One exception is the total bank loans, L. Its own shocks have had a limited impact on its volatility after a 1-year forecast horizon, accounting for 96%, 63%, 32%, and 23% of the variance of 1, 2, 4 and 8 quarter ahead forecast error variance in L, respectively.

Figure 7. Baseline model: Forecast error variance decomposition

Note: The forecast variance decompositions are estimated from the VAR model specified in the system (1)-(2) (see text for explanations).
Source: Authors' estimation.

Also, the figures suggest moderate interaction among the variables. A number of results are interesting to note. First, monetary policy shocks have had impacts on the volatility of output (15%) and credit (20%) at the 8-quarter horizon. Second, macroprudential policy shocks help explain 17 percent of the 8-quarter ahead forecast variance of credit, while these shocks play a very minor role in accounting for the variability in output. Third, most of the policy variation, both monetary and macroprudential, arises as a consequence of their own shocks, as shown in Figs. 7.5 and 7.6. Still, macroeconomic shocks, but not financial-condition shocks, play a nontrivial role in accounting for the variability in monetary policy, with 20% and 9% due to price level shocks and output shocks, respectively, in the medium run. In contrast, neither macroeconomic shocks nor credit shocks play an important role in accounting for the volatility in macroprudential policy measure. Rather, it is housing price shocks and monetary policy shocks that account, for example, for about 15% at the 8-quarter horizon. Last, macroprudential policy shocks neither account for much of the volatility of the price level nor that of the housing price. The variance of these

two price measures are partly due to output shocks and monetary policy shocks (at least for the price level in the medium run).

In sum, our findings suggest that monetary policy shocks have been an independent source of impulses to the business cycle and the credit cycle, though of only modest degree; while macroprudential policy shocks have played a limited role in explaining the credit cycle as well, but not in addressing the business cycle.

4.1.3 Discussions of real inefficacy of macroprudential policies and policy implications

In this subsection, we focus on the ineffectiveness of macroprudential policies on the real economy and the policy implications of this finding.

Macroprudential policies aim to improve financial stability by smoothening the credit cycle and improving the resilience of the financial system. Following a macroprudential tightening, bank loans fall significantly, as shown in Fig. 5. On the other hand, ups and downs in bank loans have unneglectable impact on output. Then, why has a decline of loans following a macroprudential tightening not resulted in a fall in real output? One possible explanation is that macroprudential policies are well targeted such that credit flows to the real economy are not influenced by a macroprudential tightening. For example, many macroprudential measures are designed to address credit flows to the asset market. A fall of credit is reflected in declining flows to the asset market only. In this case, a macroprudential tightening is very likely to have insignificant impact on output. Another argument for this explanation is based on a somewhat strong assumption that following a macroprudential tightening, only “bad” credit is squeezed out, while leaving “good” credit and hence the real economy not influenced.³² More disaggregated data on credit flows are needed to test this hypotheses, which we will not be able to explore in this paper due to a lack of data.

Another possibility is that financial institutions have managed to circumvent the macroprudential measures such that the private sector is still receiving credit, which is not captured in our aggregate credit measure. It is true that our total bank loans do not capture the fast development of shadow banking (e.g., WMPs and related credit issuance) in China starting from the end of the 2000s.³³ To test this explanation, we re-estimate our baseline model with two subsamples (2000-2007 and 2008-2015). In general, the impulse response estimates for subsamples are more imprecise and sometimes even erratic due to a

³² “Bad” credit is defined as that “related to things such as lower lending standards, higher LTV ratios, speculation, overvaluation of assets, and so on”, while “good” credit is “related to financial deepening and developments that does not weaken but rather strengthens the financial system” (Svensson 2016: 4).

³³ See also Footnote 27.

smaller number of observations in subsamples. Focusing on macroprudential policy impact on credit and output, for the subsample of 2000-2007 we obtain a qualitatively same conclusion as that for the whole sample,³⁴ while for the subsample of 2008-2015, the impact of macroprudential policy on both credit and output is estimated statistically significant. Clearly, neither can this circumvention hypothesis explain the result for the first subsample as it is unlikely that firms and households obtain other credit rather than bank loans during the 2000-2007 period. Nor can it explain the result for the second subsample when the circumvention is likely but the real effect of macroprudential policy is found statistically significant.

