Journal of Financial Stability 66 (2023) 101124

Contents lists available at ScienceDirect

Journal of Financial Stability

journal homepage: www.elsevier.com/locate/jfstabil

Effects and Conduct of Macroprudential Policy in China☆

Soyoung Kim [a], Seri Shim [b,*], Hongyi Chen [c]

[a] Department of Economics, Seoul National University, 1 Gwanak-ro, Gwanak-gu, Seoul 08826, Republic of Korea
[b] Economic Research Institute, Bank of Korea, Republic of Korea
[c] Hong Kong Institute for Monetary and Financial Research (HKIMR), Hong Kong

ARTICLE INFO

JEL Classifications:
E58
E61

Keywords:
Macroprudential policy
Monetary policy
VAR
Sign restriction
China

ABSTRACT

This paper investigates the effects and conduct of macroprudential policies in China compared to those of monetary policy. Two types of structural VAR models, one with recursive zero restrictions and the other with sign restrictions on impulse responses, are used with monthly data. The main results of this paper are as follows. First, macroprudential policy has substantial effects on financial variables such as credit and house prices and macro variables such as output and inflation rate, as monetary policy does. Second, contractionary macroprudential policy is taken to stabilize credit in response to credit shocks, but monetary policy is not.

1. Introduction

The experience of the global financial crisis (GFC henceforth) illustrated that financial stability is essential for macroeconomic stability. Since the GFC, central banks and other policy authorities have intensively used macroprudential measures to mitigate systemic risks. However, the empirical effects and conduct of macroprudential policy are less known, given its short history. Only recently have some studies analyzed the conduct and effects of macroprudential policy (e.g., Kuttner and Shim, 2016; Cerutti et al., 2017; Kim and Mehrotra, 2017, 2018, 2022; Richter et al., 2019).

China has frequently used various macroprudential tools such as capital requirements, concentration limits, LTV (loan-to-value limits), reserve requirements on foreign currency, and reserve requirements on local currency, even long before the GFC. However, few empirical studies investigated the effects and conduct of macroprudential policy in China. For example, Wang and Sun (2013) used bank-level panel data to analyze the effects of macroprudential policy and showed that some macroprudential tools, such as the reserve requirements and house-related instruments, are effective in addressing systemic risks. Recent studies, such as Klingelhöfer and Sun (2019) and Jiang et al. (2019), provided some initial empirical evidence using VAR frameworks. Klingelhöfer and Sun (2019) found that macroprudential policies are effective in financial stability without triggering an economic slowdown, unlike monetary tightening. However, the impact on housing prices was not clear. Similarly, Jiang et al. (2019) estimated the effects of macroprudential policies on asset prices and reported negative but statistically insignificant responses.

This paper aims to empirically examine the effect and conduct of macroprudential policy in China by constructing structural VAR models and improving upon previous studies. First, this paper analyzes the effects of macroprudential policy shocks on financial variables such as loans and house prices and key macroeconomic variables such as output and price level. Second, this paper documents the conduct of macroprudential policy by investigating how macroprudential policy responds to financial instability, such as increases in credit, loans, and house prices. Lastly, the effects and conduct of macroprudential policies are jointly analyzed with monetary policy. Monetary policy, as well as macroprudential policy, can be used for financial stability objectives. Moreover, macroprudential policy may affect macroeconomic variables that are the target variables of monetary policy, in addition to financial variables, as discussed in Kim and Mehrotra (2018, 2022). Thus, we expect that a joint analysis of both policies can provide important insights into how to conduct two policies jointly to achieve financial and macroeconomic stability.

We consider various identification methods, such as recursive

☆ The views expressed in this paper are those of authors and do not necessarily reflect those of the Bank of Korea. This work was supported by the Ministry of Education of the Republic of Korea and the National Research Foundation of Korea(NRF-2020S1A5A2A01041205).

* Corresponding author.
E-mail addresses: soyoungkim@snu.ac.kr (S. Kim), serishim@bok.or.kr (S. Shim), hchen@hkma.gov.hk (H. Chen).

https://doi.org/10.1016/j.jfs.2023.101124
Received 4 June 2022; Received in revised form 19 March 2023; Accepted 4 April 2023
Available online 6 April 2023
1572-3089/

restrictions on contemporaneous structural parameters (Sims, 1980) and sign restrictions on impulse responses (Uhlig, 2005), with monthly data to improve upon previous studies. Monetary, macroprudential, macro, and financial variables are generally likely to interact, wherein a recursive model based on annual or quarterly data used in previous studies may be too restrictive. However, by using monthly data, we can loosen the restrictions on contemporaneous structural parameters and increase the degree of freedom. Also, monthly rather than quarterly or annual data is better for capturing the exact timing of policy actions and their effects.

Compared to previous studies such as Klingelhöfer and Sun (2019) and Jiang et al. (2019) that used the recursive identification in which target variables are assumed to be contemporaneously exogenous to policy variables, this paper considers the VAR models with sign restrictions that allow more general contemporaneous interactions among various variables. For example, contemporaneous relations between policy variables and target variables are allowed. This can be important in estimating the correct effects of macroprudential policies because target variables such as credit and loans can respond to policy within a given period. Some previous studies, such as Kim and Shim (2022), developed the VAR models with sign restrictions for macroprudential policy. This paper extends the empirical methodology for China.

Moreover, past studies on China have not investigated how macroprudential policy responds to financial instability, such as increases in credit, loans, and house prices. Even for other countries, such questions are addressed in only a few studies, such as Kim and Mehrotra (2022) and Kim et al. (2022). Thus, we construct various empirical models to allow proper interactions between the variables to measure not only the effects of policy on target variables properly but also the responses of policy variables to target variables for China.

Our main findings are as follows. First, macroprudential policies have substantial effects on credit, loans, and house prices. This result is robust in the model with the recursive identification and the model with sign restrictions. In particular, the effects on house prices and credit are substantial and significant, different from previous studies on China (Klingelhöfer and Sun, 2019; Jiang et al., 2019). This difference may come from the usage of monthly data in the current study.[1] This result may support that monthly data is more appropriate for capturing policy effects. In addition, output and price levels decrease in the long run in response to the macroprudential tightening, although the effects are weakened when considering individual instruments – LTV and loan restrictions – respectively.

Second, macroprudential policies rather than monetary policies are tightened in response to credit shocks, suggesting that macroprudential policies have been used for credit stabilization. Third, the impact of macroprudential policies is stronger when taking the reserve requirements, which is the most frequently used tool in China, into account. Finally, the estimated policy responses indicate that the reserve requirements are used to stabilize house prices.

This paper is related to the literature on the effects of macroprudential policies on financial stability (e.g., Akinci and Olmstead-Rumsey, 2018; Alam et al., 2019; Alpanda, Zubairy, 2017) and macroeconomic conditions (e.g., Richter et al., 2019; Kim and Mehrotra, 2018, 2022). It also relates to theoretical literature incorporating monetary and macroprudential policies in a single framework (Angelini et al., 2014; Quint and Rabanal, 2014; Gelain and Ilbas, 2017; Sinclair and Sun, 2021) and related empirical literature (Kim and Shim, 2022). Lastly, this paper provides some empirical evidence on policy responses to credit instability or house price instability, which has yet to be addressed in a few studies (Kim et al., 2022).

The remainder of the paper is organized as follows. Section 2 discusses the conduct of macroprudential policies in China. Section 3 presents the empirical methodology and the data, and Section 4 reports the empirical results. Section 5 concludes the paper.

2. Macroprudential policy in China

This section outlines the macroprudential policy framework and policy actions in China. The People's Bank of China (PBoC) officially adopted the "twin-pillar" framework of monetary and macroprudential policies in 2017 and continues to improve this regulatory framework. This is because the central bank of China, like central banks of other major countries, also recognized that traditional monetary policy alone could not achieve two goals simultaneously—price (and output) stability and financial stability. By adopting this framework, each policy has room to focus more on each target: monetary policy for price (and output) stability and macroprudential policy for financial stability (Huang et al., 2019; Amstad et al., 2020).

China introduced macroprudential policies far before the GFC but mainly used the reserve requirements to address excessive liquidity in the banking system. However, the conduct of macroprudential instruments has been diversified and frequently used in the post-GFC period. Fig. 1 shows the trend of five main macroprudential measures in China based on the database developed by Alam et al. (2019).[2] The use of LTV limits, loan restrictions, and liquidity measures increased noticeably, indicating frequent tightening actions after the GFC. Until the early 2010 s, the usage of the reserve requirements increased rapidly, but it slowed down from the mid-2010 s as China gradually liberalized the interest rates and shifted from a quantity-based to an interest rate-based monetary policy framework (Wei et al., 2020; Kim and Chen, 2022).

Among the five measures, loan restrictions and LTV regulations, the second most frequently used measures following the reserve requirements directly target loans. Fig. 2 reports those two loan-targeted macroprudential measures and credit cycles. We use the quarterly credit-to-GDP gaps, obtained from BIS, as a measure of the credit cycle.[3] Fig. 2 shows that the relationship between those policies and credit cycles does not show a clear pattern. They move in the same direction in some cases but in the opposite direction in other cases. A tightening of macroprudential policies mitigates credit expansion, but the policy authority tends to tighten macroprudential policy when credit expands excessively (Kim et al., 2019). Therefore, a clear pattern between the loan-targeted macroprudential measures and credit cycles may not be observed in a simple time series graph. The effects of macroprudential policy and the reaction of macroprudential policy to financial instability are formally analyzed in the analysis.

3. Data and Empirical Methodology

3.1. Structural VAR

We assume that the economy is described by the following structural form equation:

$$G(L)y_t = C(L)x_t + e_t, \tag{1}$$

where $G(L)$and $C(L)$ are matrix polynomials in the lag operator L, y_t is a $m \times 1$ vector of m endogenous variables, x_t is a $k \times 1$ vector of exogenous variables, and e_t denotes a $m \times 1$ vector of structural disturbances. By assuming that structural disturbances are mutually uncorrelated, $\mathrm{var}(e_t)$ can be denoted by Λ, which is a diagonal matrix where diagonal elements are the variances of structural disturbances.

Then, we can estimate the following reduced form VAR:

[1] We also reported the impulse responses when quarterly data is used for the recursive model under consideration in Appendix 4.

[2] More details on the database are in Section 3.

[3] We use quarterly end-of-period values of LTV and loan restrictions measures.

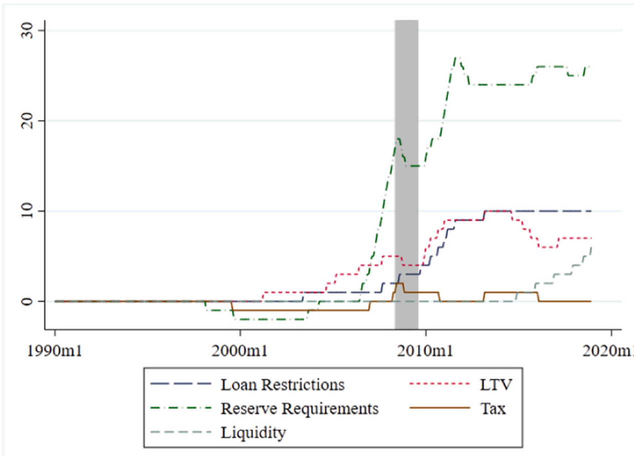

Fig. 1. Trend in Main Macroprudential Measures. Note: The index has + 1 for a tightening action and – 1 for a loosening action for a given month. The graph is obtained by accumulating the values of each measure over time. The shaded area indicates the GFC periods.

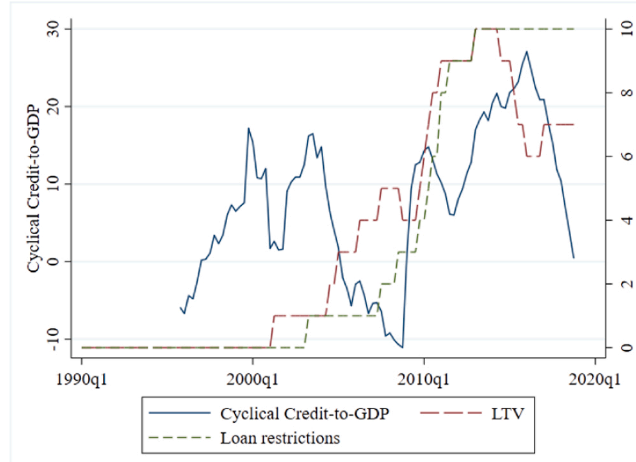

Fig. 2. Credit Cycles and Loan-Targeted Instruments. Note: Cyclical credit is shown in the left axis, while LTV and Loan restrictions are shown in the right axis.

$$y_t = B(L)y_{t-1} + D(L)x_t + u_t, \tag{2}$$

where $B(L)$ and $D(L)$ are matrix polynomials in the lag operator L, u_t is a $m \times 1$ vector of reduced form residuals, and $\text{var}(u_t) = \Sigma$.

Several methods exist to recover the parameters in the structural form equation from the estimated parameters in the reduced form equation. This paper first considers the identification schemes imposing recursive zero restrictions on contemporaneous structural parameters by applying Cholesky decomposition to the variance-covariance matrix of reduced form residuals, Σ, as in Sims (1980).

In addition, we identify the policy shocks, i.e., monetary and macroprudential policy shocks, by imposing sign restrictions on impulse responses, following Uhlig (2005) and Mountford and Uhlig (2009). Consider the following definition:

Definition 1. An impulse matrix of rank n is a $n \times m$ submatrix of some $m \times m$ matrix A, such that $AA' = \Sigma$. An impulse vector a is an impulse matrix of rank 1, i.e., a vector $a \in \mathbb{R}^m$ such that there exists some matrix A, where a is a column of A such that $AA' = \Sigma$.

Mountford and Uhlig (2009) showed that any impulse matrix $[a^{(1)}, \ldots, a^{(n)}]$ can be characterized by $[a^{(1)}, \ldots, a^{(n)}] = \widetilde{A}Q$, where $\widetilde{A}\widetilde{A}' = \Sigma$ is a Cholesky decomposition of Σ, and $Q = [q^{(1)}, \ldots, q^{(n)}]$ is a $n \times m$ matrix of $QQ' = I_n$. Then, let $r_{ji}(k)$ be the impulse responses of the jth variable at horizon k to the ith column of $\widetilde{A}$, and the m-dimensional column vector $r_i(k)$ be $[r_{1i}(k), \ldots, r_{mi}(k)]$. Then the m-dimensional impulse response $r_a(k)$ at horizon k to the impulse vector $a^{(s)}$ is given by

$$r_a(k) = \sum_{i=1}^{m} q_i r_i(k) \tag{3}$$

where q_i is the ith entry of $q = q^{(s)}$.[4]

3.2. Data and Empirical Model

The vector of endogenous variables, y, is [IP, CPI, RCRD, RHP, PP, R]'. Industrial production (IP) and the consumer price index (CPI) are included as indicators of overall macroeconomic conditions. They are also the target variables of monetary policy. As the target variables for macroprudential policy, we use the outstanding loans from financial institutions as a proxy for credit (RCRD) and include house prices (RHP).[5] We include an index of macroprudential policies (PP) and the 7-day repo rate (R) as instruments of macroprudential and monetary policies, respectively. We use the 7-day repo rate as a proxy for the policy rate.

Table 1
Identifying Sign Restrictions.

Shocks/Variables	IP	CPI	RCRD	RHP	PP	R
Monetary policy shock		–				+
Macroprudential policy shock			–		+	

Note: IP = industrial production, CPI = consumer price index, RCRD = real credit, RHP = real house prices, PP = macroprudential policy measure, R = 7-day repo rate

We use the data from Alam et al. (2019) for the macroprudential policy measure, PP. The dataset comprises various macroprudential instruments, and each instrument takes + 1 for a tightening action, – 1 for a loosening action, and zero for no changes for a given month. We sum up the monthly observations for each instrument (excluding the reserve requirements) and accumulate them over time to construct the variable PP. We exclude the reserve requirements because the reserve requirements ratio is often used as a monetary policy instrument, although it is also used as a macroprudential tool. For example, Kim and Chen (2022) treated the reserve requirement ratio as a monetary policy instrument. However, it is not clear whether the reserve requirements are used for monetary or macroprudential goals (Alam et al., 2019). Thus, we exclude the reserve requirements when constructing PP.[6]

First, we use the recursive identification method, as in previous studies such as Kim and Mehrotra (2018, 2022). We assume that target variables, IP, CPI, RCRD, and RHP, are contemporaneously exogenous to the policy measures, PP and R. This identification assumes that policymakers set the policy stance after observing the current economic and financial conditions (Christiano et al., 1999; Kim and Mehrotra, 2018, 2022). This identification also allows monetary policy to consider current credit conditions and its key target variables, such as output and price levels. In addition, current price levels and overall economic conditions can be considered when implementing macroprudential policies (Angelini et al., 2014; Gelain and Ilbas, 2017). Thus,

[4] See Uhlig (2005) and Mountford and Uhlig (2009) for further technical details.

[5] The variables, RCRD and RHP, are used in real terms, deflated by the CPI.

[6] We experiment with an extended model that includes the reserve requirements. The results are discussed in Section 4.3.

macroprudential instruments, PP, are assumed to be contemporaneously exogenous to monetary instruments, R.[7]

Secondly, we impose the sign restrictions on impulse responses to identify two policy shocks, following Kim and Shim (2022), as reported in Table 1. First, monetary policy shock is defined as moving interest rates and price levels in opposite directions. That is, contractionary monetary policy shocks increase interest rates and decrease price levels. By identifying monetary policy shocks in this way, we can resolve the price puzzle.

We can consider the following restrictions for macroprudential policy shocks. First, the contractionary macroprudential policy shocks increase the macroprudential policy measure, PP. It is a necessary restriction to identify the contractionary macroprudential policy shocks. Second, the contractionary macroprudential shocks reduce outstanding loans. This restriction is used because most macroprudential policy instruments directly target loans by limiting loan supply and/or demand. Therefore, we identify the macroprudential policy shocks by imposing the positive sign restrictions on the responses of PP and the negative sign restrictions on the responses of RCRD, as reported in Table 1.

With the second restriction, we assume that contractionary macroprudential policy actions are binding, resulting in an immediate decrease in loans. If a macroprudential policy action is not binding, the action is not likely to have a significant effect, and investigating such a case is not meaningful.[8] Therefore, we consider such a case to analyze the effects. When previous theoretical studies investigate the effects of macroprudential policy actions, they assume that policy actions are binding. For example, Kuttner and Shim (2016) emphasized that, in the theoretical framework, key requirements for DSTI (debt--service-to-income) and LTV (loan-to-value) regulations to affect housing credit is that households are borrowing constrained. In addition, Aiyar et al. (2014) cited that bank capital requirements should be binding as one of the necessary conditions to affect credit growth effectively. Alpanda, Zubairy (2017) also assumed that borrowing constraint always binds when investigating the effects of LTV regulations.

As shown in Kim and Mehrotra (2018, 2022) and Kim and Shim (2022), the two policies may interact and have similar effects on macroeconomic and financial conditions. In this case, it is important to exclude monetary policy shocks when identifying macroprudential policy shocks, as the effects of the two policies may be intertwined. Therefore, we construct macroprudential policy shocks to be orthogonal to monetary policy shocks.[9] The sign restrictions for both policy shocks are imposed for the impulse responses of the initial 12 months after the shocks.

The VAR models are estimated from March 1998 to December 2018 because the data for monthly house prices is available from March 1998. Monthly data are used, and six lags for endogenous variables are included in both baseline and extended models. We also include the vector of the exogenous variables, [USIP, USFFR]' where USIP denotes industrial production of the US and USFFR denotes the Federal Fund rate.[10] These US (or world) variables are likely to affect the real economy, financial conditions, and monetary and macroprudential policies of China.

For all variables except for R and USFFR, a logarithm is taken and multiplied by 100. Further details on the variables and data sources are reported in Appendix 1.[11] As we follow the Bayesian inference, our statistical inference is not affected by the presence of non-stationarity (Sims, 1988; Sims and Uhlig, 1991).