One other possibility is that macroprudential policies are partly used as an offsetting measure to neutralize the negative impact of a monetary policy easing on financial stability. Recall Fig. 7.6 that monetary policy shocks account for about 15% of the volatility in macroprudential policy measure. Also as shown in Fig. 2, the PBC eased monetary policy in 2001 and 2010 to stimulate the real economy. At the same time, it tightened various macroprudential measures (window guidance, supervision and housing-market policies) to maintain financial stability. A simple regression of output on a constant and a time trend suggests that in both 2001 and 2010, output rose up faster than the trend. In these two cases, the real effects of a monetary easing dominates, leaving the real impact of a macroprudential tightening hardly detectible. Analogously, we study historical episodes in which there were macroprudential policy actions but no monetary policy actions to test whether macroprudential policy alone has real effect. This occurred in the period of 2013Q1-2014Q1 when $MPP = -1, -2, 0, -1, 1$ while $MP = 0$ in these five quarters. Output turns out to rise up faster than the time trend in 2013Q1-2013Q2, at the trend in 2013Q3, but slower than the trend in 2013Q4-2014Q1. These outcomes, with the exception of 2013Q4, are in favor of the real-efficacy hypothesis of macroprudential policy.³⁵

Well-targeted macroprudential policies do not have impact on output despite their impact on credit. But how about the financial stability channel? Will improved financial stability through macroprudential policies contribute to output growth? Most of studies in this line are on the real cost of financial *instability*. It is widely agreed that financial crisis recessions are costlier in the way that such recessions are usually deeper and longer lasting, compared to typical recessions (see, e.g., Reinhart & Rogoff 2009; Jordà *et al.* 2013; Ball 2014; Jordà *et al.* 2014; Reinhart & Rogoff 2014; Romer & Romer 2015; Jordà *et al.* 2016). Usually, the benefit of maintaining financial stability is interpreted as restraining the buildup of financial vulnerabilities so as to reduce the possibility of future financial crisis (e.g., Adrian & Liang 2014;

³⁴ More specifically, for the subsample of 2000-2007 we find that macroprudential policy has no statistically significant impact on output, with point estimates small and close to zero though sometimes positive, while credit declines immediately and significantly, but the uncertainty around this estimate is high after 10 quarters.

³⁵ But one needs to be cautious in interpreting this result as it is drawn from a limited number of observations. Alternatively, one can use all the data, as summarized by a VAR, to say something about what would have happened by isolating exogenous shifts in macroprudential policy (i.e., by shutting down its endogenous responses to monetary policy changes), as what is done in, for example, Bernanke *et al.* (1997) and Bachmann and Rüdth (2017).

Svensson 2016). This argument applies to the Chinese case well, where there has been so far neither a financial crisis nor a recession. Macroprudential policies contribute to financial stability in China.

Our real inefficacy result of macroprudential policies differs from empirical findings in the literature on the monetary-macroprudential interaction. As mentioned in the introduction, Aikman *et al.* (2016) find that credit control policy has impact on output as well. The possible explanation is that their measures of macroprudential policy are broader. Plausibly, credit control policy was used for the macroeconomic stability purpose as well. On the contrary, our measure, as discussed in details in Section 2, is narrowed to capture macroprudential policy actions only. This suggests that well-targeted tight macroprudential policy actions safeguard financial stability, which does not necessarily lead to an economic slowdown.

Of course, this policy implication does not mean that there are no costs associated with macroprudential policies. Well-targeted policies by themselves imply that it is likely that banks or firms and households circumvent these policies, for example, turning to off-balance-sheet lending. Such regulation arbitrage breeds financial instability in turn. Policy makers need to take various distortions and possible loopholes into account when designing macroprudential policies.