4. Empirical Results

4.1. Recursive Model

In this section, we report and discuss the empirical results. Fig. 3 shows the impulse responses with 68% probability bands. Each column of the graph shows the impulse responses to each shock over 60 months. The column and row headings indicate the names of the shocks and responding variables, respectively. The impulse responses to macroprudential and monetary policy shocks, our main interests, are reported in the fifth and sixth columns, respectively.

In response to the contractionary macroprudential policy shocks, PP increases by approximately 0.70 and decreases back toward the initial level in the long run. In response to such macroprudential policy shocks, credit (RCRD) decreases, which differs from zero, with an 84% probability, for some short and long horizons. The decline in credit is also found in Kim and Mehrotra (2018, 2022) for various countries and Klingelhöfer and Sun (2019) for China. The house prices, RHP, decline persistently and significantly. The negative responses of house prices peak by approximately − 0.60% in the 14th horizon and remain negative, with approximately − 0.50% in the long run. The results suggest that tightening macroprudential policy actions effectively reduce both credit and house prices, although the effects on house prices are more significant and quicker than those on credit.

Regarding the impulse responses of macroeconomic variables, both output (IP) and price levels (CPI) decline substantially, which is significant several months after the shock. IP falls by approximately 0.53%, and CPI decreases by approximately 0.22% in 60 months. The negative macroeconomic impacts of tightening macroprudential policy shocks are consistent with the findings of Kim and Mehrotra (2018, 2022) for various countries.

The overall results show that macroprudential policies have substantial effects on macroeconomic and financial conditions. However, these results differ from Klingelhöfer and Sun (2019), which show insignificant effects of macroprudential policies on output, inflation, and house prices. This may be because they measure narrative actions such as window guidance and supervisory pressure and some housing-related policy actions that may have a weak effect but are not considered in our macroprudential policy measures.[12] It may also be because it is better to use monthly data to capture the policy effects over time by relaxing the contemporaneous restrictions on the parameters and increasing the degree of freedom. In the sixth column of Fig. 3, credit and house prices decline significantly in the short run in response to contractionary monetary policy shocks. IP declines significantly, but CPI does not decrease significantly.[13] Overall, the negative effects of contractionary macroprudential policy on output and price levels are larger and more significant than those of monetary policy. Macroprudential policy shocks tend to have more persistent effects on credit and house prices than monetary policy shocks.

[7] The overall results, including the policy effects and responses, are similar under various alternative orderings. The results are available upon request.

[8] We also experiment with the identification scheme using the first restriction only (imposing the positive sign restrictions on the responses of PP only), allowing the possibility that the macroprudential policy actions are not binding. As expected, the effects tend to be insignificant. The results are reported in Appendix 2.

[9] The main results are similar when macroprudential policy shock is identified first and then monetary policy shock is set to be orthogonal to macroprudential policy shock.

[10] Only contemporaneous values are included for exogenous variables to save the degree of freedom.

[11] All variables, except for R and USFFR, are seasonally adjusted using the X-13 ARIMA method.

[12] The main findings of this paper are robust when examining additional experiments that use the same sample period, orderings of policy variables, and data frequency as those in Klingelhöfer and Sun (2019).

[13] This can be regarded as the "price puzzle." The "price puzzle" refers to a phenomenon in which prices do not decrease but rather rise following a contractionary monetary policy shock, generally identified with an increase in interest rates (Sims, 1992).

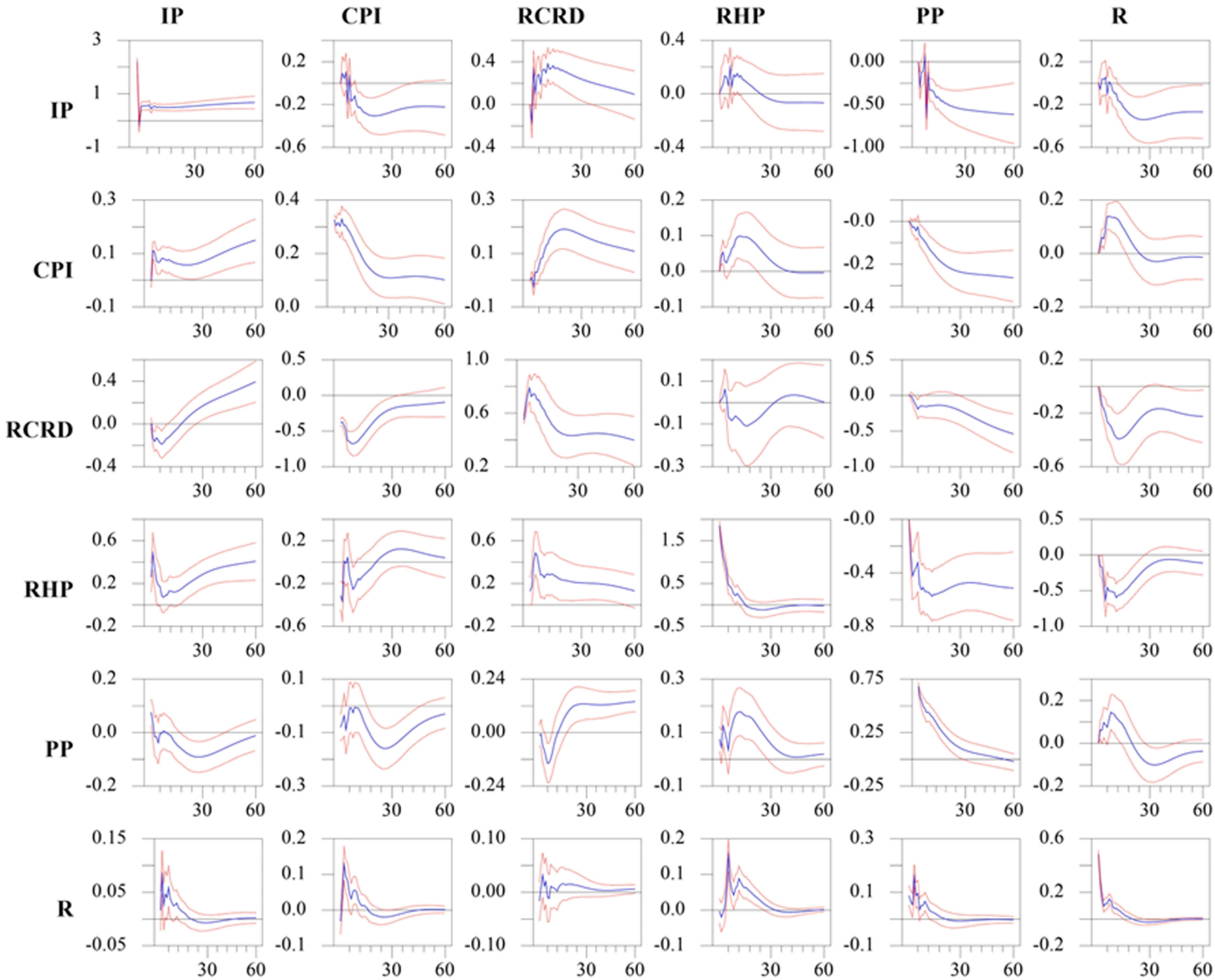

Fig. 3. Impulse Responses: Baseline Model. Notes: 1) IP = industrial production, CPI = consumer price index, RCRD = real credit, RHP = real house prices, PP = macroprudential policy measure, R = 7-day repo rate, 2) The solid lines refer to the median impulse responses, and the dotted lines show 68% probability bands.

Regarding the policy reactions, in response to output and price shocks, the 7-day repo rate, R, increases significantly in the short run, but the macroprudential policy measure, PP, does not. This is not surprising because monetary policy is known as stabilizing output and price fluctuations, but macroprudential policy is not. In response to the positive credit shocks in the third column, PP shows positive and significant responses from the 18th month after the shock. However, R does not show significant responses to the credit shocks at any horizons. This may suggest that macroprudential policy reacts to credit expansion to stabilize it with some lags, but monetary policy does not. In response to the house price shocks, both R and PP increase significantly, suggesting that monetary and macroprudential policies react to an increase in house prices for stabilization.

We further examine the effects of each macroprudential policy, such as LTV and loan restrictions (LOANR henceforth). LTV and LOANR are frequently used macroprudential instruments in China, as discussed in the previous section (See Fig. 2). The main difference between the two policy instruments is that LTV directly targets loan demand, but LOANR targets the loan supply side (Alam et al., 2019).[14]

Fig. 4 shows the impulse responses of credit and house prices to LTV shocks and LOANR shocks, respectively. In response to tightening LTV shocks (the first column), credit decreases substantially at all horizons. The decline in credit peaks at approximately − 0.57% in the 26th month and is still far below the initial level by approximately − 0.48% in the long run. House prices also decrease at all horizons, which is similar but slightly weaker, and long-run responses are much smaller than the baseline result. To summarize, LTV, which is a more targeted instrument, is more effective in reducing loans than PP, the aggregated measure, while its impact on house prices is weaker than those of PP.

The second column in Fig. 4 shows the impulse responses from an extended model in which PP is replaced with LOANR. Credit still decreases substantially by approximately − 0.74% in the long run. Such

[14] In Alam et al. (2019) database, LTV limits include those targeting housing, automobile, and commercial real estate loans. Loan restrictions include limits and prohibitions on loans by banks.

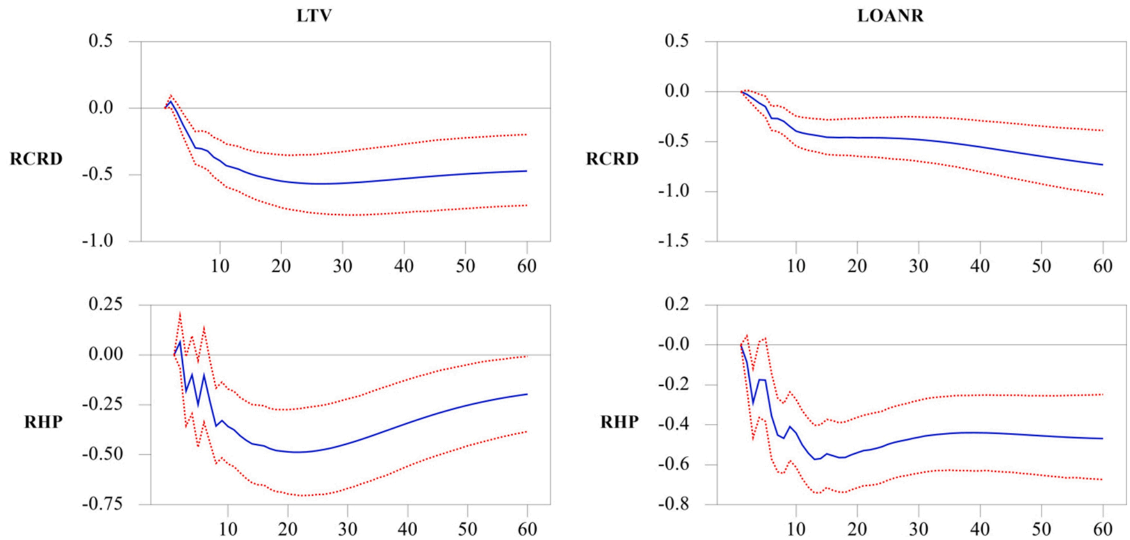

Fig. 4. Selected Impulse Responses: LTV and Loan Restriction Shocks. Notes: 1) LTV = loan-to-value limits, LOANR = loan restrictions, RCRD = real credit, RHP = real house prices, 2) The solid lines refer to the median impulse responses, and the dotted lines show 68% probability bands.

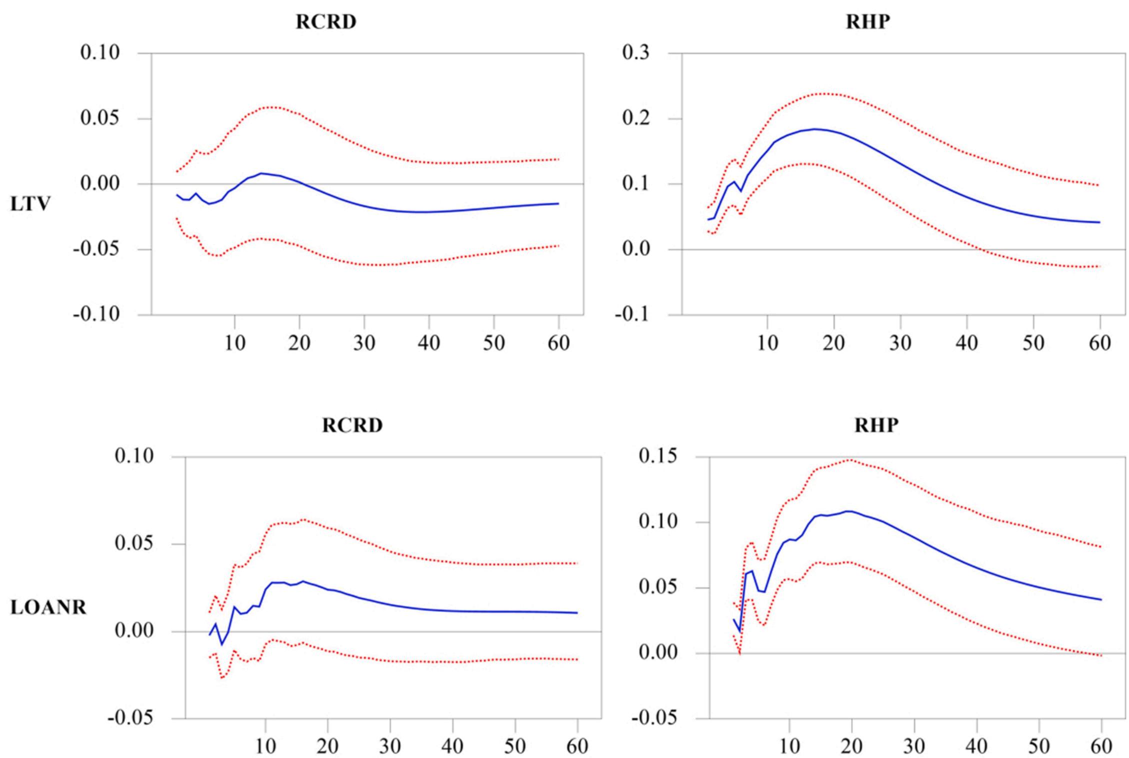

Fig. 5. Policy Responses to Credit Shocks and House Price Shocks. Notes: 1) LTV = loan-to-value limits, LOANR = loan restrictions, RCRD = real credit, RHP = real house prices, 2) The solid lines refer to the median impulse responses, and the dotted lines show 68% probability bands.

negative responses are larger than those to LTV or PP shocks, implying that the instrument targeting loan supply is more effective in reducing credit. House price responses are also negative and more persistent under LOANR shocks than LTV shocks.

Then, we can also infer how macroprudential regulations react to credit and house price shocks (see Fig. 5). The left panel of the first row shows that LTV does not respond significantly to credit shocks. This result may be related to the fact that the variable RCRD refers to total outstanding loans to all sectors, including households, firms, and others, while LTV mainly targets the households' loan demand. On the other hand, as shown in the right panel in the first row, LTV increases significantly in the presence of house price shocks, which indicates that

LTV is tightened to stabilize the house price appreciation.

The second row shows the impulse responses of LOANR to credit and house price shocks. The point estimate of LOANR is positive, although insignificant, in response to the credit shocks (left panel). On the other hand, LOANR increases significantly in response to the house price shocks (right panel), but the increase is weaker than that of PP and LTV in previous models.

4.2. Models with Sign Restriction

This section further investigates the effects of monetary and macroprudential policy shocks by employing the VAR models with sign restrictions. Fig. 6 shows the impulse responses with 68% probability bands. The column headings indicate the name of the shocks: MP shock denotes the contractionary monetary policy shocks, while PP shock denotes the macroprudential tightening shocks.

In response to monetary policy shocks (the first column), credit shows negative responses, which are significant in the long run. On the other hand, the decline in house prices is persistent and significant for most horizons. As expected, monetary policy shocks negatively affect output and prices.

In response to macroprudential policy shocks in the second column, credit decreases persistently and substantially for all horizons, given that the restrictions are imposed for the initial 12 months. Credit peaks by − 0.54% in the half-year after the shocks and stays at approximately − 0.48% in the long term. In response to such macroprudential policy shocks, house prices decline, which is significant in the medium run. The negative responses of output and price levels are significant at some horizons.

To summarize, macroprudential policy shocks have a more substantial effect on credit than monetary policy shocks. However, the effects on output, prices, and house prices are similar to those of monetary policy shocks.

As in Section 4.1, we examine the effects of LTV and LOANR using the sign restrictions. We replace PP with LTV and LOANR, one by one, to identify each shock. Fig. 7 shows the impulse responses to LTV and LOANR shocks, respectively. We do not report the impulse responses to monetary policy shocks because they are quite similar to those in the baseline model.

The effects of LTV shocks in the first column are weaker and less significant than those of PP shocks in the previous model. The responses of output, price levels, and house prices are not significant at any horizon. The effects are also weaker than those of LTV shocks in the baseline recursive model. This result may be because the size of identified LTV shocks, leading to changes in LTV by approximately 0.1 on impact, is much smaller in these models than in the baseline recursive

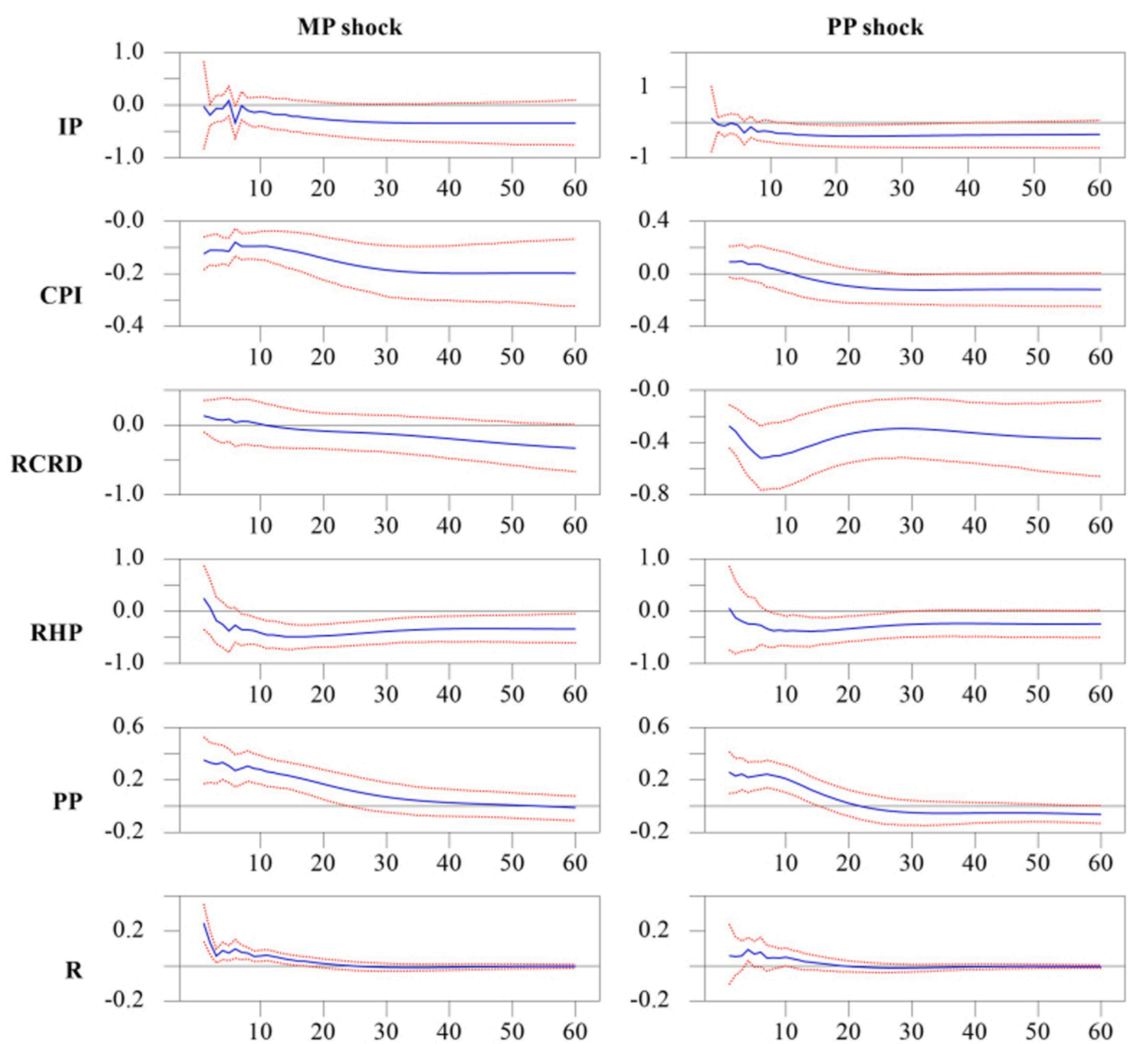

Fig. 6. Impulse Responses with Sign Restrictions. Notes: 1) IP = industrial production, CPI = consumer price index, RCRD = real credit, RHP = real house prices, PP = macroprudential policy measure, R = 7-day repo rate, 2) The solid lines refer to the median impulse responses, and the dotted lines show 68% probability bands.