To conclude the baseline model, our impulse response estimates (in Figs. 4-6) suggest that monetary policy is effective on both macroeconomic and financial variables, while macroprudential policy has effects only on credit. The finding on the impact of monetary policy is consistent with what theory predicts. Changes in monetary policy have impacts on output and inflation via transmission channels, which are reflected in changes in financial variables. A monetary policy easing will lead to faster growth of credit. However, not all credit booms are what the PBC desires as this can lead to an unintended buildup of financial vulnerabilities. With the macroprudential policy toolkit, it is possible for the PBC to design a policy mix with a simultaneous macroprudential tightening to offset the negative impact of a monetary easing on financial stability, as it did in 2001 and 2010. On the other hand, the ineffectiveness of the overall macroprudential policy on output and inflation builds a buffer for the PBC to rein in the fast growth of credit in attaining financial stability, but without harming real economic activities, when facing two conflicting policy objectives. In this way, the PBC can use macroprudential policies as a complement to monetary policy to address the financial stability problem.

4.2 Alternative models

In this part, we consider some variations. First, we examine the policy impacts on two other financial-condition indicators – medium- and long-term loans and the loans to households. Second, we examine the impact of individual macroprudential policy instruments.

Model I and II: Other financial-market indicators. We ask the question of the policy efficacy on other measures of financial conditions. The VAR model are specified as in Eqs. (1)-(2). Vector $\mathbf{X}$ (the policy block) continues to contain the monetary policy index (MP) and the overall macroprudential policy index (MPP). The variations are reflected in the changes in macroeconomic and financial-condition block $\mathbf{Y}$. We examine two variations. In the first variation (Model I), we incorporate medium- and long-term loans ($MLTL$) into the model. In this case, the macroeconomic and financial-condition block $\mathbf{Y}$ contains four variables: Y , CPI , L and $MLTL$, all in logarithm. In the second variation (Model II), we incorporate the loans to households (HHL) into the model. It then follows that $\mathbf{Y}$ includes Y , CPI , L the HHL , all in logarithm. For this model, the sample period is shorter (2007-2015) due to the data availability of HHL .

Figure 8. Model I: Accumulated impulse responses – policy effects on medium- and long-term loans

Figure 9. Model II: Accumulated impulse responses – policy effects on the loans to households

The estimation of accumulated responses of credit to policy shocks is robust against these variations: The estimated results from Model 1 and Model 2 are similar to those obtained in the baseline model. Figs. 8 and 9 show the cumulative impacts of one-standard-deviation innovation to two policy variables (MP , MPP) on two alternative financial indicators (medium- and long-term loans; the loans to households) over the 20-quarter horizon, together with one-standard-error bands. Following a monetary tightening, both medium- and long-term loans (in Fig. 8) and the loans to households (in Fig. 9) drop significantly. A macroprudential tightening yields a decline of these two financial measures as well. In particular, the

loans to households fall immediately and then stay significantly below what they would otherwise be. Macroprudential policy has immediate and persistent impact on the loans to households. Yet, the uncertainty around the estimated impact of macroprudential policy on medium- and long-term loans is high: After 7 quarters, the estimated cumulative responses turn to be statistically insignificant.

Model III: Individual policy instruments. So far, we have examined the policy efficacy of the overall macroprudential policy. A related question is: What are the dynamic effects of four individual policy measures? We model the interaction of individual macroprudential policies with financial-condition indicators (Model III). Again, the model is specified as in Eqs. (1)-(2). This time, the variations are reflected in vector $\mathbf{X}$, while macroeconomic and financial-condition block $\mathbf{Y}$ contains four same variables as in the baseline model – Y , CPI , L and HP , all in logarithm. We let vector $\mathbf{X}$ include *five* policy variables: monetary policy index (MP); four individual macroprudential policy index: RRR_MPP , *window guidance*, *housing policy*, *supervision*. This specification ensures us to examine the policy efficacy of each individual policy measure, while controlling for all other policy actions (including monetary policy).