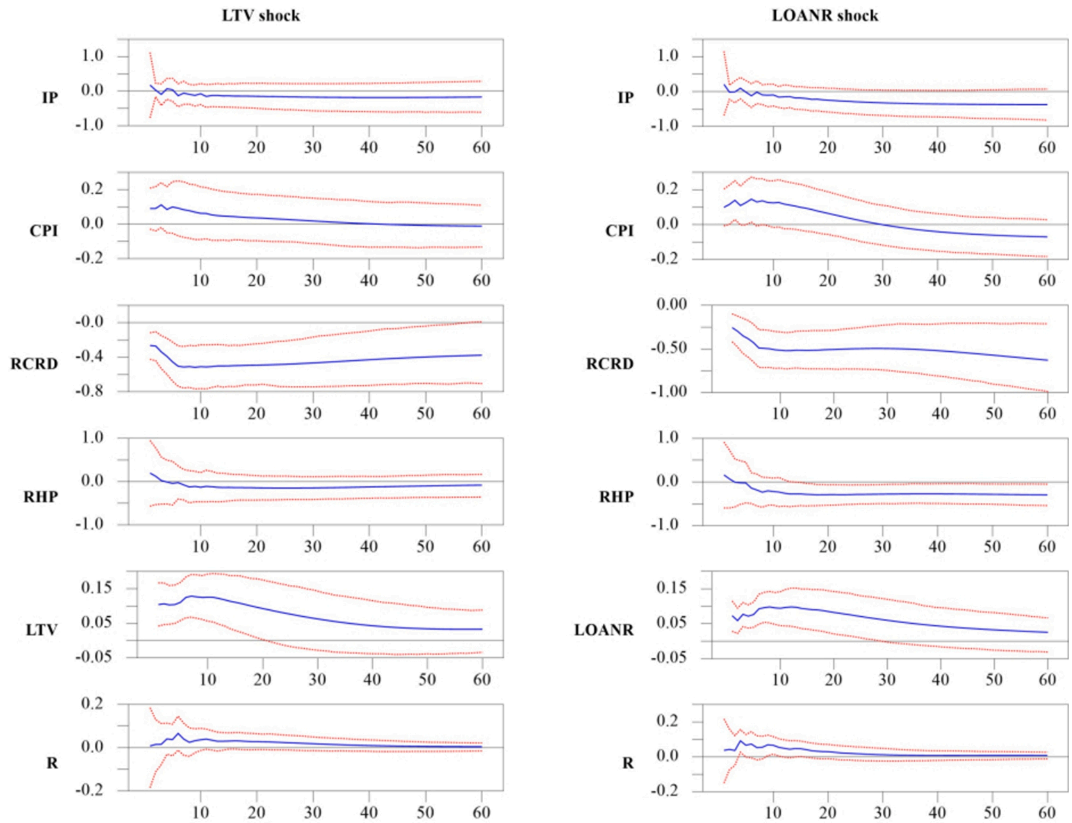

Fig. 7. Impulse Responses with Sign Restrictions: LTV and Loan Restriction Shocks. Notes: 1) IP = industrial production, CPI = consumer price index, RCRD = real credit, RHP = real house prices, LTV = loan-to-value limits, LOANR = loan restrictions, R = 7-day repo rate, 2) The solid lines refer to the median impulse responses, and the dotted lines show 68% probability bands.

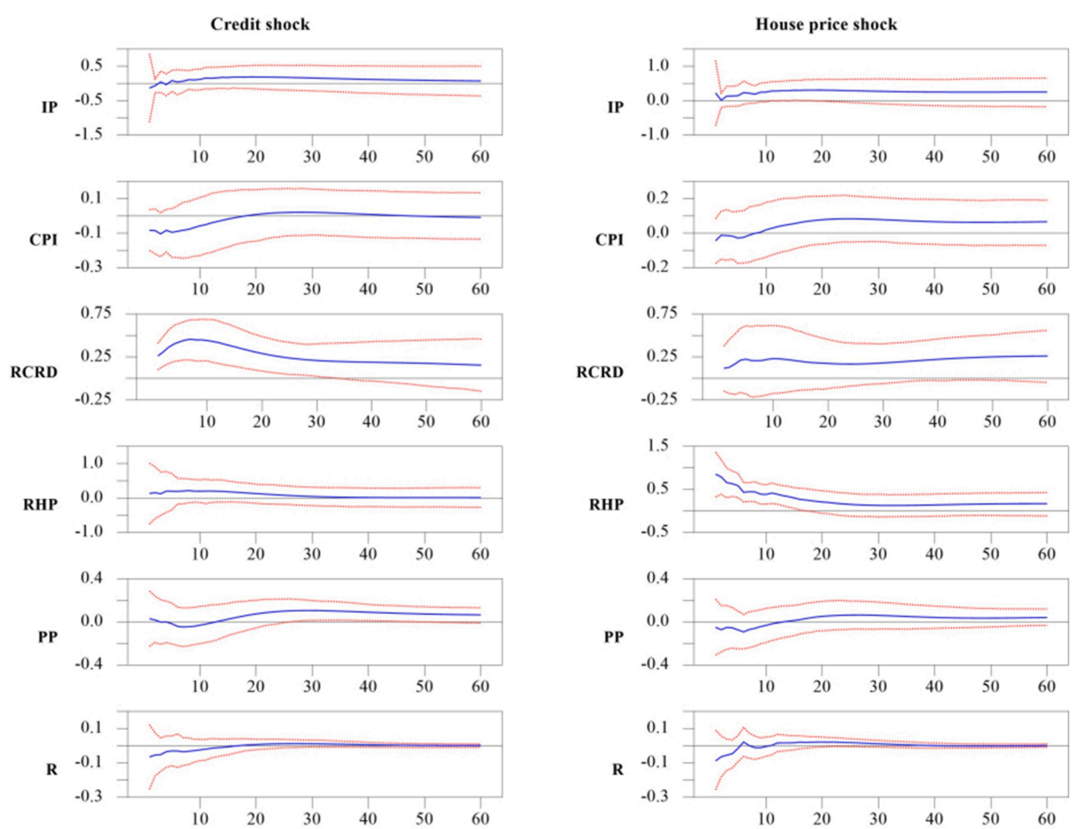

Fig. 8. Impulse Responses to Credit and House Price Shocks. Notes: 1) IP = industrial production, CPI = consumer price index, RCRD = real credit, RHP = real house prices, PP = macroprudential policy measure, R = 7-day repo rate, 2) The solid lines refer to the median impulse responses, and the dotted lines show 68% probability bands.

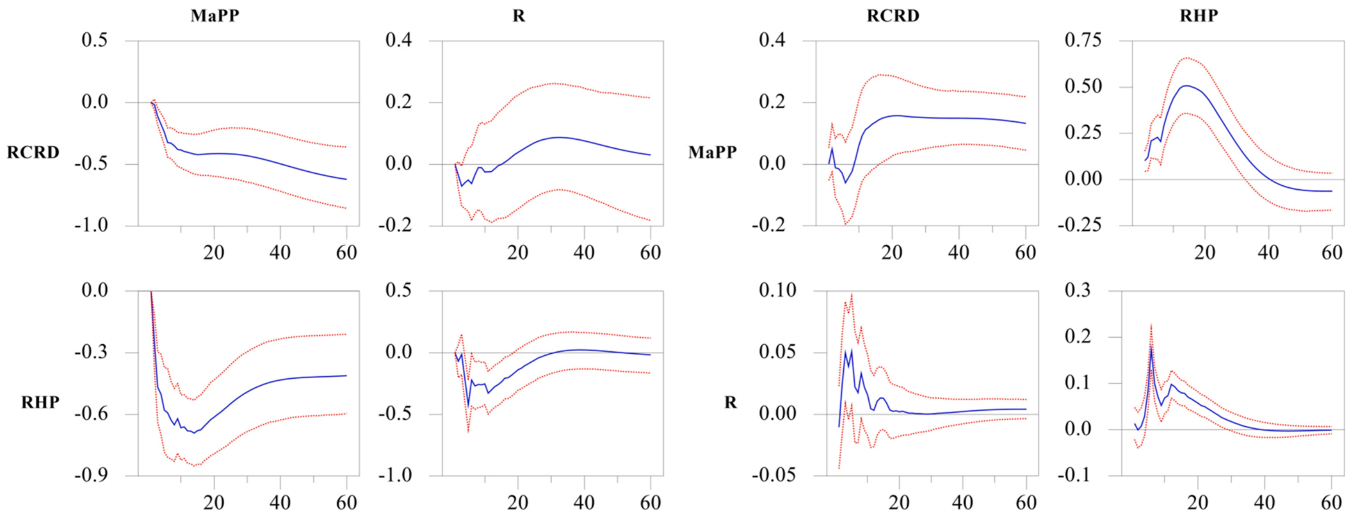

Fig. 9. Selected Impulse Responses: Considering Reserve Requirements. Notes: 1) MaPP = macroprudential policy measure including the reserve requirements, R= 7-day repo rate, RCRD = real credit, RHP = real house prices, 2) The solid lines refer to the median impulse responses, and the dotted lines show 68% probability bands.

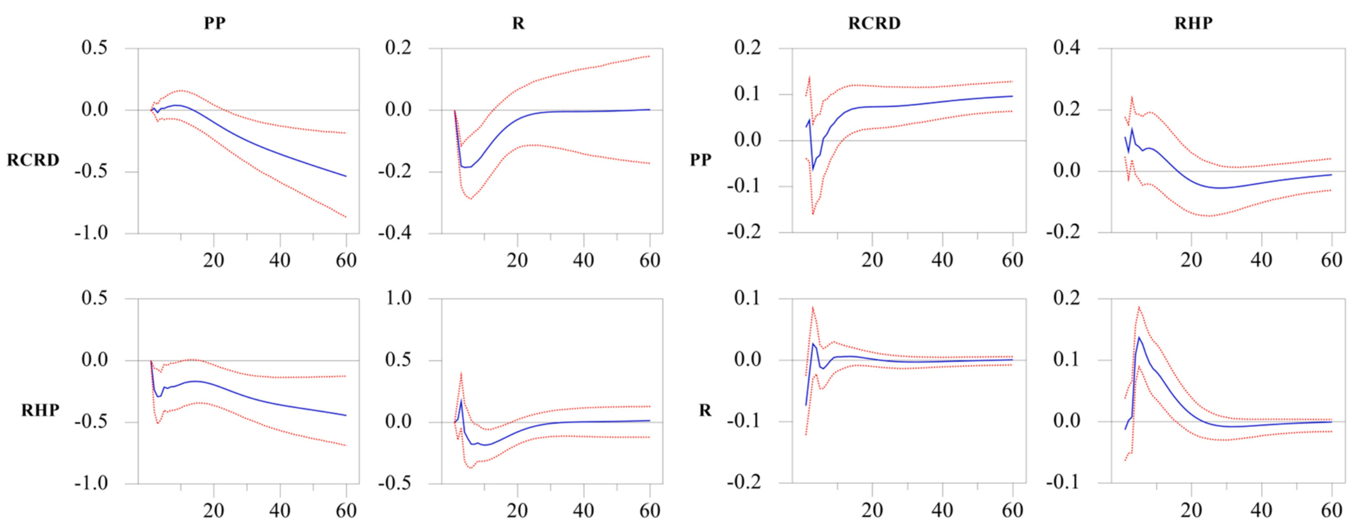

Fig. 10. Selected Impulse Responses: Flexible Exchange Rate Regime. Notes: 1) PP = macroprudential policy measure, R= 7-day repo rate, RCRD = real credit, RHP = real house prices, 2) The solid lines refer to the median impulse responses, and the dotted lines show 68% probability bands.

model.

Next, we investigate the impacts of LOANR shocks in the second column. In response to the LOANR shocks, credit decreases substantially by approximately − 0.6%. House prices also decline by approximately − 0.3%, which is statistically significant from almost 12 months after the shocks. Output decreases in the long run, but price levels have insignificant responses for all horizons, responding to the LOANR shocks.

Overall, the effects of LOANR shocks tend to be stronger than those of LTV shocks, as in the recursive models in the previous section. However, the effects of LOANR shocks tend to be still weaker than those of PP shocks.

Lastly, we consider credit and house price shocks in the model with the sign restrictions. We impose the positive sign on credit and house prices for the initial 12 horizons to identify positive credit and house price shocks, respectively. Each shock is assumed to be orthogonal to monetary and macroprudential policy shocks. The impulse responses to monetary and macroprudential policy shocks are similar to those in Fig. 6, wherein we report only the impulse responses to the credit and house price shocks in Fig. 8.

In response to positive credit shocks (first column), RCRD increases by 0.26% on impact and peaks by approximately 0.45% in the sixth horizon. PP has a positive and significant increase in response to such shocks in the long run, but R responses are insignificant at any of the horizons. This result implies that macroprudential policy stabilizes credit shocks, but monetary policy does not. Interestingly, the results are similar to the results of the model with the recursive identification, but the initial decrease in PP, which is statistically significant in the baseline model, is now insignificant.

In response to positive house price shocks (second column), RHP increases by 0.85% on impact and decreases back to the initial level. PP and R start to increase in approximately a year, but the responses are insignificant. This result differs from that of the recursive models, but it may be because the size of identified house price shocks is much smaller than that of the recursive model.

4.3. Robustness

In this section, we further investigate some extended analyses. First, we experiment with the macroprudential policy index, including the reserve requirements (MaPP henceforth), which is the most frequently used instrument in China. The selected impulse responses with 68% probability bands are shown in Fig. 9. The left panel shows the responses of target variables to policy shocks, and the right panel shows the policy reactions to the credit and house prices shocks.

Regarding the policy effects, credit declines by approximately − 0.62% in the long run in response to MaPP shocks, and such negative responses are significant for all horizons. That is, the effects of macroprudential policies on credit are larger and more significant when considering the reserve requirements. The negative responses of house prices peak by approximately − 0.69% in the 14th horizon, which is larger than those in the baseline case without reserve requirements. These results indicate that the reserve requirements may work as an effective macroprudential tool to stabilize credit and house prices (Wang and Sun, 2013; Klingelhöfer and Sun, 2019).

In response to the credit shocks (the first column in the right panel), macroprudential policy increases significantly from the medium run, which is similar to those in the baseline model. In response to house price shocks (the second column in the right panel), macroprudential policy increases significantly, as in the baseline model. However, the size of the increase is far larger than that in the baseline model, which may suggest that reserve requirements are used to stabilize house prices.

Next, we investigate the policy effects for the subsample period starting from August 2005 because China transitioned from the fixed to the flexible exchange rate regime in July 2005. We include three lags of the endogenous variables as the degree of freedom decreases. The left panel in Fig. 10 shows the impulse responses for the sample period from August 2005 to December 2018. The negative responses of credit and house prices to PP shocks are qualitatively similar to the baseline results. Monetary policy shocks still have significant impacts on credit and house prices. However, these responses tend to be weaker than those in the baseline model.

The right panel reports the impulse responses of policy variables to credit and house price shocks, respectively. The policy responses to credit shocks are qualitatively similar to the baseline results. In response to house price shocks, both monetary and macroprudential policies seem to be tightened, although significant increases in PP are found only in the short run.[15]

5. Conclusion

China, which had experienced a sharp rise in credit and house prices before the COVID-19 pandemic, recently faced a downturn in house prices due to the strong policy regulations and default risk of Evergrande Group, one of the largest property developers in China. As the PBoC is expected to react to the real estate market instability with monetary and macroprudential policies (for example, the recent reserve requirement ratio cut), it is timely and important to investigate the effects and conduct of two policies in China.

This paper investigates the effects of monetary and macroprudential policies on key macroeconomic and financial variables and the responses of two policies to key macro and financial variables. Two types of structural VAR models are employed, the one with recursive zero restrictions and the other with sign restrictions on impulse responses.

The main findings of this paper suggest that macroprudential policies have substantial effects on house prices and credit. More specifically, loan restrictions targeting loan supply are more effective in containing credit and house prices than LTV regulations targeting loan demand. These findings are robust across the various identification assumptions. We also find that macroprudential policies have non-negligible effects on output and price levels.

We also investigate the policy actions to credit and house price shocks. In response to credit shocks, contractionary macroprudential policy is taken, but monetary policy is not. This suggests that macroprudential policy, instead of monetary policy, has been used to stabilize credit conditions.

Data Availability

Data will be made available on request.

Appendix 1. Data Descriptions and Sources

The variables used in the VAR estimation are described below. The data that are not seasonally adjusted by the data provider are seasonally adjusted using X-13 ARIMA, except for the financial variables, such as R and USFFR (Table A.1).

Table A.1
Data Descriptions and Sources.

Variable Name	Description	Source
IP	Industrial Production	CEIC
CPI	Consumer Price Index, 2010 = 100	CEIC
RCRD	Outstanding Loans from financial institutions	CEIC
RHP	Property Price: YTD Avg: Residential	CEIC
PP	Macroprudential Policy Index	Alam et al. (2019)
R	7-Day Repo Rate	CEIC
USIP	US Industrial Production	FRED
USFFR	Effective Federal Funds Rate, average of period, %	FRED

[15] We also performed the experiments for robustness checks (including reserve requirements and considering the sub-period) in models with sign restrictions. The policy effects and responses to credit and house price shocks are qualitatively similar but less significant. The results are reported in Appendix 3.

Appendix 2. Alternative Identifying Assumptions on Macroprudential Policy Shocks

Figure A.1

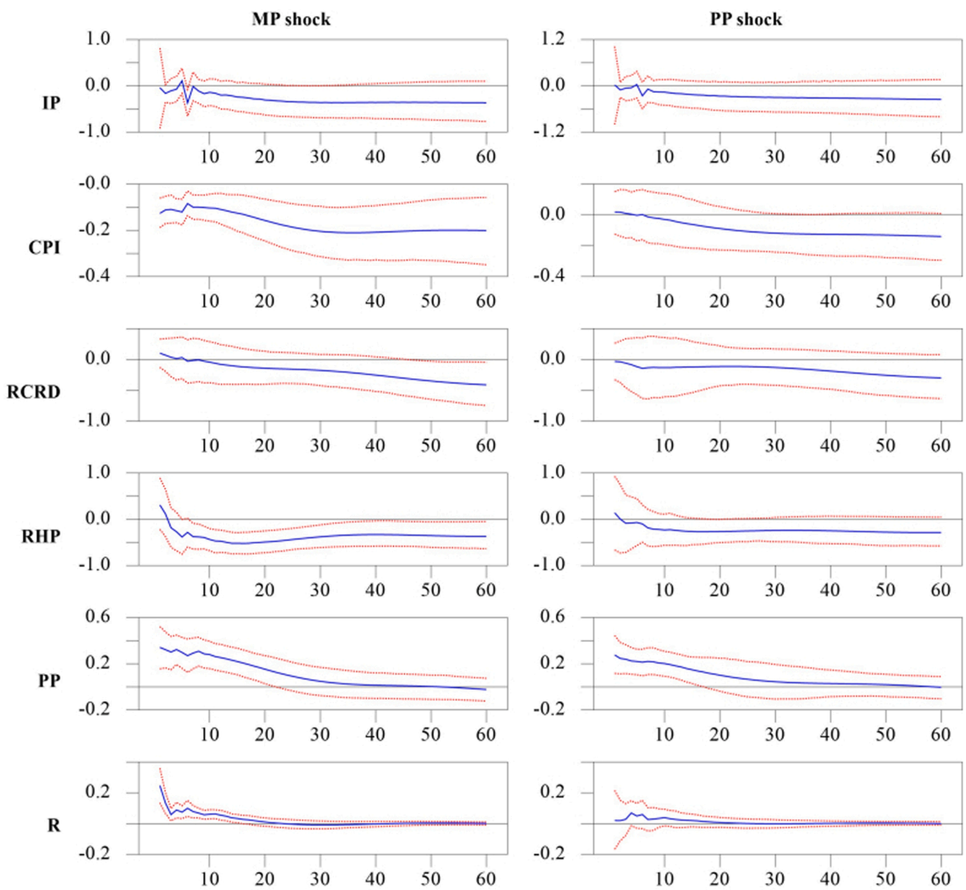

Fig. A.1. Impulse Responses: Alternative Macroprudential Policy Shocks. Note: The solid lines refer to the median impulse responses, and the dotted lines show 68% probability bands.