Fig. 10 shows the estimated cumulative responses of loans and the housing price to one-standard-deviation innovation to four individual policy measures over the 20-quarter horizon, together with one-standard-error bands. First, of these four measures, window guidance is most effective in slowing down the total credit. Following a tightening in window guidance, credit drops immediately and about 8 quarters later, reaches the trough. However, this policy effect is not persistent: It dies out and after 14 quarters, it is not statistically significant. Housing policies have immediate impact on credit, but this impact turns to insignificant after 5 quarters. The supervisory pressure has impact on credit, but with a 4-quarter delay. This impact lasts about 2 years and then turns to insignificant. Following a tightening in the required reserve ratio, credit rises, though it is estimated with high uncertainty and is not significant. This is puzzling and not consistent with what the theory predicts.³⁶

Second, of four policy measures, only the housing policy index is effective in reining in housing prices. Following a tightening in housing policies, the housing price falls immediately and reaches the trough 8 quarters later. The impact is persistent: After 5 years, the housing price is still significantly lower than what it would otherwise be. The estimated responses of the housing price to a policy shock of the reserve requirement and supervisory pressure are both puzzling: The housing price goes up following a tightening of these two policy measures. It could be due to the fact that these two are not intended to address the housing price. Rather, they are used to rein in the total credit. Credit and the housing price is interlinked

³⁶ We will leave the investigation to this puzzle to our future work. Plausibly, the PBC tightens this ratio in expecting a rise in credit. The possible solution could be to include a variable to proxy the PBC's expectation of credit.

with each other, but not perfectly. The housing price is estimated to drop following an exogenous tightening in window guidance, but not significantly.

Figure 10. Model III: Policy effects of individual instruments on loans and the housing price

1. Policy effects on loans

2. Policy effects on the housing price

Note: See note to Fig. 4 and text for explanations.
Source: Authors' estimation.

Fig. 11 shows the estimated impulse responses on individual policy reaction to financial market shocks. In response to an unexpected rise in credit, the PBC tightens all these four policy measures, though the uncertainty around the estimated responses of reserve requirement is high. In response to an unexpected

hike in the housing price, the PBC tightens the reserve requirement and housing policies, while the estimated responses of window guidance and supervisory pressure are not significant.

Figure 11. Model III: Individual policy reaction to loans and the housing price

1. Policy responses to loans

2. Policy responses to the housing price

Note: See note to Fig. 4 and text for explanations.
Source: Authors' estimation.

In Fig. 12, we report the VAR forecast error decomposition. A curve in each panel gives the percentage of the variance of the k-quarter ahead forecast errors in Y, CPI, L, HP, MP and four individual macroprudential policy tools that attribute to shocks to each variable.

The forecast error variance decomposition for the first five variables, Y, CPI, L, HP and MP, reported in Figs. 12.1-12.5, is comparable to those reported for the baseline model in Figs. 7.1-7.5. It is not surprising as neither shocks to the overall macroprudential policy indicator nor shocks to individual macroprudential policy tools account much for the variance of these five variables, except their moderate explanatory power for credit forecast errors (as shown in Figs. 7.3 and 12.3).

Figure 12. Model III: Forecast error variance decomposition

Note: The forecast variance decompositions are estimated from the VAR Model III (see text for explanations).
Source: Authors' estimation.

Three interesting observations can be drawn from the forecast error variance decomposition of four individual macroprudential policy tools, as shown in Figs. 12.6-12.9. First, although the own shocks account for the majority of the volatility of these individual policy tools, this impact is moderate. In particular, the explanatory power of their own shocks never exceeds 80 percent for the volatility of both the required reserve ratio and supervision. The possible explanation is that quite often, these individual macroprudential policy tools are used on a discretionary basis, especially the required reserve ratio and supervision, as indicated in Fig. 1 as well as Table A1 in the online appendix. Second, in general the figures do not suggest close interaction among individual policy variables. One moderate interaction is found in Fig. 12.9, where window guidance and housing policy consistently help explain 18 percent and 12 percent of forecast variance of supervision after a 2-quarter forecast horizon. On the contrary, our last

observation suggests that monetary policy shocks account for unneglectable part of the volatility of these macroprudential policy tools. This is particularly the case for the reserve ratio and housing policy.