Appendix 3. Robustness Check with Sign Restriction

Figure A.2 and A.3

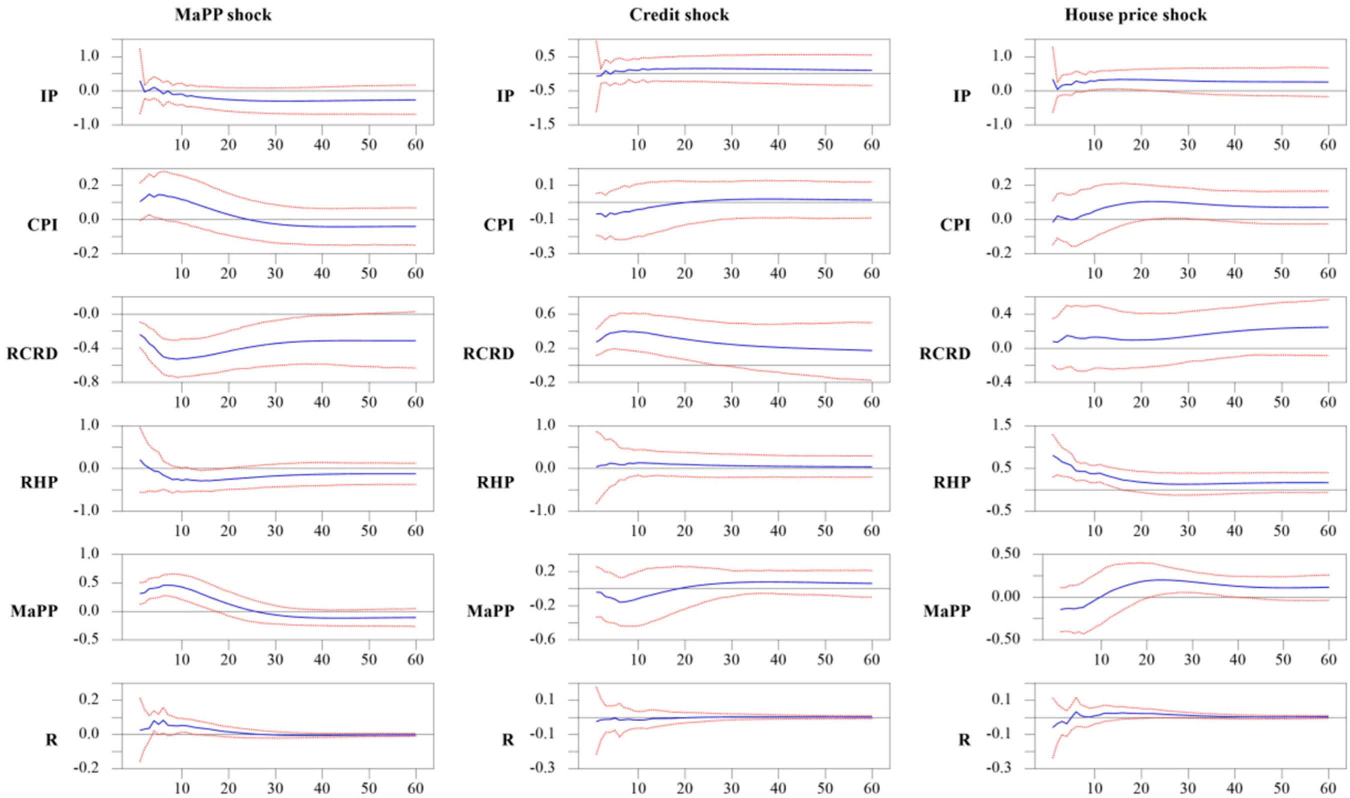

Fig. A.2. Impulse Responses with Sign Restrictions: Considering Reserve Requirements. Note: The solid lines refer to the median impulse responses, and the dotted lines show 68% probability bands.

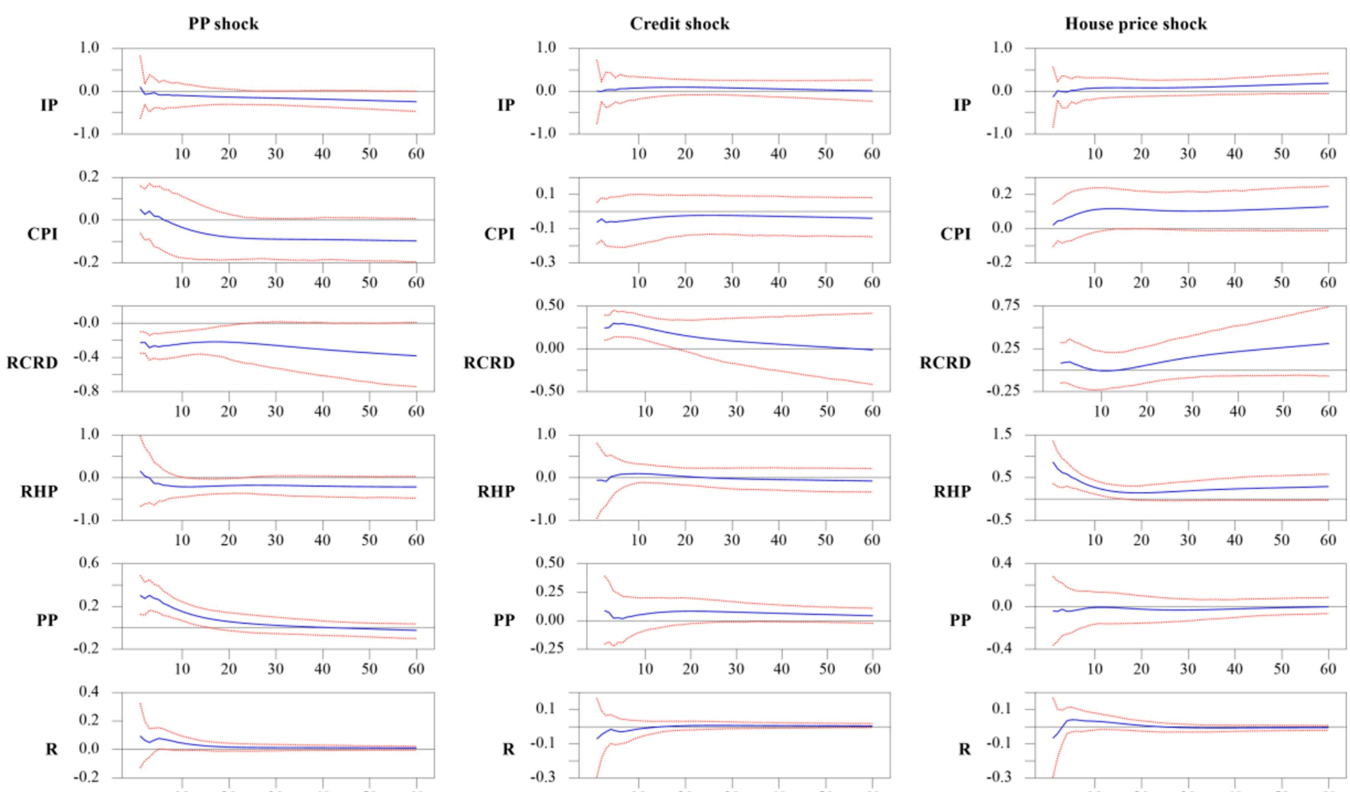

Fig. A.3. Impulse Responses with Sign Restrictions: Flexible Exchange Rate Regime. Note: The solid lines refer to the median impulse responses, and the dotted lines show 68% probability bands.