The results drawn from the alternative models conform our findings from the baseline model. Furthermore, we find that of various individual policy measures, window guidance is particularly effective in slowing down credit while only housing policies are found to have significant effects in reining in the housing price. As for the policy toolkit choice, the PBC tightens up all these four policy measures in response to a credit shock, but it chooses to contract the reserve requirement and housing policies only in response to a housing price shock. The interaction of monetary policy with macroprudential policies exists, which is particularly noticeable for the requirement reserve ratio and housing policy.

5. Conclusion

Based on the Chinese experience, this paper shows that a central bank can play an active role in safeguarding financial stability. We find that many monetary policy tools can be used as macroprudential to lean against credit bubbles, such as the reserve requirement, window guidance, housing-market policies and supervisory pressure. We show that these policy measures help to smooth the credit cycle and contribute to financial stability.

Our VAR estimates show that monetary policy has impacts on both output and credit, while macroprudential policy has effects on credit only. It suggests that with both monetary policy and macroprudential policy in use, the central bank does not have to face a tradeoff between macroeconomic and financial stability. Rather, it can use well-targeted macroprudential measures alone to retain financial stability, without sacrificing economic growth; or as a complement to monetary policy to offset the negative impact of a monetary easing on financial stability. A well-designed mix of these two policies helps to achieve both macroeconomic and financial stability objectives. Our study of the Chinese experience provides supportive evidence for the argument that the central bank can use both monetary and macroprudential policy to reinforce each other (see, e.g., Blanchard 2012; IMF 2013; Aikman *et al.* 2016; Woodford 2016).

We do not argue that these PBC's macroprudential measures are universal for all countries. After all, the design of macroprudential policy measures and the assessment of their efficacy are country-specific, as emphasized in Blanchard (2012) and IMF (2013). The key message from our study is that it is the PBC's multiple-instrument operating framework that enables it to choose different instruments while addressing different problems. To incorporate financial stability and macroprudential policy into its operating

regime, a central bank needs to be equipped with multiple instruments and instrument independence. This finding sheds light on the current debates about the post-crisis central banks' design such as whether all the unconventional monetary policy tools should fade out when the ZLB is no longer a concern or whether the monetary operating regime should go back to its (prior-crisis) normal, a one-instrument and one-target framework (see also Blanchard 2012; IMF 2013; Aikman *et al.* 2016; Blinder *et al.* 2016; Woodford 2016).

A search for the macroprudential toolkit needs to take the country's specific institutional features into account. Many instruments, such as capital or reserve requirements on banks and down-payment or margin requirements on borrowers, help to absorb shocks and make the financial system more resilient. But obviously, there are social costs linked to these shock absorbers. Meanwhile, too many interventions (such as credit controls) lead to distortions, resulting in capital misallocations, while country-specific or sector-targeted measures can give rise to spillovers or regulatory arbitrage, pushing banks to shift their loans off the balance sheets. All these have aroused concerns among the academia and policy makers (see, e.g., Yellen 2010; Blanchard 2012; IMF 2013; Reis 2013; Adrian & Liang 2014; Aikman *et al.* 2016; Buch & Goldberg 2016; Mendoza 2016; Woodford 2016; Collard *et al.* 2017). In short, macroprudential policy is promising but also challenging. While designing it, central banks or other regulators should monitor and balance the tradeoffs between the costs and benefits (Blanchard *et al.* 2012: 80). Our study suggests that in addition to all these mentioned instruments, supervision and communication tools work well as macroprudential instruments. The latter can take form of window guidance, as used in China through regular meetings with banks; or forward guidance, as used in the U.S. and the Euro Area in the post-crisis era to improve the policy transparency and guide the market's expectations. They appear to be able to affect banks' lending decisions as well as their risk-taking attitudes, and so to moderate financial instability risks.

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