Appendix 4. Experiments with Quarterly Data

Figure A.4 and A.5

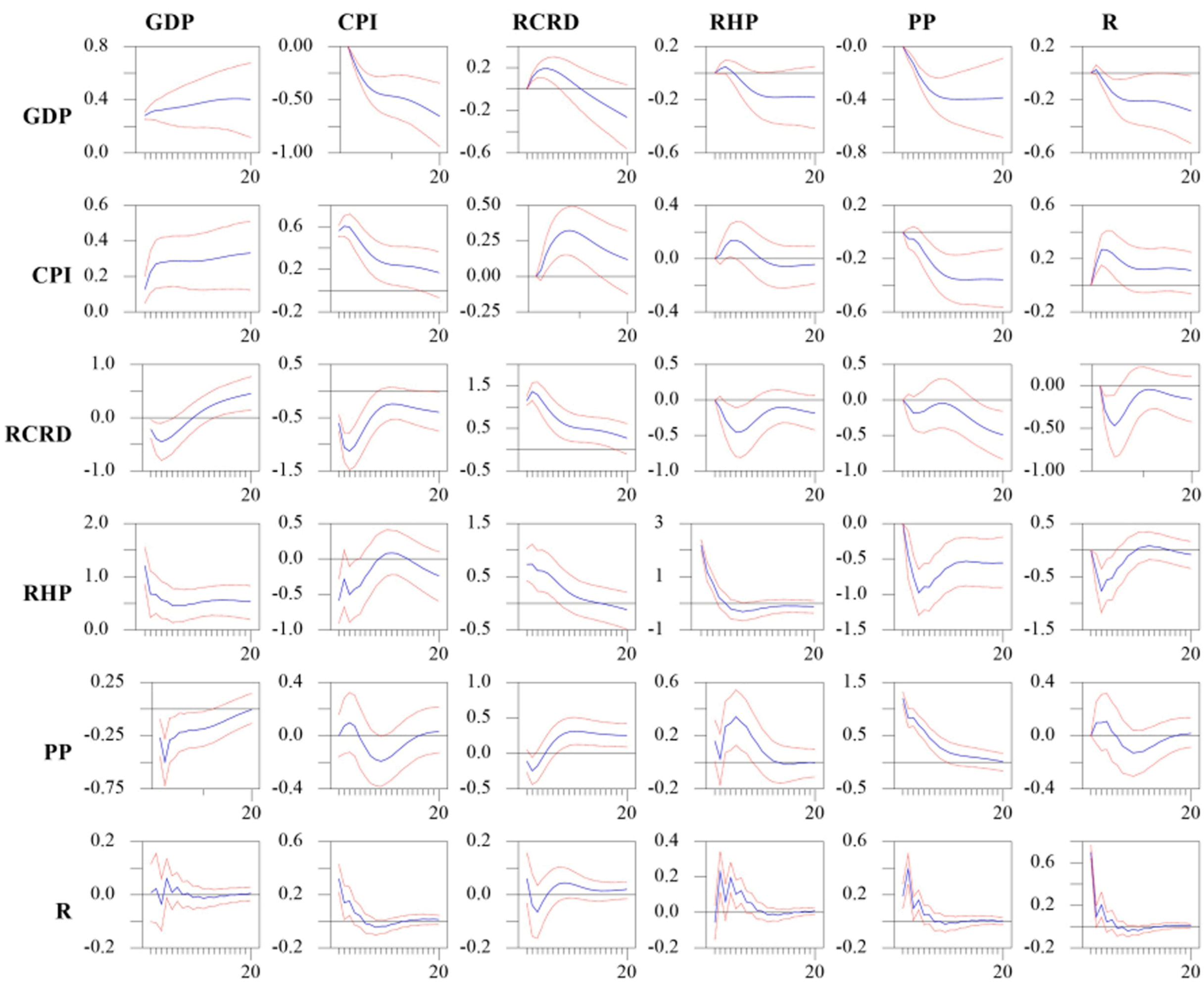

Fig. A.4. Impulse Responses with Recursive Restrictions. Note: The solid lines refer to the median impulse responses, and the dotted lines show 68% probability bands.

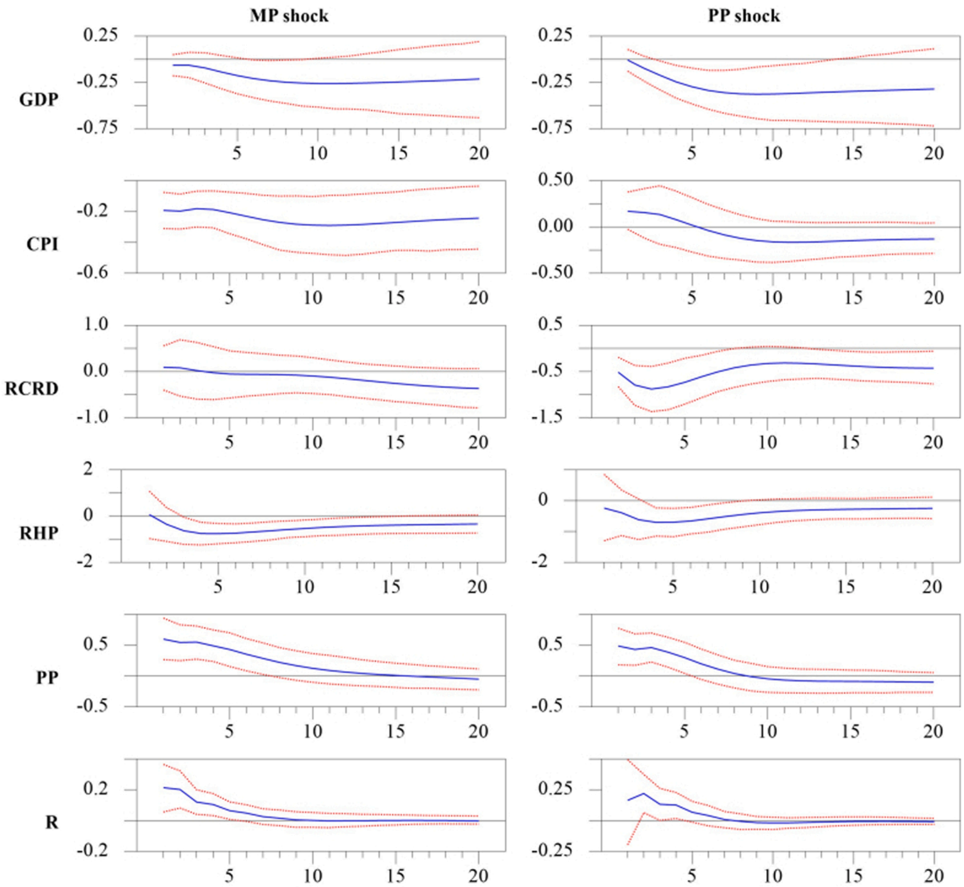

Fig. A.5. Impulse Responses with Sign Restrictions. Note: The solid lines refer to the median impulse responses, and the dotted lines show 68% probability bands.

References

Aiyar, S., Calomiris, C.W., Wieladek, T., 2014. Does macro-prudential regulation leak? Evidence from a UK policy experiment. J. Money, Credit Bank. 46 (s1), 181–214.

Akinci, O., Olmstead-Rumsey, J., 2018. How effective are macroprudential policies? An empirical investigation. J. Financ. Inter. 33, 33–57.

Alam, Z., Alter, M.A., Eiseman, J., Gelos, M.R., Kang, M.H., Narita, M.M., Wang, N., 2019. Digging deeper – evidence on the effects of macroprudential policies from a new database. IMF Work. Pap. (066).

Alpanda, S., Zubairy, S., 2017. Addressing household indebtedness: monetary, fiscal or macroprudential policy? Eur. Econ. Rev. 92, 47–73.

Amstad, M., Sun, G., Xiong, W., 2020. The Handbook of China's Financial System. Princeton University Press, Princeton. https://doi.org/10.1515/9780691205847.

Angelini, P., Neri, S., Panetta, F., 2014. The interaction between capital requirements and monetary policy. J. Money, Credit Bank. 46 (6), 1073–1112.

Cerutti, E., Claessens, S., Laeven, L., 2017. The use and effectiveness of macroprudential policies: New evidence. J. Financ. Stab. 28, 203–224.

Gelain, P., Ilbas, P., 2017. Monetary and macroprudential policies in an estimated model with financial intermediation. J. Econ. Dyn. Control 78, 164–189.

Jiang, Y., Li, C., Zhang, J., Zhou, X., 2019. Financial stability and sustainability under the coordination of monetary policy and macroprudential policy: New evidence from China. Sustainability 11 (6), 1616.

Kim, J., Kim, S., Mehrotra, A., 2019. Macroprudential policy in Asia. J. Asian Econ. 65, 101149.

Kim, S., Chen, H., 2022. From a quantity to an interest rate-based framework: multiple monetary policy instruments and their effects in China. J. Money, Credit Bank. 54 (7), 2103–2123.

Kim, S., Mehrotra, A., 2017. Managing price and financial stability objectives in inflation targeting economies in Asia and the Pacific. J. Financ. Stab. 29, 106–116.

Kim, S., Mehrotra, A., 2018. Effects of monetary and macroprudential policies—evidence from four inflation targeting economies. J. Money, Credit Bank. 50 (5), 967–992.

Kim, S., Mehrotra, A., 2022. Examining macroprudential policy and its macroeconomic effects – some new evidence. J. Int. Money Financ. 128, 102697.

Kim, S., Shim, S., 2022. Measuring the effects of LTV and DTI limits: a heterogeneous panel VAR approach with sign restrictions. BOK Work. 2022–2023.

Kim, S., Mehrotra, A., & Shim, S. (2022). Governance arrangements and the use of macroprudential policy. Working Paper.

Klingelhöfer, J., Sun, R., 2019. Macroprudential policy, central banks and financial stability: evidence from China. J. Int. Money Financ. 93, 19–41.

Kuttner, K.N., Shim, I., 2016. Can non-interest rate policies stabilize housing markets? Evidence from a panel of 57 economies. J. Financ. Stab. 26, 31–44.

Mountford, A., Uhlig, H., 2009. What are the effects of fiscal policy shocks? J. Appl. Econ. 24 (6), 960–992.

Quint, D., Rabanal, P., 2014. Monetary and macroprudential policy in an estimated DSGE model of the Euro area. Int. J. Cent. Bank.

Richter, B., Schularick, M., Shim, I., 2019. The costs of macroprudential policy. J. Int. Econ. 118, 263–282.

Sims, C.A., 1988. Bayesian skepticism on unit root econometrics. J. Econ. Dyn. Control 12 (2–3), 463–474.

Sims, C.A., 1992. Interpreting the macroeconomic time series facts: the effects of monetary policy. Eur. Econ. Rev. 36 (5), 975–1000.

Sims, C.A., Uhlig, H., 1991. Understanding unit rooters: a helicopter tour. Économ.: J. Econom. Soc. 1591–1599.

Sinclair, P., Sun, L., 2021. China's monetary and macroprudential policies: are they complementary or substitutive? CESifo Econ. Stud. 67 (2), 186–209.

Uhlig, H., 2005. What are the effects of monetary policy on output? Results from an agnostic identification procedure. J. Monet. Econ. 52 (2), 381–419.

Wang, M.B., & Sun, T. (2013). How effective are macroprudential policies in China?. IMF Working Paper No.13/75.

Wei, X., Li, J., Han, L., 2020. Optimal targeted reduction in reserve requirement ratio in China. Econ. Model. 85, 1–15.